ABSTRACTS

ORAL TALKS

*student presenter

THURSDAY SESSIONS

SEAGRASS

Uncertainties and sampling patterns in global biological collections of marine plants

Barnabas H. Daru

Herbarium records of terrestrial plants are nonrandomly collected and suffer from a number of significant data gaps and biases in multiple dimensions, potentially leading to spurious conclusions. Just as the occurrence records of terrestrial biodiversity is limited and prevalent with gaps and uncertainties, our knowledge of marine biodiversity might be characterized by key data gaps and sampling biases. Seagrasses and mangroves constitute the only vascular flowering plants in the marine environment, anchoring several marine food chains and are under threat from anthropogenic activities. Yet, the only data available for studying marine plants at large scales are expert-opinion range maps derived from opportunistic records, sightings and specimen collections, and might be characterized by nonrandom sampling. In this study, I mapped the spatial, phylogenetic and temporal distributions of marine plants (seagrasses and mangroves) at a global scale using global datasets to examine key data gaps. I discuss significant gaps in marine plants diversity data across the world's coastal regions, and provide solutions for the biases inherent in these biological collections.

Seagrass status, distribution, and community composition at the Chandeleur Islands, Louisiana

Kelly M. Darnell; Christian T. Hayes; M. Zachary Darnell

The Chandeleur Islands are a chain of barrier islands in the northern Gulf of Mexico that are located approximately 30 km offshore, support the only marine seagrass beds in Louisiana, and are the sole location of the climax seagrass species turtlegrass (*Thalassia testudinum*) across nearly 1,000 km of the Gulf Coast from west Florida to central Texas. Seagrass beds at the Chandeleur Islands are considered relatively pristine, because of the inaccessibility of the Islands and lack of direct human impacts; however, this area is a hotspot for dynamic changes in seagrass cover, as seagrass presence relies on the protection provided by land area, which has decreased by over half during the last 150 years. Long-term monitoring of seagrass beds provides valuable information on bed status and trends, can inform predictions under future scenarios, and is an essential component of ecosystem-based and adaptive management. Seagrass monitoring at the Islands has been sporadic, often coinciding with a major disturbance such as a hurricane or oil spill, and monitoring methodologies have not been standardized, making quantification of changes in cover and community composition difficult. In 2018, we established a long-term monitoring program of seagrasses at the Chandeleur Islands following the widely-used and recommended tiered monitoring approach. Here, we present the results of our first year of monitoring, combined with a finer-scale assessment of turtlegrass distribution and plant biomass, and frame these results in the context of previous monitoring efforts along the Islands.

In the wake of a major hurricane: Differential impacts on early versus late successional seagrass species

Victoria M. Congdon; Christina E. Bonsell; Meaghan R. Cuddy; Kenneth H. Dunton*

Severe meteorological events can impart extensive damage on coastal ecosystems depending on the intensity and proximity to the storm. Hurricane Harvey battered the Texas coast on August 25, 2017 with maximum winds of 130 knots and produced prolific rainfall as the storm stalled over the state. To assess the immediate impacts of this major hurricane on coastal marine ecosystems, we examined the response of two seagrass species and sediment dynamics to storm intensity. Following the landfall of Hurricane Harvey, we obtained measurements of percent cover and blade length for the dominant seagrass species, *Halodule wrightii* and *Thalassia testudinum*, at 525 permanent stations along the Texas coast. We collected sediment cores for the analyses of total organic carbon (TOC), grain size, and ammonium from a bay exposed to the storm's eyewall. We compared post-storm measurements to pre-hurricane observations from the most previous sampling year for all analyses. For both species, greater wind intensity corresponded with a significant decrease in mean blade lengths relative to pre-storm measurements (R2 *T. testudinum*=0.42, R2 *H. wrightii*=0.05). Only *T. testudinum* displayed significant reductions in percent cover (R2 *T. testudinum*=0.13, R2 *H. wrightii*=0.01) with some stations exhibiting complete loss of aboveground and belowground biomass. We did not observe a difference in sediment ammonium concentrations or TOC. We found significant differences among groups for rubble, sand, silt, and clay percentages (ANOVA, α=0.05) with a shift to sand-dominated sediments. The variance in the grain sizes of the post-hurricane measurements relative to pre-storm compositions suggest the redistribution of sediments in remnant seagrass beds. Our observations document the acute effects of wind intensity on habitat structure in response to a category 4 hurricane. The poor colonization abilities of *T. testudinum* coupled with the changes in sediment composition may prolong the recovery of seagrass meadows directly impacted by Hurricane Harvey.

Evaluating a seagrass productivity model for the Lower Laguna Madre

Hudson R. DeYoe; Warren M. Pulich Jr.; Nicole Laas; John N. Garcia

The Lower Laguna Madre (LLM) is a unique and ecologically important region in the northwestern Gulf of Mexico, and is known for its extensive seagrass beds (over 60% of the total seagrass in TX). Although highly productive and relatively healthy, the LLM is changing, and in particular its extensive seagrass beds have undergone a steady decline in percent cover over the past two decades and seagrass community composition has been changing as well. This study relates to the sustainability of LLM seagrass by focusing on landscape dynamics in particular seagrass gap dynamics. Field sites were identified for study that all had *Thalassia* seagrass meadow bare patches (gaps) but had differences in water and sediment characteristics. Based on previous studies, nine photosites were selected to obtain current color aerial photography covering the area from the Arroyo Colorado to Port Isabel. Four sites were chosen for detailed field studies and monitoring and 5 to 8 bare patches in each of the four sites were identified and marked. Boat surveys and ground truthing was done to assess whether bare patches changed in size or shape. In addition, seagrass biomass and growth measurements were taken at each bare patch to assess on a fine scale seagrass change. Imagery confirmed by ground truthing suggested that the bare patches regardless of field site within this one year study did not change in size.

Nekton use of turtlegrass across the northern Gulf of Mexico

Christian T. Hayes; M. Zachary Darnell; Lee D. Smee; Charlie W. Martin; Brad T. Furman; Kelly M. Darnell*

Seagrass meadows in the northern Gulf of Mexico provide critical nursery habitat for a diverse assemblage of fishes and invertebrates, many of which support recreational and commercial fisheries. We conducted a simultaneous trawl survey of nekton in turtlegrass (*Thalassia testudinum*) beds during summer 2018 at six sites across the northern Gulf of Mexico (Apalachicola, FL; Cedar Key, FL; Charlotte Harbor, FL; Chandeleur Islands, LA; Redfish Bay, TX; and Lower Laguna Madre, TX) to assess nekton use of this widespread sub-tropical seagrass species across its' range in the region. We examined differences in nekton abundance, biomass, and diversity across sites and relationships with turtlegrass structure. Dominant species collected in trawl surveys included pinfish (*Lagodon rhomboides*), pigfish (*Orthopristis chrysoptera*), and multiple species of drum, pipefish, goby, and penaeid shrimp. Two-minute trawl tows regularly collected more than 500 individuals (all species combined) with biomass exceeding 3 kg, which reinforces the importance of turtlegrass as essential fish habitat throughout the region. This study provides important information on nekton use of turtlegrass across an unprecedentedly large scale and can be used to inform adaptive management and restoration efforts.

Seagrass impacts on porewater biogeochemistry: A comparison of 4 species

Mackenzie Rothfus; Katherina Smyth; Florian Cesbron; Jane M. Caffrey*

Marine ecosystems rely heavily on seagrass productivity ensuring both a stable and healthy environment. The Pensacola Bay system in Florida is home to several seagrass species where environmental conditions and nutrient concentrations vary along different locations within the Estuary. This study focuses on the relationship between nutrient porewater concentrations found in relation to the belowground biomass distribution of four seagrass species within Pensacola Bay*: Halodule wrightii, Thalassia testudinum, Ruppia maritima* and *Vallisneria americana*. Biomass for each seagrass bed sampled in September and June, sorted into aboveground and belowground biomass, with belowground separated into 2 cm depth intervals, dried and weighed. Ammonium, phosphate, sulfide, and iron concentrations within porewater and overlying water for each seagrass bed sampled were analyzed and compiled to understand how each species may affect and utilize these nutrients. Seasonal fluctuation and variation in nutrient concentration were observed along with higher nutrient concentration found in the sediment porewaters. With higher nutrients observed in sediment porewaters, seagrass roots and rhizomes are likely to play a major role in nutrient acquisition. Comparing biomass and nutrient concentration shows us how different species of seagrass utilize nutrients within Pensacola Bay system relative to their abiotic environment.

WATER QUALITY

Molecular characteristics of dissolved organic matter from three South Texas rivers: Insights provided by thermal slicing pyrolysis gas chromatography mass spectrometry and amino acid analysis

John A. O'Connor; Kaijun J. Lu; Jianhong Xue; Zhanfei Liu*

River transport of dissolved organic matter (DOM) provides a crucial energy subsidy to coastal ecosystems through remineralization processes. Understanding both the quantity and the molecular

characteristics of riverine DOM is key to understanding the potential for coastal DOM remineralization. In South Texas, there is extreme interannual variability in hydrologic controls on freshwater inputs from rivers to coastal embayments, and thus total DOM transport. Utilizing three coastal rivers from three distinct watersheds, the Mission, Aransas, and Nueces Rivers, we sought to decipher variability in both quantity and quality of the South Texas riverine DOM matrix with a unique thermal slicing pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) technique. River water, collected in June of 2017 and January of 2018, was pre-filtered before DOM isolation by solid phase extraction (SPE). SPE-DOM was pyrolyzed at five thermal slices before chromatographic separation then molecule identification by mass spectrometry. The thermal stability of each river's DOM matrix was similar, as ~90% of all pyrolyzates were released between 190 and 530°C. Of the pyrolyzates detected, there were 14 significant compound classes, and their proportions varied tremendously between rivers. However, methanol, acetic, benzenes, and CO2, likely sourced from polysaccharides, lignin-like materials, and carboxyl-rich alicyclic molecules, were predominant in all rivers. Results of total hydrolysable amino acids (THAA) analysis also showed consistent amino acid composition in these DOM samples, dominated by aspartic acid, glycine, beta-alanine, and alanine. Analysis for $\delta^{13}C$, $\delta^{15}N$, C:N, and %-OC are ongoing, but the preliminary results show that the DOM isolated by SPE is compositionally similar among the three rivers, and no seasonal trend was observed between diagenetic state and molecular diversity. Despite different sources and hydrologic conditions driving differences between proportions of compound classes, DOM characteristics between these rivers showed little variability.

Synthesis of water quality studies in Baffin Bay with a view towards solutions

Michael S. Wetz; Emily K. Cira; Kenneth C. Hayes

Baffin Bay is an economically and ecologically-important estuary on the South Texas coast. In the past few decades however, it has begun to exhibit symptoms of eutrophication including high and increasing chlorophyll concentrations, episodic hypoxia/anoxia, recurring blooms of the harmful brown tide alga *Aureoumbra lagunensis*, and fish kills. Unfortunately, our understanding of the causes of the water quality degradation has been limited due to lack of data. Results from a 5-year (ongoing) water quality study as well as analysis of historical TCEQ data is now providing answers. Results show that dissolved organic nitrogen and total Kjeldahl nitrogen concentrations in Baffin Bay are 2-5 fold higher than in other Texas estuaries. In contrast, inorganic nitrogen (ammonium, nitrate) and phosphate concentrations are relatively low except following episodic rain events. The dominance of organic nutrients compared to inorganic nutrients, prolonged hypersaline conditions during drought, and a long-term increase in spring-summer water temperature create conditions favorable for "brown tide" persistence in this system. Given the long residence time (> 1 year) of Baffin Bay, the system is likely sensitive to nutrient inputs and thus reductions in loadings are be needed to prevent further water quality degradation.

Long-term water quality trends in Texas estuaries: Relationships with climatic variability and watershed land use change

Kalman Bugica; Blair Sterba-Boatwright; Michael S. Wetz*

Estuaries are critical habitats for numerous bird, fish, and shellfish species, and they play a critical role in the economy of coastal communities. Despite this, eutrophication, with accompanying water quality and habitat degradation, is becoming pervasive in many estuarine systems. Here we report findings from a study of long-term changes in water quality in 40 bays along the Texas coast. Seasonal increases in water temperature were observed for most systems, as were annual increases in salinity. Indicators of

eutrophication were found throughout Texas coastal waters, from small systems (e.g., Oso Bay and Carancahua Bay) to larger estuaries (e.g., Galveston Bay). One heavily impacted area is the Upper Laguna Madre, which includes Baffin Bay. Baffin Bay displayed multiple symptoms of eutrophication including high organic carbon, organic nitrogen, and chlorophyll concentrations. In addition, statistically significant long-term annual increases in chlorophyll a and salinity were observed, while long-term seasonal increases were observed for water temperature. Much of the increase in chlorophyll coincided with blooms of the mixotrophic "brown tide" phytoplankton species, Aureoumbra lagunensis, which is thought to be favored under high proportions of organic to inorganic nitrogen. One notable exception to the widespread eutrophic conditions found throughout coastal Texas was the Nueces-Corpus Christi Bay system, which conversely displayed symptoms of oligotrophication. Annual and seasonal decreases in phytoplankton biomass, including during the winter-spring bloom period, are occurring. These varied shifts in Texas water quality, combined with land use changes and population growth, can have serious implications for the benthos and fisheries of Texas. Identified systems of poor water quality can be used to drive future higher resolution studies to better understand potential drivers of changes in estuarine health.

Hydrology, water chemistry and biological indicators used to assess effects of treated effluent flowing via groundwater to the Lower Laguna Madre

Rosamarie Perdomo; John Garcia; Eli Gonzalez; Chu-Lin Cheng; Hudson R. DeYoe*

Water treated by the Laguna Vista Waste Water Treatment Plant contains nutrients such as ammonium, nitrate, and phosphate that can lead to nutrient loading of adjacent coastal water. The effluent is released into a designated and confined reservoir about 1.5 km from the shores of the Lower Laguna Madre. Our research indicates that elevated levels of nutrients observed in the surface water of the reservoir enters the water-table and flows towards the lagoon possibly affecting the lagoon ecosystem. This study monitored hydraulic flow of the pond effluent, water composition of surface and groundwater. Potential environmental effects were assessed by use of nitrogen isotopic analysis of common coastal vegetation- black mangrove *Avicennia germinans*, turtlegrass *Thalassia testudinum* and honey mesquite *Prosopis glandulosa*. The presence of effluent sourced nutrients should affect the nitrogen isotopic signature of these plants. Examination of chlorophyll, and *E. coli* presence will be used this fall to assess environmental health in areas where effluent flows outside reservoir boundaries.

Comparative analysis of nitrate levels in Pensacola Bay area rain water

Jade Jacobs; Jane Caffrey; William Landing; Alexander Maestre; Subhash Bagui*

There is reason to believe that there is a correlation between atmospheric NOx levels and nitrate levels of rain water. This specific link between air and water quality was tested over a course of summer 2017 and compared to data from 2005-2012. Rain water samples collected from late May through early July of 2017 were tested for their pH levels and nitrate concentrations. These months were one of the stormiest on record for the Northwest Florida region. The data analyzed from these rain events was compared to previous data through the PERCH study (2005-2012 data) to show the trends of nitrate and pH levels in the rainwater since the project's conclusion. According to the paper published as part of the PERCH study, "There was a significant drop in deposition and VWM concentrations between 2006 and 2007," (Caffrey 2013) suspected to be caused by the implementation of a scrubber at Plant Crist coal fired power plant in 2007. Following analysis, a statistical comparison testing for correlation between atmospheric NOx and rainwater NO3 was run to determine broader impacts on both air and water

quality.

Sediment nitrogen cycling and removal in tidal freshwater zones of two Texas rivers

Xin Xu; Hengchen Wei; Kevan Moffett; James McClelland; Amber Hardison*

Nitrogen is the major limiting nutrient in marine ecosystems, and river-borne sources provide 20-30% of nitrogen input to global oceans. Tidal freshwater zones (TFZs) in the lower reaches of rivers may substantially alter the amount and composition of nitrogen transported from watersheds to estuaries due to longer water residence times (compared to non-tidal river reaches) and associated build-up of organic-rich sediments. We conducted flow-through sediment core incubations from TFZs and upstream riverine sites in the Aransas and Mission rivers in south Texas during multiple seasons and years. We measured net fluxes of different constituents (O2, N2, DIC, NH4+, NO3-) across the sediment-water interface to quantify organic matter decomposition and major nitrogen cycling processes. Our results showed higher respiration and denitrification rates in TFZ sediments than in non-tidal riverine sediments. Average O2 fluxes were -771±35 μmol m-2 hr-1 and -797±69 μmol m-2 hr-1 in summer in the Aransas River TFZ (AR) and the Mission River TFZ (MR), respectively; and -363±38 μmol m-2 hr-1 and -484±70 μmol m-2 hr-1 in winter, with negative values indicating net O2 consumption. Average N2 fluxes were 53±8 μmol m-2 hr-1 (AR) and 22±5 μmol m-2 hr-1 (MR) in summer and 36±8 μmol m-2 hr-1 (AR) and 30±6 μmol m-2 hr-1 (MR) in winter, with positive values indicating net denitrification. Average dissolved inorganic nitrogen (DIN) fluxes were 49±9 μmol m-2 hr-1 (AR) and 106±9 μmol m-2 hr-1 (MR) in summer, and -12±11 μmol m-2 hr-1 (AR) and 22±6 μmol m-2 hr-1 (MR) in winter, with negative values indicating net DIN removal. Within the TFZs, rates of biogeochemical processes varied as a function of sediment physical properties, nutrient loading, and seasonal temperature changes.

CARBON CYCLE

Fiddler crab burrowing and oil pollution alter greenhouse gas fluxes from salt marsh soil

Charles A. Schutte; Adrianna Grow; Scott Jones; Brian Roberts

Coastal wetland soils are important sites of carbon burial that can mitigate the intensity of carbon-induced climate change. However, soil microbial processes produce potent greenhouse gases, such as carbon dioxide and methane, which can then be released into the atmosphere and offset some of the climate benefit provided by carbon burial. A great deal is known about the influence of seasons, tides, and salinity on salt marsh greenhouse gas emissions, but little effort has been devoted to determining their responses to natural and anthropogenic disturbances. In this study, we specifically evaluate how fiddler crab (*Uca longisignalis*) bioturbation and oil pollution affect the fluxes of carbon dioxide and methane from Louisiana salt marsh soil. This study included three burrow treatments (no burrow, artificial burrow, and crab-made burrow) and four oil treatments with oil concentrations of 0 mg cm-2, 0.85 mg cm-2, 8.52 mg cm-2, and 25.55 mg cm-2. Soil microcosms were incubated for five days after which carbon dioxide and methane fluxes were measured using a field gas analyzer and the microcosms were extruded to quantify burrow size and depth. Oil concentration did not affect carbon dioxide fluxes, but methane fluxes were significantly lower in the high oil treatment than in the other treatments. We found a linear relationship between the mass of burrowed material and the carbon dioxide flux, but burrow size did not influence the methane flux. Instead, we determined in a follow-up experiment that burrows of any size were sufficient to drive an enhanced methane flux. Our study demonstrates the potential of both natural and anthropogenic disturbances to alter salt marsh soil greenhouse gas fluxes, but more work is required to determine their influence on the ecosystem scale.

Diel variation in carbon fluxes and photosynthetic efficiency in salt marsh ecosystems
Brian J. Roberts; Scott Jones; Herbert Leavett; Ryann Rossi; Charles Schutte

Wetlands are globally important sites for carbon sequestration accounting for 44 million metric tons of carbon per year and can also be large sources of methane (CH4) to the atmosphere. Sequestration occurs via a net flux of carbon dioxide (CO2) into the soil as a result of photosynthesis exceeding respiration and through direct deposition of organic carbon onto marsh platforms. Much of our current knowledge of marsh carbon fluxes is based on sampling during windows of anticipated maximal photosynthesis limiting our understanding of diel variation in these important fluxes In this study, we took advantage of a new *Spartina alterniflora* marsh mesocosm (2.7m diameter) facility in which we were able to maintain constant water levels in 4 marshes over a diel cycle, allowing us to decouple variation due to diel patterns from flooding regime seen in natural marshes. We measured CO2 and CH4 fluxes in 3 types of static chambers (light and dark plant chambers and a dark soil chamber located between stems) in each of 4 marshes at 7 time points over a diel cycle. Simultaneously, we measured photosynthetic yield on a leaf from five stems in each gas flux plot at the same frequency. There was essentially no net CO2 emission in early morning and late afternoon (despite the sun being up), high net influxes into the soil during the midday and net emission to the atmosphere at night. In term of photosynthetic parameters, the slope of the response in electron transport rate (ETR) with increasing light (alpha) was higher during day than night but didn't vary throughout the illuminated period. In contrast, maximum electron transport rate (ETRmax) followed a very similar pattern to that observed for CO2 fluxes. These results have important implications for scaling discrete measures of gas fluxes into wetland carbon cycling and sequestration models.

Anthropogenic inputs enhance CH4 and CO2 values in the Hudson River Estuary
Brian A. Brigham; Jeffrey A. Bird; Andrew R. Juhl; Angel D. Montero; Gregory D. O'Mullan

The tidal Hudson River Estuary (HRE) receives significant inputs of readily dissolvable carbon and nitrogen from wastewater treatment concentrated in urban areas. The largest urban metros, New York City (NYC) and Albany are located at the terminal ends of the tidal HRE with varied levels of salinity as well as terrestrial and anthropogenic inputs found in intervening waters. Over the course of ten cruises, we quantified carbon dioxide (CO2) and methane (CH4) surface concentrations in parallel with biogeochemical parameters including anthropogenic indicators throughout the tidal Hudson River, its embayments, and tributaries. Additionally, efflux values were calculated from mid-channel sites utilizing a series of meteorological towers. Greatest surface concentrations were found in urban embayments, likely to be sewage delivery areas, with diminishing concentrations observed at urban followed by less developed mid-channel sites. CH4 and CO2 surface concentrations were also correlated with salinity, oxygen saturation, fecal indicator bacteria, and temperature with multiple regression analyses producing models with high predictive power. The HRE was found to be both a CO2 and CH4 source for every site and almost all (>99%) sampling dates. The greatest combined effluxes (37 - 289 mg C m-2 day-1) were quantified in close proximity to NYC and Albany. Conversely, the lowest combined effluxes (14.3 - 140 mg C m-2 day) were quantified in suburban/rural regions. If climate warming potential is considered, the ratio of efflux between urban: suburban/rural was due to (77%) CH4 efflux. However, large variation in efflux values were driven by pervasive variability in windspeed data which obfuscated potential differences in urban vs. nondeveloped regions of the HRE. The magnitude of elevated CH4 and CO2 surface concentrations/efflux observed here can be used to evaluate the potential climate impact coastal mega cities have on estuaries.

Elevated temperature and atmospheric CO2 impacts on tidal freshwater forest and oligohaline marsh resilience and ecosystem services

Courtney T. Hall; Camille L. Stagg; Ken W. Krauss; Kim Hamm; Darren Johnson

Multiple environmental drivers, including sea-level rise, storm intensity and frequency, precipitation, elevated temperature and atmospheric carbon dioxide (CO2), will impact coastal wetland resilience and ecosystem services. Understanding climate change impacts on ecosystems currently facing habitat transition is important to anticipate future landscapes and to proactively manage for future conditions. Oligohaline marsh and tidal freshwater forest are coastal wetlands that provide a variety of ecosystem services that may be impacted by increased future atmospheric warming and CO2 concentrations. The objective of this study is to understand the interactive effects of increasing temperatures and atmospheric CO2 along this landscape gradient.

We hypothesize that organic matter cycling will be significantly impacted by both elevated temperature and atmospheric CO2, which will have implications for both resilience and ecosystem services of these habitats. Treatment conditions (water temperature elevated 3.5°C above ambient and 935 ppm CO2) were maintained throughout the experiment, and compared to ambient water temperature and CO2 (400 ppm) to mimic predictions from IPCC 2013 RCP 8.5.

We measured the effect of atmospheric CO2 and temperature on wetland surface elevation change to assess habitat resilience. In addition, we measured above- and belowground production and decomposition of labile carbon to identify the response of carbon cycling to changing environmental conditions among these habitats. Preliminary findings suggest the effect of depth, temperature, and atmospheric CO2 on belowground decomposition and the effect of temperature on aboveground decomposition is dependent on community type.

These findings can help predict how ecosystem services and resilience will be influenced across coastal wetland landscapes in a changing climate and provide insight on how to best manage these at-risk systems. Additionally, experiments that manipulate multiple drivers are less common than single-treatment studies, therefore these data may offer additional insight regarding how future conditions will impact carbon cycles and longevity of coastal habitats.

How does CO2 affect bioactive metabolite accumulation by freshwater and marine cyanobacteria?

I-Shuo Huang; Xinping Hu; Paul V. Zimba*

Cyanobacterial bloom occurrences are predicted to become more common with global climate change and anthropogenic nutrient inputs. Major concern of cyanobacterial bloom is their bioactive secondary metabolites, including over 55 compound classes that threaten the health of human and animals. No laboratory studies have evaluated how increased CO2 availability affects cyanotoxin co-production. This study investigated the effects of CO2 availability on two cyanobacterial strains: a marine *Synechocystis* sp., from Palacios, TX, and freshwater *Microcystis aeruginosa* clone LE3 from Lake Erie. Cyanobacterial strains were semi-continuously cultured in modified growth media at pH 7.5, 7.8, 8.2, and 8.5 (for freshwater pCO2 at 4057, 2027, 799, and 395 µatm, respectively; for marine at 1717, 806, 209, 106 µatm, respectively). Carbon dioxide levels were achieved via a combination of CO2 addition and the control of alkalinity. Samples were analyzed for cyanotoxins using High Performance Liquid

Chromatography in-line with Triple Quadruple Mass Spectrometry. Accumulation of most toxins by freshwater *M. aeruginosa* and marine *Synechocystis* sp. increased at elevated CO2 levels. At pH 7.8, toxin accumulation by *M. aeruginosa* was 1.5 times greater than the other three treatments and the accumulation by *Synechocystis* was 1.2 times greater. Concentration of microcystins accumulated by both marine and freshwater strains was highest in pH 7.8 treatment. Microginin accumulation in *M. aeruginosa* at (pH = 7.5) was reduced by 50% compared to the other three treatments, indicating the high CO2 availability potentially inhibited the production of microginin. The pattern of microcyclamide-bistratamide B production affected by CO2 availability was inconsistent between these two strains, with accumulation of this compound in *M. aeruginosa* decreased and in *Synechocystis* increased at elevated CO2 levels. These results indicate that cHABs have the potential for increased toxicity with higher CO2 concentrations which will be important for water source management.

SHARKS & MAMMALS

The effects of lipid extraction on delta 13C and delta 15N ratios across taxa, tissues, and trophic groups

Carl S. Cloyed; Kayla P. DeCosta, Matthew R. Hodanbosi, Ruth H. Carmichael

Lipid extraction is often necessary in stable isotope analysis, and general patterns for when it is necessary need to be more fully explored. We studied the effects of lipid extraction on delta 13C and delta 15N ratios in liver, muscle, and skin of West-Indian manatees (*Trichechus manatus*) and bottlenose dolphins (*Tursiops truncates*), two ecologically important species in the Gulf of Mexico that occupy different trophic groups. We also performed a meta-analysis to more broadly determine how the effects lipid extraction vary across taxa, tissues, and trophic groups. Lipid extraction did not affect delta 13C ratios of the three tissues in manatees but significantly affected all tissues in dolphins. The effects of lipid extraction on delta 13C ratios increased with lipid content of tissues and was greatest in liver, followed by skin and muscle. Lipid extraction had no effect on delta 15N ratios of any tissue in either manatees or dolphins. Across 103 species, lipid extraction significantly affected delta 13C ratios in all three tissues we reviewed, and the effects were stronger in lipid-rich tissues. Across species, lipid extraction significantly affected delta 15N ratios in muscles, marginally in liver, but not at all in skin. Finally, lipid extraction had a much smaller effect on herbivores than on carnivores or omnivores, which may explain why lipid extraction did not affect manatee tissues. Researchers have assumed that tissues with C:N ratios > 3.5 require lipid extraction, but we found this was not always true. Our results strengthen the growing body of evidence that the necessity of lipid extraction is tissue- and species-specific. Furthermore, trophic group may forecast the necessity for lipid extraction, possibly due to differences in diet composition or the physiology of lipid synthesis, both of which may lead to variation in lipid composition and subsequently affect the need for extraction.

Florida manatee (*Trichechus manatus latirostris*) diet in the northcentral Gulf of Mexico

Kayla P. DaCosta; Ruth H. Carmichael*

Manatees are herbivorous mammals found throughout the southeastern United States and are currently expanding their range to higher latitudes. Their diets have been extensively studied throughout the Florida peninsula, but little is known about what they eat at the edges of their range, in areas such as the northcentral Gulf of Mexico (nGOM). To better understand manatee diets in the nGOM, we took vegetation surveys and behavioral observations of tagged manatees approximately weekly in the nGOM during the warm months and at least bi-monthly during the cold months (outside

of the nGOM). In addition, opportunistic observations of untagged manatees were conducted. We analyzed stable isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) in vegetation and epidermis, muscle, and liver of deceased manatees to better understand the types of vegetation that contributed to manatee diet. Throughout the study manatees were most often observed in freshwater/brackish habitats, eating freshwater vegetation. Studies of manatees along the west coast of Florida indicate that seagrasses make up 48% of manatee diet, however our results indicate that freshwater submerged aquatic vegetation (SAV) was the primary diet source of manatees in the nGOM (from MS to Apalachicola, FL). Preliminary results indicate that tape grass (*Vallisneria* sp.) was the most common plant observed in areas manatees were spending time, with Southern naiad and Eurasian watermilfoil as the second most common. Initial stable isotope results showed that $\delta^{13}C$ values of manatee tissues and vegetation ranged from -24 to -11, indicating that manatees consume a broad diet. $\delta^{15}N$ values were ranged from 3-11, suggesting manatees may exhibit some degree of carnivory, either directly or indirectly via consumption of epibionts found on vegetation. Understanding manatee diet in the nGOM will provide information about resources that may be important to manatees as their population grows and they continue to expand their range.

Influence of freshwater influx on the diet and body condition of the common bottlenose dolphin, *Tursiops truncatus*, in Mobile Bay, Alabama

Matthew R. Hodanbosi; Ruth H. Carmichael*

The northern coast of the Gulf of Mexico contains many large estuaries that convey freshwater to northern Gulf ecosystems, including Mobile Bay. Mobile Bay is the sixth largest drainage basin among watersheds within the United States and has the third largest freshwater discharge. Periods of intense rainfall within the watershed can rapidly change the salinity and forage communities in the bay. Currently, it is unknown how the common bottlenose dolphin (*Tursiops truncatus*) that resides within Mobile Bay responds to these pulses of freshwater. Dolphins may alter their diet or foraging patterns in response to freshwater exposure, which could affect body condition and lead to death. To study the effects of freshwater influx on dolphins in a freshwater-dominated estuary, I will sample skin, muscle, liver, and teeth and quantify body condition of dolphins that stranded dead around Mobile Bay from 2011 to 2018. This 8-year period includes multiple wet and dry seasons to enable comparisons of diet and body condition relative to freshwater influence. I will use stable isotope ratios in dolphins and prey species and mixing models to compare the short- and long-term shifts in the diets of the dolphins between wet and dry periods. I will use trace element signatures along with sclerochronological techniques in teeth to relate changes in diet to freshwater sources through time within individual dolphins. Photographic analyses and histology (when possible) will further determine the prevalence of pathologies related to freshwater exposure. This research will aid understanding of how highly mobile and high trophic-level, long-lived marine species manage potentially stressful low-salinity conditions associated with residency in freshwater-dominated estuarine environments. These data also provide a baseline to assess effects of other stressors (e.g., oil or other contaminant spills, cold stress, hurricanes, freshwater diversion) that are common to coastal waters, particularly in the Gulf of Mexico.

Factors influencing the nursery dynamics of juvenile bull sharks (*Carcharhinus leucas*) in two Texas estuaries

Amanda J. Lofthus; Jeffrey R. Wozniak; Philip Matich*

Nursery habitats provide refuge for juvenile organisms to grow and develop, and are typically characterized by lower predation risk than surrounding habitats. Globally, estuaries are recognized for providing critical nursery habitat for many fish species. Juvenile bull sharks (*Carcharhinus leucas*) utilize

estuarine environments as nursery habitats. Yet, little is known about bull shark nursery dynamics along the Texas coast, especially for the young-of-the-year (YOY) age-class. This study investigated how predation risk and abiotic factors (salinity, dissolved oxygen, water depth, and temperature) influenced the occurrence patterns and densities of YOY bull sharks in two Texas estuaries: San Antonio Bay and Sabine Lake. In situ drumline sampling was used to assess predation risk along a freshwater-marine gradient in both estuaries, and data from long-term fisheries independent monitoring by Texas Parks and Wildlife Department was used to quantify occurrence patterns and catch rates of YOY bull sharks along this gradient. Preliminary analyses indicate that predation risk is correlated with salinity, depth, and proximity to the Gulf of Mexico, and YOY bull sharks are found less frequently in these riskier habitats. Understanding the effects of changing environmental conditions on predation risk and YOY bull shark habitat use will allow us to better understand shark nursery dynamics along the Texas coast, and identify important nursery habitats for this estuarine predator.

Resident and migratory behavior of blacktip sharks revealed through natural tracers and electronic tags

John A. Mohan; Jill Hendon; Elizabeth Jones; Brett Falterman; Kevin Boswell; R.J. David Wells

Understanding movement patterns of large predators requires interdisciplinary approaches. Broad-scale horizontal and fine-scale vertical movements can be characterized with pop-off satellite archival tags (PSAT) that record light based geolocation, temperature and depth. Regional differences in primary producers, result in elemental isoscapes that propagate through food webs and are assimilated into predator tissue signatures that reflect long-term dietary history. Combining both natural and electronic tags, can unveil previous trophic dynamics and detailed movement behaviors. In this study, blacktip sharks were sampled in TX (N=11), LA (N=13) and FL (N=12) with recreational fishermen. Each shark was tagged with a PSAT programmed for 30–180 day deployments, and a blood sample was collected for stable carbon and nitrogen analysis. A total of 36 PSAT tags were deployed, 13 of which did not provide useful data, but 11 recovered tags provided complete archived datasets consisting of high frequency (3 s) measurements of temperature, light level, and depth ranging from 5 to 153 days. Most sharks displayed highly resident behavior in each coastal regions, however one shark tagged in TX moved south to Campeche Bay Mexico over a 90 day period demonstrating long range movements. Carbon and nitrogen stable isotopes of blood indicated unique foraging ecology of FL sharks that separated from LA and TX, which displayed overlapping isotope values. These results suggest ecologically separate populations in the north eastern and western Gulf, but connectivity between the north and southern Gulf of Mexico. Integrating natural and electronic tags can increase our knowledge of the population structure of sharks on multiple scales.

MARSH/MANGROVE

Modeling effects of subgrid scale topography in shallow coastal marshes

Zhi Li; Ben R. Hodges*

In the restoration of a hypersaline shallow coastal marsh, the Nueces River Delta, the 2D depth-integrated Frehd model was used to evaluate the existing freshwater-pumping strategies by simulating the fate of pumped water and its effect on the spatial variation of salinity. When comparing simulation results with field data, although the decrease of salinity upon pumping was qualitatively captured by the Frehd model, quantitative model-data agreement was not reached. One reason for the mismatch was that relatively coarse grids (30x30m) were used to reduce computation cost. The subgrid-scale (< 30m)

topographical features, which have strong influence on surface connectivity, inundation patterns and salinity transport, were smoothed on the coarse grids.

To reduce the error caused by grid-coarsening and to use the fine-scale topographical information, a subgrid topography model has been designed and tested. A set of subgrid variables were computed based on the high-resolution topography (from lidar), which were used to describe the characteristics of the subgrid-scale features. These variables were embedded into the governing equations of the Frehd model (the 2D Navier-Stokes equations and the scalar transport equation). With these variables embedded, the fine-scale surface connectivity is automatically maintained and the flow rates in/out of the channels are automatically adjusted with respect to the fine-scale channel geometry. This subgrid topography model has been tested on small sections of the Nueces Delta and proven to outperform the traditional coarse grid model. It has the potential to be applied on the full Nueces Delta and other similar shallow marshes to help better manage water resources and restore ecosystems.

Diversity and ecology of algal sandflat mats of Laguna Madre, TX

Sergei Shalygin; Paul V. Zimba; I-Shuo Huang; Lixin Wang

The hypersaline Laguna Madre (~ 185 km long) is renowned habitat for many fishes, marine vertebrates and birds. Sandflat microalgae cover near half of the aerial extent and have been almost completely ignored by researchers for more than 60 years. Algal communities identified include *Lyngbya* sp. and *Shizothrix* sp. (?). We explored algal mats (mostly within Kenedy Ranch) and detected up to 30 species of cyanobacteria. Several morphotypes such as *Oxynema* sp. and *Pleurocapsa* sp. appear to be new cryptic genera and will be described in near future. The dominant species of most mats is *Lyngbya* sp. as confirmed genetically using 16S-23S rRNA markers, and is related to *Lyngbya aestuarii* strain PCC 7419, however might be a new genus. Overall species composition of cyanobacteria is unique containing peculiar representatives such as *Halomicronema* sp., *Spirulina* spp. and *Halothece* sp. Structurally mat thickness is non-uniform within locations, having different thickness (from 0.1-1 mm) and percent algae composition. Using pigment analysis, we detected shift from diatom dominance to cyanobacteria associated with decreased frequency of wetting. Possible explanations include anthropogenic modification of Laguna Madre (Intercoastal Waterway, lowered salinity with maintained passes) and global climate change (sea-level rise). Future direction include use of MiSeq techniques for more precise detection of algal mats biodiversity, together with biochemical analysis with the aim to find unique bioactive compounds.

Fungal pathogen presence and diversity of four salt marsh plants in Louisiana

Ryann E. Rossi; Karolyn L. Agosto Shaw; Brian J. Roberts

Salt marshes are important coastal ecosystems that provide several ecosystem services throughout their range. Despite their productivity, salt marshes routinely experience both abiotic and biotic stressors often simultaneously. Biotic stressors such as plant disease have received relatively little attention, especially for plants other than *Spartina alterniflora*. Here, we explored the presence of plant disease in Gulf coast marshes. Specifically, we investigated presence of plant disease in *S. alterniflora*, *S. patens*, *Juncus roemarianus* and *Distichilis spicata* and documented the fungal pathogens potentially infecting these marsh plants. We conducted disease presence surveys at three long-term marsh sites predominantly composed of *S. alterniflora*, but with all other species in patches throughout the landscape. We collected leaf tissue samples from plants showing signs of disease, mostly fungal lesions, for each species at all sites for fungal isolation. We used both morphology and DNA sequencing to

identify fungal species. Our results suggest variation in disease presence between plant species with *S. alterniflora* having greatest disease presence followed by *D. spicata*. Additionally, we found differences in fungal species richness between plant species with *S. alterniflora* and *J. roemarianus* having the highest fungal species richness and *D. spicata* and *S. patens* having lowest fungal species richness. Our results suggest marsh plants are subject to different fungal pathogen communities and may differ in vulnerability in disease infection following disturbances. This research is some of the first to document disease and fungal pathogen communities on *S. alterniflora* and other marsh plant species. Ultimately, this will improve our understanding of the diverse stressors salt marshes regularly experience.

Freeze effects on black mangroves within the Texas marsh-mangrove ecotone
Carolyn A. Weaver; C. Edward Proffitt

Mangroves are coastal woody plants that are freeze intolerant, which severely limits their growth and distribution, therefore mangrove dominance is primarily restricted to the tropics. At their poleward limits, mangroves are intermixed with temperate dominating salt marsh species creating marsh-mangrove ecotones. Over the last 30 years, global changes are driving black mangrove (*Avicennia germinans*) stand expansion in the Northern Gulf of Mexico, with the reduction of freezing event frequency, duration, and severity invoked as the leading driver. In January 2018, Winter Storm Inga brought severe freezing conditions to the southern United States causing widespread damage to the local vegetation. We are investigating how this freeze event is impacting the black mangrove population within the Northern Gulf of Mexico marsh-mangrove ecotone. We are monitoring freeze damage and recovery at eight locations that span the Texas coast. The mangroves within the northern four sites, exhibited major freeze damage (93.6% of the total mangrove coverage), whereas the stands within the southern study sites, had minimal to no freeze damage (2.2% of the total mangrove coverage). Freeze damage consisted partial to complete defoliation, with minimal recovery after 3 months post-freeze. Some seedlings (this year's newest recruits) survived in even the heavily freeze damaged sites, though average survivorship was much lower in sites that exhibited longer freezing conditions (19.7%) than sites that didn't (64.0%). documented at all sites. These data give insight into how freezing temperatures affect black mangrove growth, recruitment, and survivability at their range limits, and the subsequent effects on mangrove range expansion or contraction. For example, major freeze damage may reduce reproductive output in mature trees in following years, thereby reducing mangrove recruitment. Therefore, a major storm event such as Winter Storm Inga may have the potential to pause mangrove expansion within the marsh-mangrove ecotone.

Fertilization affects black mangrove life history characters in Texas estuaries
C. Edward Proffitt; Donna J. Devlin; I. Candy Feller; Carolyn A. Weaver

Reduced incidence and intensity of freezes has promoted the increasing dominance by the black mangrove, *Avicennia germinans L.*, along much of the Texas coastal zone. Other factors, such as nutrients and interactions with pre-existing salt marsh species, may influence the rate or extent of dominance shift. In Texas, unlike similar latitudes in Florida, *Avicennia* tends to be short (<2 m, usually 1 m or less) and bushy (highly branched, high canopy:height ratio. We have an on-going field experiment initiated July 2017 in which mangroves imbedded in a marsh plant "matrix" are subjected to different fertilization treatments (Control, N, P, N+P, and Fe added approximately every 6 months) in the root zone. Response variables include: Target mangrove "tree" reproductive output, growth, side stem production; volunteer seedling mangrove survival and growth; and marsh plant size and robustness. Within 3 months, differences were noted in reproductive output. By the end of year 1, growth and

branching were affected by fertilization treatments. Most response variables responded more to N and less to other fertilization treatments. Numbers of propagules per branch and per tree were much greater possibly because of increased propagule survival as indicated by the facts that flowering, bud production, and fruiting was already done or well underway at experiment initiation. This suggests that black mangrove expansion will be accelerated in nutrient-high regions.

Avicennia germinans survival and growth in a common garden experiment in Texas South Coastal Bend

Donna J. Devlin

Avicennia germinans is rapidly expanding along the Texas Coast. In some areas, small trees and shrubs form contiguous strips of mangrove forest along island and mainland coasts. In other areas, *Avicennia* occurs as individual trees within salt marsh dominated sites. I performed a manipulative common garden experiment to determine if survival and growth of propagules varied with maternal plant, natal site, dominant vegetation (*Avicennia* or *Spartina*) at natal site and diversity at the experimental site. Two levels of diversity treatments were applied: a) low –all six seedlings in a plot from the same maternal tree and b) high-plots with two individuals from each of three different maternal trees. Plots were assigned to blocks along a transect within the *Batis* zone at approximately the same tidal level. Results over the first 1.5 yrs are as follows. Seedling survival over the first six months was less than 50% and varied with maternal tree and natal site, but not diversity treatment–all seedlings from some maternal trees perished regardless of diversity treatment. Slight variation in elevation is important for seedling establishment; all individuals in one block located at a slightly lower elevation failed to establish and perished within the first three months. In contrast, mortality of established seedlings that were immersed for greater than one month after Hurricane Harvey was very low. Finally, there was no association between dominant vegetation and survival of seedlings. Data from this experiment suggest that the role of biodiversity in *Avicennia* seedling survival and growth is different from that recorded for *Rhizophora*. Survival and growth of seedling mangroves, both *Avicennia* (this study) and *Rhizophora* (earlier study) is complex and affected by environment (elevation) and factors such as maternal genotype.

FISH

Characterization of Saltmarsh Topminnow - *Fundulus jenkinsi* populations along the Texas coast

George J. Guillen; Jenny Oakley; Cory Scanes; Mandi Gordon

In 2011 the federal government received a petition to list the Saltmarsh Topminnow under the ESA. This species was believed to occur sporadically in marsh habitat along the Gulf of Mexico, from Galveston Bay, Texas to Escambia Bay, Florida. Past studies document this species occurring in very small isolated populations within the northern Gulf of Mexico. It was believed that the Galveston Bay population represented the western extent of this species. Current long-term coastal fisheries independent monitoring in Texas utilizes bag seines, trawls and gillnets which most likely under samples or cannot capture this species due to gear and habitat bias. Given this species potential limited range in Texas and projected development, subsidence and sea level rise, it is important to describe and document the occurrence and habitat associations of this species. Systematic surveys of coastal tidal creeks and wetlands were conducted during February 2014 to November 2014, and October 2016 to April 2018. Sampling was conducted using common sense seines and Breder Traps from Sabine Lake to Copano Bay.

Data on fish community composition, water quality and adjacent land use was recorded. Based on analysis of the occurrence data it is apparent that Saltmarsh Topminnow are more common than previously believed and extend down to the middle coast of Texas. The range of environmental conditions and habitat types were this species are collected are presented along with recommendations for future conservation. Our study concurs with past research describing direct links between Saltmarsh Topminnow abundance and coastal tidal creek habitat associated with middle to lower salinity regimes. This project provided important information needed to conserve and protect Saltmarsh Topminnow within Texas and across the Gulf of Mexico, and will be useful in determining whether ESA listing is warranted.

Microplastic in the diet of juvenile fish from Corpus Christi Bay

Polly A. Hajovsky; Michelle J. Bromschwig; Simon J. Geist*

Plastic pollution and the negative consequences of plastics entering marine food webs has gained public attention in recent years. Small pieces of plastic, microplastic (<500 µm), have been found globally in aquatic systems, such as oceans, bays, lakes and rivers. Corpus Christi Bay is a major bay in South Texas, surrounded by a large amount of petroleum-based industries and several cities. One of these cities is Corpus Christi, the 8th largest city in Texas and home to the 6th busiest port in the US. This produces various types of potential microplastic pollution sources. At the same time Corpus Christi Bay is an important juvenile nursery area for several fish species such as redfish (*Sciaenops ocellatus*), spotted seatrout (*Cynoscion nebulosus*), Atlantic croaker (*Micropogonias undulatus*) and anchovies (*Anchoa* spp). However, a baseline study of microplastic pollution in the water column, ingestion by early juvenile fish and effect on nutritional condition is lacking. Here, we examined the diet of selected species representing different foraging types. The hypothesis tested was, water column filter feeders (*Anchoa* spp.) will have higher amounts of plastic in their digestive tract than bottom feeders (*M. undulatus*). Preliminary results show that microplastic pollution is apparent in Corpus Christi Bay and that it is taken up by juvenile fish. Out of 75 fish, ~ 94% had some microplastic in their digestive tract. Blue and black colored fibers were the most abundant with a total of 134 for blue and 120 for black. Waste water treatment plants are the prime suspect to be the source as it is assumed that most of these fibers stem from shedding of clothes and enter the bay through. As a next step, the type of plastics found in the digestive tracts will be determined by a micro Fourier Transform Infra-red system.

Feeding ecology and food web structure of larval fish at a Gulf of Mexico coastal inlet

Michelle J. Bromschwig; Polly A. Hajovsky; Simon J. Geist*

The availability of food in terms of quantity and quality is an important factor regulating survival of early life stages of fishes, as it determines the rate of development of bodily function and somatic growth. Understanding food web interactions during the larval stage is thus an important component of predicting success of larval recruitment to adult fish populations. Coastal inlets pose a potential bottleneck for larval stages of Gulf of Mexico (GoM) fish species that utilize estuarine bays as juvenile nurseries. The trophic relationships among larval fish were investigated for larvae passing through a south Texas coastal inlet connecting the GoM to Corpus Christi Bay, Texas, during the fall spawning season 2017. The objectives of this study were to 1) describe the larval fish food web across the whole range of species collected, 2) determine how much the larval fish food web shifts throughout the fall spawning season, and 3) compare the diet of a representative larval fish species to the available prey field. Food web structure was assessed using δ13C and δ15N stable isotope analysis of selected larval fish species. Diet composition of an abundant species (Atlantic croaker, *Micropogonias undulatus*) was

determined to the lowest taxonomic level possible via stomach content analysis. Stable isotope analysis showed that most larval fish species feed at the same trophic level, but that carbon sources varied among species. Gut content analysis of Atlantic croaker indicated that copepods were the most abundant diet item, and that croaker showed selectivity for certain species of copepods over others.

Food web effects of mangrove encroachment on penaeid shrimp

Justin S. Lesser; Jennifer Doerr; James A. Nelson*

Increased temperatures have allowed the black mangrove (*Avicennia germinans*) to expand its range and overtake salt marsh habitats typically dominated by smooth cordgrass (*Spartina alterniflora*) throughout much of the Louisiana coast. As this dramatic shift in dominant ecosystem type occurs over timescales as short as a few years, major questions that must quickly be answered involve the effect of this habitat shift on commercially and culturally important species that rely on these areas as essential to the completion of their life cycle. We assessed effects of this habitat shift on the diet and condition of white shrimp, *Litopenaeus setiferus*, and brown shrimp, *Farfantepenaeus aztecus*, in the salt marshes surrounding Port Fourchon, Louisiana, an area currently experiencing rapid mangrove encroachment. Shrimp primarily rely on algae-derived production, not on production derived from the macrophytes themselves, and as a result, resource use and energetic condition of shrimp was not influenced by the type and amount of dominant habitat type present within their home range. However, the structural change from salt marshes to mangroves may affect how shrimp acquire resources to meet their energetic demand. Thus, differences in the underlying variability in the ability of different bays to produce could temper the effect of this habitat shift on resident communities.

Influence of habitat heterogeneity on estuarine fish communities in Espiritu Santo Bay, Texas

Mallika R. Beach-Mehrotra; Jeffrey R. Wozniak; Philip Matich*

Estuaries are a transition zone between riverine and marine habitats, with waters ranging from freshwater to brackish to hyper-saline. This variability provides ideal conditions for the formation and maintenance of a wide range of aquatic habitats, including seagrass beds, saltmarshes, oyster reefs, and mud flats. Within these habitats, fluctuations in environmental conditions can lead to heterogeneity, both in habitat structure and community composition. This project sought to identify the effects of habitat heterogeneity on the biodiversity of estuarine fishes in Espiritu Santo Bay, Texas. Preliminary results indicate that biodiversity varied across sampling sites based on geographic location and varying environmental conditions, specifically temperature and dissolved oxygen. In addition, fish abundance and density were influenced by sampling month, with greater abundances in June and July. The presence and heterogeneity of submerged aquatic vegetation influenced the abundance of dominant fish species (pinfish, silversides, croaker, anchovies, and mojarra), with lesser impacts on overall fish biodiversity. Similar to other estuaries, connections between habitat characteristics and biodiversity suggest that habitat monitoring and protection are important management priorities in the western Gulf of Mexico.

Linking habitat use and trophic ecology of spotted seatrout (*Cynoscion nebulosus*) on a restored oyster reef in Matagorda Bay, Texas

Thomas C. TinHan; John A. Mohan; Mark Dumesnil; Bryan M. DeAngelis; R.J. David Wells*

Predicting population- and ecosystem-level benefits of habitat restoration minimally requires an understanding of the link between the trophic ecology of a species and their use of a habitat. This study

combined novel, non-lethal natural tracers of trophic ecology with acoustic tagging techniques to examine spatial and temporal patterns of habitat use of spotted seatrout (*Cynoscion nebulosus*) on Half Moon Reef (HMR), a recently restored oyster reef in Matagorda Bay, Texas. Forty-one spotted seatrout (408 ± 25 mm total length) were captured at HMR, surgically implanted with acoustic transmitters, and monitored by an array of underwater listening stations from December 2015 to August 2016. Patterns of presence-absence on HMR were strongly influenced by water temperature, and to a lesser extent, salinity and tidal height. Overall, spotted seatrout residency to HMR was low, with fish being present on the reef 24% of days. When present, individual fish exhibited strong site-attachment to small portions of the reef. Residency to HMR increased significantly with size, while scale stable isotope analysis revealed fish exhibiting high residency to HMR occupied significantly smaller isotopic niches. If indeed smaller fish with decreased residency rely upon a wider range of prey items across multiple habitats than larger, more resident individuals, restored oyster reef habitat may be expected to primarily benefit larger spotted seatrout.

FRIDAY SESSIONS

RESTORATION

Oyster reef restoration leads to faunal production enhancement in Matagorda Bay, Texas

Abby E. Williams, Terence A. Palmer, Jonathan H. Grabowski, Jennifer B. Pollack*

Oyster reefs, which are valued for providing essential fish habitat, were historically abundant throughout the Western Atlantic and U.S. Gulf of Mexico yet have been severely degraded throughout this range. For instance, Half Moon Reef in Matagorda Bay, TX, was originally 500 acres, but intensive dredging throughout the 1900's destroyed the infrastructure of the reef and led to the collapse of local oyster populations, before being partially restored by The Nature Conservancy in 2013. The purpose of this study is to estimate the enhancement of fish and macroinvertebrate production resulting from this restoration. Fish and macroinvertebrate samples have been collected via suction sampling and modified epibenthic sled surveys on the reef quarterly for the past four years. These data are being used to calculate the per-unit-area enhancement of faunal production expected from the restoration of oyster habitat. Preliminary analyses indicate that Half Moon Reef has enhanced overall faunal biomass compared to surrounding unrestored areas. In particular, the reef supports greater biomass of mobile crustaceans including *Menippe adina*, *Petrolisthes* sp., and *Panopeus herbstii*, and fish including *Hypsoblennius hentz*, *Gobiesox strumosus*, *Gobiosoma bosc*, and *Opsanus beta*. The information gained from this study will help inform expectations of faunal enhancement that could be derived from future restoration efforts in the region.

Oyster reef restoration: Influence on oyster recruitment and health, benthic infauna, and reef-associated macrofauna

Meghan J. Martinez, Terry A. Palmer; Jennifer Beseres Pollack*

The Eastern oyster, *Crassostrea virginica*, is a foundational species that enhances estuarine ecosystems by performing numerous ecological functions, such as filtration of water, provision of complex three-dimensional habitat and food for nekton, and stabilization of shorelines via mitigation of erosion processes. In summer of 2017, approximately 600 meters of oyster reef were restored using recycled oyster shells in St. Charles Bay, TX to support the establishment of a self-sustaining oyster population and improvement of ecosystem services and benefits. Ecological monitoring is being conducted to

quantify the effects of restoration on oyster recruitment and health and faunal community metrics for nekton and infauna. We hypothesize that the density and size of oysters on the restored reef will become more similar to reference reefs over time. We also expect that the restored oyster reef will support higher densities of infauna and nekton compared to the adjacent, unstructured bottom. Preliminary assessments of the restored oyster reef indicate that reef-associated macrofauna biomass, infaunal abundances, and the number of live oysters all show increasing trends when compared to reference areas. Dermo (*Perkinsus marinus*) oyster disease has been observed in oysters at both reefs with severity dependent on bay conditions. Continued monitoring will provide a better understanding of the effects restoration efforts have on important estuarine species and ecosystem service provisioning, and support decisions in management, conservation, and restoration planning of oyster reef habitat.

Evaluating primary productivity and respiration on artificial reefs using biofilm samplers
Beija Gore, Florian Cesbron; Kendra Brooks; William Patterson; Jane Caffrey*

Artificial Reefs are known to increase fish availability but little is known about their larger effects on the ecosystem. Recent research at four artificial reef sites in the Mississippi Sound suggests that the ability of artificial reefs to enhance primary production may be limited to depths within the shallow photic zone. The goal of this research is to look at the effect of artificial reef habitat on ecosystem productivity. We address these questions: are artificial reefs biogeochemical hotspots with increased rates of primary productivity and what the relationship between the attach algae is and how it influences oxygen fluxes on the reefs. We measured primary production on plexiglass plates that were deployed on an artificial reef in 14 m of water. Biofilm growing on the plates were collected from the field after being deployed for a few months, next they were placed in water filled chambers in a controlled temperature environmental chamber. Changes in oxygen concentrations over time in the light and dark were monitored and used to calculate primary production and respiration. Following the incubations, plates were scraped to collect chlorophyll *a* and total biomass as dry weight. We found that higher chlorophyll *a* fluorescence levels correlated with higher oxygen net production. Higher averages of attach epifauna were observed in the summer months with the highest average of 1.94 mg/cm^2. We also examined how environmental factors such as temperature, nutrients and light that could also influence the benthic microalgae community.

Comparison of genetic diversity of the gulf killifish (*Fundulus grandis*) between restored and natural Spartina salt marshes in Galveston Bay, Texas
G. Janelle Espinoza, Jaime R. Alvarado Bremer*

Comparisons of the levels of genetic variation of representative fauna inhabiting natural *Spartina alterniflora* salt marshes against the levels of genetic variation in fauna recolonizing restored marshes can provide useful information regarding the connectivity between source and recolonizing populations. Such information is particularly useful when dealing with founder populations and may help forecast their status. Coastal populations lacking sufficient genetic diversity may be unable to cope with the selective pressures imposed by global climate change, or to new conditions set by catastrophic events such as hurricanes. Conversely, more stable, diverse, and resilient marshes are expected to function better as protective barriers and fisheries nurseries.

The genetic diversity of colonizing fauna of restored *Spartina* marshes has not been characterized to date. This study evaluates the impacts of wetland restoration on genetic diversity of gulf killifish (*Fundulus grandis*), which are among the most abundant nekton in coastal marsh habitat. Specimens

were obtained from a natural reference marsh, and from restored marshes of differing ages in the Galveston Bay, Texas area. DNA was extracted and segments of mitochondrial genes Nitrogen Dehydrogenase Subunits 2 and 5 (ND2, ND5), and the Control Region (CR) were PCR amplified and sequenced. The analyses of a total of 1,088 bp is expected to show strong phylogeographic association, with natural marsh populations having higher levels of genetic diversity than those of restored marshes, and restored marsh populations having increasing genetic diversity with increasing age. This work represents a portion of a larger study on the effects of restoration on the genetic diversity of colonizing fauna that will include more species and a greater range of genetic markers.

Assessment of food web recovery following restoration using hypervolume analysis

W. Ryan James, James A. Nelson*

The primary goal of habitat restoration is to recover the ecological structure, function, and services of natural ecosystems that is lost due to disturbance. Post-restoration success typically focuses on the return of a desired habitat type, consumer species composition, or abundance relative to a reference site. Little attention is focused on understanding how energy flows through an ecosystem following restoration, even though it is an important ecosystem function. We conducted a meta-analysis to assess the recovery of ecosystem function and the success of habitat restoration using food web analysis. Using published stable isotope values from seven restored habitats, we used Bayesian mixing models to quantify resource use by consumers and generated natural and restored food web hypervolumes for each ecosystem. Our analysis revealed two major themes that mediate food web recovery to habitat restoration. Restoration efforts that restore macrophytes take longer to recover than those that restore structural habitat. Restoration increases the variability in basal resource use of consumers in the food web except in tidally connected habitats, where consumers decrease variability in basal resource use. Hypervolume analysis is a powerful tool that can be used to quantify the recovery of ecosystem function and improve restoration efforts.

BENTHIC

Eastern oyster (*Crassostrea virginica*) settlement and population connectivity in a freshwater dominated estuary

Haley Nicholson Gancel, Ruth H. Carmichael*

The Northern Gulf of Mexico, including Mobile Bay, AL, is home to one of few remaining harvestable oyster populations in the U.S., and knowledge of oyster population connectivity is needed to inform restoration and management activities of remaining populations. Along with data on settlement patterns, trace elemental (TE) signatures within shells of oysters have potential to serve as natural geochemical tags to define larval origins and infer population connectivity. To determine oyster settlement patterns, settlement plates were deployed in the Mobile Bay/Mississippi Sound (MB/MS) System bi-monthly from May-September 2014 and 2016. To determine oyster larval origins and population connectivity, we quantified TE concentrations (Mg, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Sr, Cd, Ba, Pb) in native adult oysters and newly settled spat (on 2016 settlement plates) along a ~40 km freshwater gradient and compared TE values in larval shell (origin) to settled and adult shell (grow-out sites). Overall, oyster settlement was higher in 2016 (70 ± 19 oysters plate-1) compared to 2014 (18 ± 6 oysters plate-1), with maximum settlement occurring at higher salinity sites in MS in both years (2014: 174 oysters plate-1; 2016: 1,137 oysters plate-1). Settlement increased exponentially from July until September (end of field sampling) each year, suggesting larvae were available for settlement post

sampling. Linear discriminant function analysis (LDA) identified spatially distinct TE signatures, with Fe, Mn, and Cr accounting for 88% and Sr accounting for 69% of the variation among sites in adult and settled shell, respectively. Preliminary classification results from LDA determined that larvae originated from the Portersville Bay area in northeastern MS, rather than MB. Future restoration efforts and oyster farming/harvesting operations in the MB/MS system may benefit from grow-out in these areas that naturally promote oyster recruitment and by targeting projects to enhance/conserve natural reefs and associated broodstock.

A meta-analysis of oysters and organic matter sources in the northwestern Gulf of Mexico using stable isotopes

Danielle Aguilar, Jennifer Pollack; Megan La Peyre; Benoit Lebreton

Across northern Gulf of Mexico estuaries, freshwater inflow drives productivity, and remains a dominant factor affecting the success of oyster populations. Freshwater inflow influences salinity, a key factor determining oyster population success, and may also alter food quality and quantity. Suspended particulate organic matter (SPOM), which is generally composed of detritus, microphytobenthos, and phytoplankton, provides an important food source for oysters. In estuarine systems, freshwater inflow provides limiting nutrients of terrestrial origin, spurring autochthonous phytoplankton production and producing higher quality organic matter, as measured by carbon/chlorophyll a ratios.

We combined published and unpublished isotopic ($\delta^{13}C$ and $\delta^{15}N$) data on oysters, SPOM, and surface sediment organic matter (SSOM) from studies across the Texas Coastal Bend region between 2011-2017. Salinity is used as a proxy for freshwater inflow, assuming lower estuarine salinities reflect periods of higher inflow. Results indicate that over a salinity range of 13 to 40, oyster $\delta^{13}C$ values were enhanced as salinity increased. Specifically, mean oyster $\delta^{13}C$ values ranged from -23.5 ± 0.6 at mean salinity 21, to -16.6 ± 0.7 at mean salinity 35. At all reefs, mean SSOM $\delta^{13}C$ values were significantly more enriched than SPOM $\delta^{13}C$ values, and SSOM contribution to oyster assimilation was higher. SPOM contribution was increased following lower salinities associated with freshwater inflow events. The carbon/chlorophyll *a* ratio, a proxy for the quality of organic matter, was significantly related to salinity ($p<0.05$). Changes in freshwater inflow can cascade to changes in the composition of SPOM, as indicated by the changing $\delta^{13}C$ value and carbon/chlorophyll *a* ratio, respectively. Ultimately, this may affect the general functioning of the reef via energy transfer to higher trophic levels. However, this impact of freshwater inflow on oyster populations will likely reach a threshold as salinities become significantly reduced.

Early recruitment of *Crassostrea virginica* to restored and historic oyster reefs in the western Mississippi Sound: Larval supply and post-settlement success

Leah Margaret Morgan, Chet F. Rakocinski*

The eastern oyster (*C. virginica*) is an important foundation species within coastal ecosystems. Oysters improve water quality, provide refuge for smaller fish and invertebrates, and serve as an important fisheries resource. The successful early recruitment of eastern oyster is vital for resupplying adult populations in the face of harvesting. Healthy coastal oyster populations are also challenged by various sources of stress, including pollution, freshwater input, hypoxia, disease, and predation pressure. Thus, considerable efforts have been dedicated toward oyster restoration within the northern Gulf of Mexico. The objective of our study is to evaluate the role and importance of early recruitment to oyster restoration success in western Mississippi Sound. During the summer 2018 recruitment period, we compared larval supply and spat settlement among eight sites, including four recently restored inshore

reef sites (2 limestone, 2 relic shell), two historic unrestored inshore reef sites, an unrestored offshore reef site, and a previously restored offshore reef site (1 limestone). Variation in recruitment success will be quantified relative to region, restoration materials, and the degree of background predation on post-settlement oysters. Local oyster spawning stock biomass will also be considered as a potential source of early recruits. Preliminary results from zooplankton samples as well as from spat settlement plates both with and without predator exclusion cages will be discussed.

Phylogeography and species delimitation reveals cryptic diversity and the impacts of the Mississippi River formation on a sand-burrowing crustacean

Zachary B. Hancock, Jessica E. Light; Mary K. Wicksten*

The Gulf of Mexico harbors a unique geological history that has imprinted itself in the biogeography of many Gulf inhabitants, perhaps most influential of all being the impact of the Mississippi River. Disjunct distributions may be reinforced in contemporary taxa by the radically different current regimes on either side of the Mississippi. This study investigates these potential impacts on a widespread beach-dwelling amphipod (Haustoriidae). These crustaceans are ideal for biogeographic study as they are benthic filter-feeders and lack pelagic larvae. Fifteen sites ranging from southern Mexico to central Florida were selected for sampling. From each site, two mitochondrial genes (COI and 16S) and a nuclear gene (28S) was sequenced from 2–10 individuals. Gene trees were reconstructed under both maximum-likelihood and Bayesian paradigms, and a TCS parsimony haplotype network was constructed. Population parameters including Tajima's D, nucleotide diversity (π), FST, and pairwise genetic distances were estimated. A variety of molecular species delimitation methods were applied to infer putative species. Between 5–10 putative species were identified depending on the method used where only 4 species are morphologically distinguishable suggesting the presence of multiple cryptic species. Divergences and estimated population parameters are discussed in the context of the geological history of the Gulf of Mexico.

Bottom-up effects of a changing coastal wetland landscape on *Uca* spp. in the Gulf of Mexico

Janelle A. Goeke, Anna R. Armitage*

Ecosystems are shaped by the productivity of the organisms that support the base of the food web. A change in the plant community therefore has the potential to alter species composition and interactions within an ecosystem. Such a change is currently ongoing in wetlands along the Gulf Coast of Texas where black mangroves, *Avicennia germinans*, are encroaching into *Spartina alterniflora* dominated salt marshes. It is currently unknown how this community shift may affect coastal wetland food webs. Fiddler crabs (*Uca* spp.) are detritivorous organisms that are important basal species in salt marsh food webs. They serve as prey for organisms at higher trophic levels, and play important roles in nutrient cycling and soil aeration. In order to determine the bottom-up effects mangrove encroachment may have on such an important basal consumer, we measured the behavioral and physiological responses of *Uca* to different diets. Crabs were presented with a marsh diet consisting of plant matter from *Spartina* and a mangrove diet consisting of *Avicennia*. Feeding arena trials were used to directly measure feeding activity, and no choice experiments were used to assess food quality. *Spartina* was a more preferred and higher quality diet for *Uca*. The feeding activity of crabs was approximately four times higher on the *Spartina* diet when compared to the *Avicennia* diet. Crabs also lost significantly more weight and reproduced less on the *Avicennia* diet. These findings indicate that a diet dominated by *Avicennia* will most likely not function as a replacement for a *Spartina* dominated diet in the field. This may lead to

decreased abundance of fiddler crabs in mangrove encroached areas and, subsequently, changes in marsh sediment characteristics and coastal food web structure.

Exploring the microbial loop: Trophic interactions between microzooplankton and phytoplankton in eutrophic and oligotrophic waters of the northern Gulf of Mexico

Mrunmaye Girish Pathare, Hans J. Prevost, Beth A. Stauffer*

Microzooplankton (MZP) grazers are major consumers of phytoplankton primary production in coastal systems and play an important role in the microbial loop. MZP form an important trophic link between small producers and larger consumers while also remineralizing the biomass they consume into inorganic nutrients. They also play a role in structuring phytoplankton communities due to preferential feeding on different size fractions, which can influence trophic transfer of energy and food-web structure. Trophic interactions between MZP and phytoplankton were studied using dilution experiments in eutrophic waters of Vermilion Bay and oligotrophic waters of the northern Gulf of Mexico (nGOM). Vermilion Bay is a shallow, turbid estuary which receives freshwater from the Atchafalaya River and smaller river inputs. To examine the trophic interactions between MZP and phytoplankton, dilution experiments were conducted bimonthly between September 2016 and 2018 from Vermilion Bay, and in July 2017 and October 2017 from three sites ranging from nearshore to offshore in the nGOM. Dilution experiments in which apparent growth rates were calculated based on chlorophyll biomass showed a variety of grazing responses: oligotrophic areas generally showed the expected negative slopes predicted by Landry & Hassett (1982), while experiments in the more eutrophic, nearshore waters were characterized by positive slopes and non-linear dynamics. Grazing rates ranged from 0.21 day-1 to 0.27 day-1 at the eutrophic site, and from 0.05 day-1 to 0.6 day-1 at the oligotrophic sites. Cell counts using flow cytometry and Utermöhl settling chambers were used to interpret the observed non-linear and positive slopes and quantify grazing rates on four functional groups of phytoplankton; picoeukaryotes and picocyanobacteria (0.2-2 µm), nanoautotrophs (2-20 µm) and microautotrophs (20-200 µm). These results confirmed that the different groups are selectively grazed by MZP, which may have implications for population growth of other phytoplankton functional groups.

HURRICANE

Impact of Hurricane Harvey on sediment biogeochemistry in the Mission Aransas Estuary, Texas

Amber K. Hardison, Xianbiao Lin; Xin Xu; Kaijun Lu, Sarah Douglas; Jianhong Xue; Zhanfei Liu

Hurricane Harvey made landfall in Texas as a category 4 storm on August 25, 2017. The eyewall passed directly over the Mission Aransas Estuary (MAE), part of the Mission-Aransas National Estuarine Research Reserve, bringing sustained winds >130 mph, storm surge, and rainfall. These disturbances had profound impacts on the biogeochemistry of the MAE, which is a shallow (<1 m) system characterized by limited exchange with the open Gulf. We collected sediments (0-5 cm) at 19 stations within the MAE pre-Harvey (June 2017) and post-Harvey (October 2017 to June 2018) to characterize the effects of the storm on sediment properties, including grain size, organic content, pigments, and nitrate reduction rates (denitrification, anammox, DNRA). Continuous turbidity data from the NERR system wide monitoring program show extremely high turbidity levels (>1300 NTU) for two days following the storm, the highest recorded level since the sensors were installed in 2007. Sediment grain size also changed dramatically post-storm, with sediments becoming coarser on average, at some stations by up to 100

um. Turbidity and grain size results reflect resuspension of fine material from wave action and surge, indicating major movement of sediment within the MAE. Sediment organic matter concentrations were mostly unchanged from June to October 2017, but the quality of that organic matter changed post-storm. Benthic chlorophyll a decreased at most stations by an average of 40% from June to October 2017. Chla values at most stations were returning to pre-Harvey levels by March 2018. Rates of benthic denitrification, anammox, and DNRA were spatially variable pre-Harvey, with denitrification dominating NO3- reduction. These rates decreased substantially from June to October 2017 at most stations, indicating reduced biogeochemical activity estuary-wide. Analyses are ongoing, but preliminary data suggest that redistribution of sediments may have impacted sediment organic content and related sediment nitrogen cycling processes post-Harvey.

Impact of Hurricane Harvey on phytoplankton communities in the Mission-Aransas Estuary, TX

Elizabeth A. Schattle, Amber K. Hardison; Zhanfei Liu; Sarah V. Douglas; Hengchen Wei; Jianhong Xue*

As a foundation species in aquatic food webs, phytoplankton in estuaries react rapidly to environmental disturbances due to their quick growth rates. Changes in phytoplankton community composition were used as a proxy to gauge the major long- and short-term impacts on the biogeochemical processes of the Mission-Aransas Estuary after Hurricane Harvey, a category 4 hurricane, struck the coast of Texas in August 2017. Phytoplankton community was determined by size using size fractionation filtration and flow cytometry, and by using accessory pigments determined by high performance liquid chromatography (HPLC). Three days after the hurricane, salinity decreased by 36% at Copano Bay West (CW), the site closest to the Aransas River mouth, and by 47% at the Ship Channel (SC), the site closest to the Gulf of Mexico. The salinity did not return to pre-Hurricane levels by the time of sampling, 7 months after the Hurricane. The phytoplankton community at CW maintained a constant percent composition from June before the hurricane until October after the hurricane, with a high proportion of cyanobacteria. There was no obvious chlorophyll a peak at CW or SC following the storm. Phytoplankton community composition at SC showed common seasonal trends in the fall after the hurricane, with an increase in cyanobacteria and a decrease in diatoms. One notable exception is that dinoflagellates made up a large proportion of the percent composition of phytoplankton on September 13 after the hurricane, but decreased by the next sampling point on September 28, which might have been caused by the seasonal temperature drop. Percent composition of plankton by size six months after Hurricane Harvey showed common seasonal trends as well, indicating the phytoplankton community was not affected in the long-term by the sharp drop in salinity brought on by the hurricane.

Summarizing the environmental impacts of Hurricane Harvey

Erin L. Kinney, Stephanie Glenn; Bill Bass; Qian Song

Hurricane Harvey brought record-setting rain to the Houston-Galveston Bay region between August 26 – 29, 2017. In its aftermath, the environmental community sought answers to questions about Harvey's impacts on the region, but the impacts cut across disciplines and data were scarce or difficult to find. The Houston Advanced Research Center (HARC) compiled over 15 datasets on water quality, water flow, rainfall, superfund sites, air quality, wetlands, development, Harvey-related damages, power demand and outages into a Harvey Impacts storymap Harveyimpacts.HARCresearch.org. This publicly available, interactive visualization tool is designed to facilitate research, discussion, and action related to the

resiliency of the Houston-Galveston region. As of October 1, 2017 HARC's Harvey Impacts storymap site has been visited over 5,000 times and over 280 datasets have been downloaded.

Responses of phytoplankton communities to Hurricane Harvey in the northwestern Gulf of Mexico

Gulce Kurtay, Beth A. Stauffer*

In September 2017, Hurricane Harvey brought over 50 inches of rain to the Gulf of Mexico (GOM) coast, adding a total volume of 33 trillion gallons of freshwater to the region. This massive freshwater input was expected to result in changes in the biogeochemical composition of the northwestern GOM. Given changes in salinity and nutrient availability we expected to also observe changes in the phytoplankton community. This study investigates the effects of the Hurricane Harvey floodwater plume on nutrient concentrations and phytoplankton composition. To do this, data were compared from four cruises in the northwestern GOM that sampled dissolved nutrient availability and size-specific groups of phytoplankton (as chlorophyll-a) along an onshore-offshore gradient from Galveston Bay, TX. These include samples collected prior to Hurricane Harvey on the Gulf of Mexico Ecosystems and Carbon Cruise (GOMECC-3) in late July 2017 and three cruises after the storm in October 2017 (RAPID-1), January 2018 (RAPID- 2), and March 2018 (RAPID-3). The three RAPID cruises were designed to understand both the initial effects and recovery of the system. Preliminary results suggest that nearshore and continental shelf stations showed differences in inorganic nitrogen concentrations six weeks after Hurricane Harvey. Additionally, nearshore phytoplankton communities showed an order of magnitude decrease in combined pico- and nanophytoplankton biomass (<20 μm) and a threefold increase in microphytoplankton (>20 μm) during that same period. By January 2018 (approx. 4 months post-hurricane), we observed pico- and nanophytoplankton biomass return to pre-hurricane concentrations, while microphytoplankton remained consistent. In contrast, phytoplankton communities on the continental shelf showed a sixfold increase in combined pico- and nanophytoplankton biomass in surface waters six weeks after Hurricane Harvey, which remained high into January 2018. These preliminary results suggest that phytoplankton community composition differed pre- and post-Hurricane Harvey, and that these differences varied along an onshore-offshore gradient.

Water quality variability in Galveston Bay, TX following the extreme flooding event caused by Hurricane Harvey

Jamie L. Steichen, Rachel Windham; Jessica Labonté; David Hala; Karl Kaiser; Hernando Bacosa; Manoj Kamalanathan; Samanatha Setta; Antonietta Quigg

Hurricane Harvey made landfall near Rockport, TX (USA) as a Category 4 storm then stalled out over southeast Texas. The storm released ~21 trillion gallons of precipitation over the Houston-Gulf coast region resulting in an extreme flooding event causing increased runoff and river discharge into Galveston Bay. Over the 24 days following Hurricane Harvey, 5 sampling campaigns were conducted in Galveston Bay from the San Jacinto River to the Gulf of Mexico (10 stations). Samples were collected to characterize fluctuations in water quality and microbial communities to determine the effects of storm water runoff on the ecology of the Bay. Parameters analyzed included: water quality (temperature, salinity, pH, dissolved oxygen), nutrients (NO3-, NO2-, NH4+, HPO43-, SiO32-), oil (PAHs, PCBs), pesticides, pharmaceuticals (cotinine, imidacloprid, carbamazepine and carbamazepine-epoxide, prednisone), organic carbon (dissolved and total), enzymatic activity (laccase, lipase, leucine amino-peptidase, alkaline phosphatase, B-glucosidase), viruses, bacteria (16S) and phytoplankton community

(18S, Imaging FlowCytobot). Following the flooding event, salinities in Galveston Bay decreased to 0-5 psu relative to pre-Harvey salinities of 20-30 psu. Pharmaceuticals (except Prednisone) were present in lower concentrations immediately following Harvey and steadily increased over successive weeks. Prednisone was detected at highest levels immediately following Harvey and then rapidly decreased in subsequent sampling events. The microbial community responded after a lag time of about 10-12 days (from peak discharge) with a substantial removal of tDOC (42%). The marine coastal microbial community dominated when samples were collected before this flooding event and then were replaced by microorganisms of terrestrial sedimentary and freshwater origin. This collaborative effort will allow for improved understanding of the physicochemical and biological changes following a large storm event within subtropical estuaries.

Dramatic estuarine response to Hurricane Harvey: Observational and numerical approaches
Jiabi Du; Kyeong Park; Timothy M. Dellapenna

Hurricane Harvey, one of the worst hurricanes that hit the United States in recent history, poured record-breaking rainfall in Houston area. This extreme precipitation event caused dramatic changes in estuarine dynamics. Freshwater load into Galveston Bay during Harvey and the following month was estimated to be 8.98±2.62×109 m^3, 1.7 to 3 times the volume of the entire Galveston Bay. Such amount of freshwater water had completely renewed the entire Galveston Bay. Harvey also delivered 9.86×10^7 metric tons of flood deposit to the bay, equivalent to 21 years of average sediment load to the bay. Acute sea-bed erosion (as large as 0.5 m) followed by significant flood deposition was observed. Slow salinity recovery (~2 month), thick flood deposit (~10.5 cm average over entire bay), and spilling of large amount of toxic chemical pollutants had likely degraded the ecosystem over the bay and the adjacent shelf.

Influence of drought, periodic storm events, and Hurricane Harvey on particulate organic matter composition in a subtropical Texas estuary
Sarah V. Douglas, Jianhong Xue; Amber Hardison; Zhanfei Liu*

Estuaries in south Texas, such as the Mission-Aransas Estuary (MAE), receive very low base freshwater inflow for much of the year, interspersed with sporadic pulses of precipitation and resulting freshwater inflow events. These episodic storm events and variable freshwater inflow are critical contributors to the MAE's dynamic salinity, nutrient availability, and particulate organic matter (POM) composition, including phytoplankton community composition. Estuarine food webs are largely fueled by POM, which includes both living and non-living organic material. Hurricane Harvey, a category 4 hurricane, passed directly over the MAE in late August, 2017, impacting the entire estuary and lower portion of the Mission and Aransas river watersheds with heavy rain and winds up to 130 mph. Previous work demonstrates that POM sources and composition change dramatically from drought to flood conditions, but the impact of a category 4 storm on the MAE's POM composition and phytoplankton community structure was unknown. We analyzed suspended particulates from four sites across the MAE taken monthly from 2011-2018, using stable carbon isotopes and accessory pigments as biomarkers for POM sources, and total particulate amino acids (TPAAs) as proxies for POM lability. We found that bulk particulate organic carbon and chlorophyll a increased significantly during non-drought conditions in the MAE, especially following periodic storm events. Overall increases of TPAAs following storm events indicated enhanced lability of available POM. Phytoplankton community composition also shifted in response to freshwater inflow events, favoring cyanobacterial species at river-influenced sites in Copano Bay. Hurricane Harvey, which caused tremendous physical mixing in the MAE, did not appear to

significantly alter phytoplankton community composition. The “flood or famine” paradigm of the MAE during typical drought/flood conditions causes dynamic responses in POM sources and quantity, and the resilience of the phytoplankton community post-hurricane may be an indication of overall system resilience to major storm disturbances.

Effects of Hurricane Harvey on larval fish distribution in the Gulf of Mexico

Shannan McAskill, Michelle Bromschwig; Simon Geist*

Hurricane Harvey was a major ecological disaster that hit the coast of Texas late August, 2017. The storm sent thousands of gallons of eutrophic freshwater into the Gulf of Mexico (GoM). Early life stages of fishes in the GoM are vulnerable to changes in environmental parameters and are unable to avoid sudden changes in environment due to their limited mobile range. While past hurricane-induced flooding events have been shown to alter the species composition and distribution of estuarine and oceanic phytoplankton and copepod communities, few studies have focused on how larval fish communities respond to hurricane-induced flooding events. This study is part of a larger research project which also investigates the response of phytoplankton and zooplankton community composition and trophic interaction resulting from the flood plume. Here we present an assessment of how the Hurricane Harvey floodwaters affected the larval fish community in the GoM near Galveston, Texas. For that we address the following questions: 1) How did the altered salinity regime affect larval fish composition and abundance, and did coastal fish larvae undergo geographic displacement, being flushed out farther onto the GoM shelf than normal? Larval fish were collected in September and October 2017, approximately three and six weeks after Hurricane Harvey occurred. The samples were collected along two SEAMAP transects, perpendicular to the Galveston Bay shoreline using a 61cm Bongo net (335µm mesh). Here we focus on the comparison of the horizontal larval fish community distribution and abundance to water column properties. In the future, this will be expanded to include a higher vertical resolution of different depth strata (MOCNESS and Neuston net samples) and to extend the temporal dimension of the response in the plankton community by including samples from to more research cruises 3 and 7 months after the event.

Has subsidence within the upper reaches of Galveston Bay resulted in elevated trapping of contaminated sediment from the floodwaters of Hurricane Harvey?

Timothy M. Dellapenna, Victoria Bartlett; Mason Bell; Lisa Hill, Mohammad al Mukaimi

Hurricane Harvey delivered 100-135 cm of rain to the Galveston Bay watershed in 5 days. The highest of this rainfall was delivered across the heavily urbanized and industrialized bayous that drain into the upper reaches of Galveston Bay, within the San Jacinto River and the Houston Ship Channel (SJR/HSC). The SJR/HSC has experienced up to 3 m of subsidence in the past century and with at least half of this new accommodation space filled with contaminated sediment, with average sedimentation rates of 2.2-2.8 cm y-1. The sediment deficit within the SJR/HSC is likely, at least in part due to the number of dams and reservoirs within the lower drainage basins of the SJR. These reservoirs include Lake Houston, which is 12 km up stream from our upstream most sampling station and the Barker and Addicks Reservoirs (BAR). The BAR are 50 km to the west of the confluence of Buffalo Bayou and the SJR/HSC, and this stretch of the Buffalo Bayou extends across center of Metro Houston. Controlled releases from the Barker and Addicks Reservoirs resulted in continual high discharges across Buffalo Bayou for weeks after the storm, resulting in the delivery of a prolong pulse of flood water into the SJR/HSC. Newly collected cores coupled with comparisons of archived cores will be used to determine the inventory of contaminants within the SJR/HSC as well as other parts of Galveston Bay pre-Hurricane Harvey and post-

Hurricane Harvey to assess the delivery and dispersal of the flood pulse sediment as well as the inventory of contaminants within this flood pulse and to assess the contribution towards filling the sediment deficit within the SJR/HSC.

Phytoplankton dynamics in a shallow river dominated estuary: Effect of water column stratification on size distribution and taxonomic composition

Michael C. Murrell

Estuaries are highly productive ecosystems and phytoplankton serve a key role in supporting secondary productivity. In conjunction with routine water quality monitoring in Pensacola Bay (FL), we collected monthly plankton samples from surface and bottom waters of the Escambia Bay sub-estuary from Apr. 2014 to May 2016. This region of the bay is often strongly stratified yet is shallow enough to be euphotic to the bottom. Thus, we examined the potential for stratification to create unique niches, resulting in distinctive phytoplankton communities. We used two principal methods to examine the phytoplankton composition: 1) direct enumeration of pico-cyanobacteria via epifluorescence microscopy, and 2) enumeration of larger phytoplankton (>10-20 µm) via FlowCam® and subsequent image analysis. Like earlier studies (e.g. Murrell and Lores 2004, Murrell and Caffrey 2005), we observed very high abundances of pico-cyanobacteria (peak abundances >3 X 10^9 L-1) during summer months. For larger phytoplankton, flow Cam analysis has yielded an image library of phytoplankton images. The abundance and biovolume of major taxonomic groups will be summarized for surface and bottom waters over a seasonal cycle and placed in context with the prevailing physical environment.

Elucidating molecular level information of dissolve organic matter from south Texas rivers before and after Hurricane Harvey

Kaijun Lu, Zhanfei Liu

Riverine dissolved organic matter (DOM) is a major source of reduced carbon from land to marine environments, and the inflow of terrestrial riverine organic matter highly affect biogeochemical cycling in estuaries and bays. Thus, any change in DOM composition, such as changes caused by flood waters as a result of hurricanes, could subsequently change estuarine environments. To investigate the impact of category 4 Hurricane Harvey on riverine DOM, multidimensional structural molecular level information of DOM from four south Texas Rivers (Aransas, Lavaca, Mission, and Nueces) was acquired using a high-resolution analytical technique, Ion Mobility Quadrupole Time of Flight Liquid Chromatography Mass Spectrometry (IM QTOF LC/MS). Pre-hurricane samples were collected in May, July and October of 2016, while post-hurricane samples were collected in September of 2017. The LC data showed that under ESI+ mode, pre-hurricane DOM share very similar chromatograms despite different seasons, but the chromatograms of post-hurricane DOM possess multiple unique peaks, suggesting the influence of flood waters. The MS data further showed that H/C ratios of the DOM molecules significantly decreased, while the O/C ratios increased. The change in elemental composition in post-hurricane DOM may indicate an increase of recalcitrance of the riverine DOM, which might be result of mobilization of refractory DOM from the watersheds by the flooding after hurricane. Principal coordinates analysis (PCoA) of DOM composition supported this conclusion as the May-2016 samples, which were collected after a storm event, were similar to the post-Harvey samples. Currently the analysis is still on going, and more results, including geometric and isomeric information of DOM, will be presented.

Submergence, nutrient enrichment, and tropical storm impacts on *Spartina alterniflora* in the microtidal northern Gulf of Mexico

Jennifer M. Hill, Peter Petraitis; Kenneth L. Heck Jr.

Salt marshes face chronic anthropogenic impacts, such as relative sea level rise and eutrophication, as well as acute episodic disturbances from tropical storms that can impact the growth and productivity of these ecologically important communities. However, it is not well understood how marshes, which are already subject to eutrophication and sea level rise, will respond to added effects of episodic storms such as hurricanes. Here we examined the interactive effects of nutrient addition, sea level rise, and a hurricane event on the growth, biomass accumulation, and resilience of the saltmarsh cordgrass, *Spartina alterniflora* in the Gulf of Mexico. In a marsh that experiences very small tidal variation, we experimentally manipulated nutrient levels and submergence and took advantage of the impacts of Hurricane Isaac. Sea level was manipulated using marsh organs, in which cordgrasses were planted in rows at differing intertidal elevations. Prior to the hurricane, grasses at intermediate and high elevations were increasing in abundance. After the hurricane, all elevations and nutrient treatments showed nearly identical effects with losses of approximately 50% of their shoot abundance, demonstrating added nutrients and elevation did not provide resistance to hurricane disturbance. At the end of the experiment, only the highest elevations demonstrated any resilience to the hurricane with increased above and belowground growth. Added nutrients provided a modest, but not always significant, increase in above and belowground growth, but only at the highest elevations indicating that elevation, and not nutrient enrichment, will enhance resistance or resilience to hurricane disturbance. These results empirically demonstrate that *Spartina* already subjected to submergence stress is much less able to recover from storm disturbance and suggest we may be underestimating the loss of marshes due to relative sea level rise.

OFFSHORE/GULF

From largest to fourth smallest: Size of northern Gulf of Mexico 'Dead Zone'

Nancy N. Rabalais, R. Eugene Turner

The area of the northern Gulf of Mexico continental shelf influenced by the Mississippi and Atchafalaya rivers is subject to perennial and severe oxygen deficiency most summers. The strongest correlate of the area of low oxygen (called hypoxia, or dissolved oxygen less than 2 milligrams per liter) in mid-summer is the load of NO2+3 in May of the preceding spring. The relationship is strong, but variability can occur from year to year due to weather conditions, including tropical storm activity, local weather systems, shifts in direction of winds from the predominantly southeastern direction to from the north and west. Weather conditions in mid-summer 2018 pushed a hypoxic area that often extends well into Texas towards the central Louisiana shelf so that the seabed footprint was much less than expected, but was thicker in volume. The hypoxic bottom-water area was calculated at 7,040 square kilometers, the fourth smallest since 1985, but the prediction was for 17,000 square kilometers. High river discharge and high nutrient concentrations in May 2017 led to a prediction of 26,131 square kilometers. The calculated area was 22,720, which was less than the prediction. There was insufficient time to finish off the western end of the bottom-area map. A multivariate analysis of 27 years of ancillary data and size of bottom-water hypoxic area identifies the greatest positive parameters of influence to be May NOx load, May orthophosphate load, May NH4 load, and June-July river discharge. Negative influences on summer area of hypoxia were high wind velocity, maximum wind gust, and wind direction two weeks prior to the cruise (i.e., from the north and west). The latter are weather conditions and are not predictive in the

form of a forecast several months out from the time of the mapping cruise, nor helpful with nutrient mitigation efforts in the watershed.

How are zooplankton abundance and distribution influenced by the Loop Current and Mississippi River plume?

Jillian Gilmartin, Hui Liu*

In the northern Gulf of Mexico (NGOM), spatiotemporal patterns in zooplankton are observed due to the complex nature of the Loop Current (LC) and associated eddies, which create zones of enhanced primary production, especially in the dynamic region where the northern extent of the LC and Mississippi River plume interact. We studied the abundance, distribution, and diversity of zooplankton in relation to environmental conditions in May 2015, July 2015, and June and July of 2016 in the northern and western Gulf. Zooplankton in the NGOM consisted of primarily copepods, chaetognaths, polychaete larvae, larvaceans, ostracods, cnidarians, decapod larvae, and echinoderm larvae. Copepods were the most dominant group, representing ~60% of the zooplankton abundance. Chaetognaths were the second most dominant group, with highest abundances in regions closest to the Mississippi River plume. Zooplankton abundance was lowest closest to the LC frontal zone, and species specific relationships emerged based on distance to the LC, as well as freshwater inflow from the Mississippi River plume. This study aims to provide new information to understand the spatial and temporal patterns of biological-physical interactions between zooplankton and the environment in the NGOM.

Patterns in phytoplankton and benthic production on the shallow continental shelf in the northeastern Gulf of Mexico

Jane M. Caffrey, Florian Cesbron; Michael C. Murrell; Melissa Ederington Hagy; Wade H. Jeffrey; William F. Patterson III

Shallow continental shelves support productive pelagic and benthic communities. In this study, we characterize water column and benthic production in the northeastern Gulf of Mexico focusing on the effect of light availability. Measurements were made between November 2015 and September 2016 on the shelf at water depths between 12 and 17 m. We measured benthic primary production and respiration as change in oxygen over time in chambers. Phytoplankton production was measured using 14C-bicarbonate incubations in a photosynthetron. Substantial benthic productivity ranging from 0.07 to 0.94 g C m-2 d-1 occurred in this region with highest productivity in the summer. Phytoplankton productivity ranged between 0.5 and 4.6 g C m-2 d-1, with maximum rates occurring in the spring. Given that light on the bottom in this region is usually between 0.2 and 3.1% surface irradiance, benthic microalgae make a significant contribution to a total primary production in the shallow waters of the northeastern Gulf of Mexico.

Modeling jellyfish population dynamics in the northern Gulf of Mexico

Chengxue Li, Hui Liu*

Gelatinous zooplankton (jellyfish) consist of numerous highly varied taxa and play a key role in shaping marine ecosystems. Jellyfish – mainly medusae, ctenophores often exhibit seasonal population blooms in response to environmental triggers, and rapidly produce enormous biomass that impacts the marine food web and fisheries. In the Gulf of Mexico, three species in particular have been associated with massive blooms: *Aurelia aurita*, *Chrysaora quinquecirrha*, and *Phyllorhiza punctata*. *Aurelia* is one of the

well-studied Scyphozoa species, and research has been conducted on factors that cause it to bloom. A quantitative description of phase-structured abundance of jellyfish allows understanding impacts of environmental changes on jellyfish dynamic and potential triggers of blooms. A full life history of the scyphomedusae has been modeled including benthic and pelagic phases (ephyrae, juvenile medusa, and mature adult medusa). In this study we report the development of an individual-based model for *Aurelia* sp. and simulation experiments to examine the population dynamics of the species and predictions of the population trends under a changing environment.

Quantitative analysis of tidal eddies for operational oil spill models

Dongyu Feng, Ben R. Hodges*

Oil spill accidents have been a consistent issue along the Gulf Coast and in the adjacent estuaries as a result of offshore oil drilling and tanker ship collisions. To minimize the ecological damage and optimize the emergency response, oil spill operational systems have been developed to provide advanced predictions for the fate and transport of oil. These systems require practical-resolution numerical models for computational efficiency and yet neglect small-scale flow features, such as tidal eddies that are commonly observed at the entrance of Texas/Louisiana lagoon-type estuaries. This research investigate the tidal eddies and their influence on the transport of passive tracers at the inlet of Galveston Bay, Texas. A grid sensitivity study on the numerical model (SUNTANS) are conducted. The result implies the practical resolution of ~400 m that simply captures the net transport through the entrance does not guarantee the correct prediction of the tidal eddies nor their effects on particle transport, which typically converge at the resolution of ~140 m. We proposed a subgrid-scale eddy model as a prototype to represent the tidal eddies at the operational scale. This research is aimed at developing and testing innovative methods for the improvement of oil spill predictions in the next-generation oil spill models operated by the Texas General Land Office and the Texas Water Development Board.

Identification of biochemical pathways contributing to oil tolerant ability of *Dunaliella tertiolecta*

Manoj Kamalanathan, Savannah Mapes; Jessica Hillhouse; Laura Bretherton; Hernando Bacosa; Antonietta Quigg

Exposure to oil has been shown to be lethal to most phytoplankton species, however some are able to survive and grow at a normal or reduced growth rates. This ability to tolerate oil exposure appears to be independent of the class and phylum of the phytoplankton and their ability to consume components of oil heterotrophically. We therefore conducted an experiment on oil resistant chlorophyte; *Dunaliella tertiolecta* in control and water accommodated fraction of oil with and without metabolic inhibitors targeting biochemical pathways (photosynthetic electron transport, cyclic electron transport of PSI, Kreb's cycle, mitochondrial electron transport, pentose-phosphate pathway and photo-respiration). We found inhibiting pathways such as photosynthetic electron transport and pentose-phosphate pathway were lethal, however inhibition of pathways such as mitochondrial electron transport chain and cyclic electron transport around PSI caused growth arrest in cells. Pathways such as photorespiration and Kreb's cycle appear to play a critical role in oil tolerating ability of *Dunaliella tertiolecta*. Analysis of photo-physiology revealed alteration in the photosynthetic apparatus under inhibition of photo-respiration and not Kreb's cycle. Further studies on how these photo-respiration and Kreb's cycle help the survival of *Dunaliella tertiolecta* is under way. Furthermore, the importance of these two pathways in other oil tolerant phytoplankton will also be tested.

MANAGEMENT/MONITORING

Developing a coastal health index for the northern Gulf of Mexico

Jenny Wrast Oakley, Frances Gelwick; Michelle Lawing; Anna Armitage; George Guillen*

Resource managers of coastal systems have widely accepted the need to move towards meaningful ecosystem-based management. Therefore, future management to promote ecosystem integrity will require coordinated monitoring of multidimensional biological, physiochemical, and socioeconomic elements for a comprehensive assessment of coastal systems. Healthy nearshore coastal waters should have the capacity to sustainably deliver a range of socio-ecological benefits to both people and wildlife now and in the future. Using nine biophysically meaningful coastal regions along the Northern Gulf of Mexico, we developed the Coastal Health Index (CHI). The CHI is a comprehensive 10-dimensional framework representing measurable outcomes of ecosystem health using a weighted linear combination of scores for each of the model variables. These ten variables mirror a global Ocean Health Index: food provisioning (fisheries and mariculture), artisanal fishing opportunity, natural products, carbon storage, coastal protection, tourism and recreation, coastal livelihoods and economies, sense of place (iconic species and lasting special places), clean waters, and biodiversity (habitats and species). Stakeholders (individuals who live in, work in, or visit the coastal Gulf of Mexico) were solicited to provide weightings on perceived levels of importance for each variable in the model. We received 2,265 surveys in which 1,815 provided enough information to include in analysis. According to the survey participants, the model variables that were the most important to consider when determining coastal health were clean water (36%) and diverse habitats and animals (33%), while the variables determined to be the least important was tourism (40%), carbon storage (18%), and non-food natural products (17%). Using stakeholder input gives flexibility to the CHI design, and its applicability to diverse user groups, each focused on variables of primary concern to their mission. Variable scores vary greatly by region and some variables with sufficient data show declining health trends. Being able to identify regions of particular concern for certain metrics of ecosystem health and to visualize trends of shifting health scores will help resource managers more effectively allocate conservation resources.

Making monitoring matter: Breaking down barriers to interdisciplinary collaboration in the Houston-Galveston area

Sarah Gossett; Lindsey Nolan

Galveston Bay Foundation's (GBF's) Water Monitoring program trains and equips citizen scientists to collect and understand essential water quality data from Galveston Bay. Through regular sampling, these volunteers create a unique portrait of water quality throughout Galveston Bay's nearshore environment. This cost-effective, results-driven approach to research has lead to an outcome-focused monitoring program that leverages citizen groups, university and research institutions, municipal officials, and businesses to investigate and respond to findings. To achieve these outcomes, GBF uses these data and associated findings to equip local stakeholders with the information needed to address the many challenges facing Galveston Bay.

This presentation will demonstrate the process necessary to create an effective citizen science monitoring team that ultimately results in program success. It will particularly focus on the process of shifting from an input/output-focused monitoring program to an outcome-focused program and the partnerships necessary to achieve impactful outcomes. This includes identifying desired outcomes and decisions, associated decision-makers, and the creation and distribution of outreach materials to

properly communicate the appropriate data and results with each targeted decision maker.

Case studies and specific examples will highlight GBF's success in using the information collected by the Water Monitoring Team to empower citizens and decision makers through targeted messaging and community-based marketing campaigns. These include mobilizing volunteers to collect some of the earliest post-Harvey water quality data within Galveston Bay, educating local recreators on potential water quality issues, and engaging with local municipal officials to address water quality concerns within their jurisdiction. This presentation will conclude with tools, suggestions, challenges and lessons learned throughout this process, as well as future plans to ensure GBF's water monitoring team continues to improve water quality in Galveston Bay through data management, analysis, education, and outreach.

Gulf of Mexico coastal science and coastal management: Teachable moments from a long, disappointing career

Kenneth G. Teague

I was trained in marine biology, marine sciences, coastal ecology, and wetland ecology, on the Gulf Coast. My career began in the mid-1980s, briefly, in academic research. Next, I worked briefly for the State of Texas on the Bays & Estuaries Program, and on Instream Flows, which was distinguished mainly by a lack of work. This was followed with my 28 year career at the U.S. Environmental Protection Agency, working mostly in coastal Texas and Louisiana. During my career, I experienced a number of notable situations which offer opportunities to consider such things as: ethics in coastal environmental management, the importance of coastal scientific training and experience in coastal environmental management, "burrowing in" in coastal environmental management, the corrosive influence of politics in coastal environmental management, ethics in academic research, the importance of science in coastal management, science denial, the importance of scientific peer review, corporate and agency scientific ethics, regulatory capture, data quality assurance, and employee harassment in coastal environmental management. I retired in 2016.

Reversing wetland death from 76,000 cuts: Opportunities to restore Louisiana's dredged canals

R. Eugene Turner, Giovanna McClenachan

We determined the number of permits for oil and gas activities in 14 coastal Louisiana parishes from 1900 to 2017, compared them to land loss on this coast, and estimated their restoration potential. A total of 76,247 oil and gas recovery wells were permitted, of which 35,163 (46%) were on land (as of 2010) and 27,483 of which are officially abandoned. There is a direct spatial and temporal relationship between these permits and land loss, attributable to the above and belowground changes in hydrology resulting from the dredged material levees placed parallel to the canal (spoil banks). These hydrologic restrictions in wetlands cause various direct and indirect compromises to plants and soils resulting in wetland collapse. Although oil and gas recovery beneath southern Louisiana wetlands has dramatically declined since its peak in the early 1960s, it has left behind spoil banks with a total length sufficient to cross coastal Louisiana 79 times from east to west. Dragging down the remaining material in the spoil bank back into the canal is a successful restoration technique which is rarely practiced in Louisiana, but could be a dramatically cost-effective and proven long-term strategy if political will prevails. The absence of a State or Federal backfilling program is a huge missed opportunity to 1) conduct cost-effective restoration at a relatively low cost, and, 2) conduct systematic restoration monitoring and hypothesis testing that advances knowledge and improves the efficacy of future attempts. The price of

backfilling all canals is about $335 million dollars, or 0.67% of the State's Master Plan for restoration and a pittance of the economic value gained from extracting the oil and gas beneath over 100 years.

Sources of water quality indicators to shellfish growing areas in the northcentral Gulf of Mexico

Ruth Carmichael; Ashley Firth; Kevin Calci

We evaluated potential sources of water quality variation, including a wastewater treatment plant outfall, river system, and adjacent shoreline sites, in Portersville Bay, AL, an area important for shellfish aquaculture. We measured fecal coliforms (fc), nutrients, and stable isotope ($\delta^{15}N$, $\delta^{13}C$) ratios as indicators of water quality at potential source sites and near shellfish farms under different temperature and rainfall conditions. Fc concentrations across all sites ranged from <5 to 5250 CFU/100 mL, with the highest fc concentrations in the river system (West Fowl River) and the lowest concentrations at the wastewater treatment plant outfall. Within the river system, downstream sites had higher fc concentrations regardless of environmental conditions, suggesting a persistent source of pollution at these locations. In contrast, upstream sites had increased fc concentrations during wet periods, suggesting these sites are fed by runoff and may be a pulse source to the river following rainfall events. $\delta^{13}C$ values were lower at river sites, consistent with freshwater influence. $\delta^{15}N$ and nutrient levels suggest residential areas in the river may be a source of unprocessed sewage to the system. Similar data collected at nearby bird roosting and cattle grazing sites showed comparable values but rapid decrease with distance (dilution) from these sources. These data indicate that the West Fowl River system is a potential source of contamination to Fowl River Bay where shellfish farms are located downstream, and specific locations in the river may be hotspots for fecal pollution. Overall, microbial and nutrient sources to the system were sufficiently different to provide endpoints for future source-tracing studies that include information on dilution and mixing. These data contribute to our identification and understanding of potential sources of water quality variation, which can inform modeling, further sampling, and enforcement efforts to improve the local water quality for recreation and aquaculture.

Cultivating a conservation ethic: The Galveston Bay report card

*T'Noya Wyndre Thompson**

The Galveston Bay Watershed is home to more than 10 million residents, with almost five million living in the Houston metropolitan region alone. These residents comprise a diverse population and represent an eclectic mix of cultures, ethnicities, and socioeconomic groups. Stakeholders must ensure that the messaging used to reach these communities, delivered with the ultimate goal of empowering local residents to protect their natural resources, is as unique as the communities themselves. What are the most effective ways to communicate best practices to such diverse audiences? Through a series of surveys and interactive presentations, six categories were identified by Galveston Bay Foundation as health topics of interest to the public in the fall of 2014: water quality, pollution events & sources, wildlife, habitat, human health risks, and coastal change. Scientists from the Houston Advanced Research Center then analyzed data and trends for 22 indicators. What has emerged is a compelling story about Galveston Bay, its challenges, opportunities, and greatest needs. Each indicator features easy-to-understand grades, similar to those you would find in a school report card. This easy to digest format is then distributed through marketing, presentations, and various community outreach events in the Houston-Galveston Area. This project is essential to preserving, protecting, and enhancing the valuable resources of Galveston Bay for generations to come. Due to this, it is important to assess the barriers and benefits of representative communities to ensure the conservation of Galveston Bay for

future generations. Prior to implementing a successful community-based behavior change campaign, one must select which behaviors to focus on, identify the barriers and incentives to these behaviors within a given community, and strategize how to reduce barriers to the behaviors to be promoted while simultaneously increasing the behavior's perceived benefits. This overview will explore how this project has been used to foster sustainable behavior change and what will change in order to cultivate a lasting conservation ethic.

POSTER SESSION

WATER QUALITY

Factors influencing the alkalinity of a South Texas estuary

Larissa Marie Dias, Xinping Hu; Dorina Murgulet*

The majority of Texas estuaries have been experiencing a long-term decrease in alkalinity and pH. In particular, during a dry year (2014), an alkalinity loss occurred in the Mission-Aransas Estuary (MAE). Even though carbonate precipitation can reduce alkalinity, the alkalinity loss observed in the MAE could not be entirely explained by calcification of biological organisms. The reaction stoichiometry suggests that another process is responsible for creating this alkalinity sink. Possible explanations include sulfide discharge from groundwater, atmospheric deposition of acids from anthropogenic or natural sources, such as sulfur dioxide from ships, reverse weathering, or cyclic sediment behavior (redox) of sulfur or metal species, such as oxidation of iron sulfide-rich sediments, during periods of low precipitation and high salinity. To identify the cause of the alkalinity loss in MAE, sediment cores were collected from the system and incubated to examine benthic processes on overlying water alkalinity. Surface water samples were collected on a weekly basis and analyzed for calcium concentration and alkalinity. Based on reaction stoichiometry, a 2:1 ratio of calcium ion to alkalinity concentration would be expected if calcification were causing the alkalinity sink. Preliminary results revealed deviation from expected calcium ion to alkalinity ratios, which suggests presence of a seasonal sulfur and metal species cycle that could have been exacerbated by low precipitation and high salinity and may have caused the alkalinity sink observed in the MAE. Cyclical redox reactions occurring in sediment may have a major impact on estuarine alkalinity and biogeochemistry; these types of reactions should not be overlooked when studying carbonate chemistry of estuarine systems.

Temporal variability and driving factors of the carbonate system in the tidal inlet of a semiarid estuary

Melissa Rae McCutcheon, Xinping Hu*

Monitoring of the carbonate system in the northwestern Gulf of Mexico's Aransas Pass was conducted via deployment of in situ pH and partial pressure of CO2 (pCO2) sensors for a period of 10 months as well as monthly discrete sample collection for over four years. Temporal variability was assessed on both diel and seasonal scales. The daily range in pH at the site often exceeded the magnitude of average pH decrease that has occurred globally due to ocean acidification over the last century. Thermal and non-thermal controls on the carbonate system were assessed at both diel and seasonal time scales, and it was concluded that temperature exerts the primary control on diel variability of pCO2, but non-thermal controls, which may include tidal fluctuations and biological activity, exert the primary control on the system over longer time scales. Differences in calculations of CO2 flux resulting from these two different sampling methods are also reported to help suggest limitations and resulting uncertainties of

current sampling methods for CO2 flux estimations. This study provides a step toward a better understanding of the highly variable carbonate chemistry of coastal ecosystems.

Short term variability in water quality in Indian Bayou

Katerina Smyth, Jane Caffrey*

Water quality in rural areas can be negatively impacted by human activities despite lower population density. Indian Bayou, a part of the Pensacola Bay System, is sparsely populated with many unpaved red clay roads for the communities living along the Bayou shoreline. Recently, widening of the interstate, ditch clearing along the many unpaved roads, coupled with heavy rain events have led to increased sediment inputs. These impacts have led to local concern for the Bayou. This project conducted high frequency monitoring of water quality to examine variability within Indian Bayou. Sensors were placed off a dock in Indian Bayou to log the variability over an eight-week period. MiniDot Dissolved Oxygen and PAR sensors were used along with the HOBO Ware Conductivity sensor and Light tag sensors. The sensors were deployed on May 31st and discrete samples were collected in weekly intervals, along with downloading data from the data sensors, until July 27th. Each sensor logged data at frequencies ranging from once a second to once every fifteen minutes. Discreet water samples included YSI readings, water depth, Secchi depth, dissolved inorganic nutrients and chlorophyll a. Weekly YSI data readings were used to examine drift in sensors during the deployments. We examined how rain events affected salinity, light availability, nutrient distributions and phytoplankton biomass within Indian Bayou.

Spatial and temporal variability in water quality in three urbanized bayous of the Pensacola Bay system, Escambia County, Florida, USA

Grace Lily Sommerville, Jane Caffrey*

Anthropogenic influence from the increasing urbanization of the environment in estuarine watersheds affects the health of estuaries all over the world. Three urbanized bayous in the Pensacola Bay System; Bayou Texar, Bayou Chico, and Bayou Grande, are estuarine systems that are affected by anthropogenic effects of their surrounding watersheds. Land use in the Bayou Texar watershed is predominantly residential although commercial development has increased in recent years in the upper watershed. Bayou Chico's lower watershed is mainly industrial, while the upper watershed is residential. In Bayou Grande, the watershed is divided between Naval Air Station Pensacola on one side and residential on the other. This study examines spatial and temporal variability of the water quality of these systems over the same time period in contrast to previous studies of these Bayous have analysed each system separately. Bimonthly sampling of water quality, nutrients, light attenuation, and phytoplankton biomass along with analysis of historical data will give perspective of how water quality has changed and responded to the increasing urbanization of the region. This research will compare these estuarine systems in close proximity to one another, and evaluate the impacts of different types of urbanization. We use mixing diagrams to examine the relationships between nutrients and chlorophyll a along the estuarine salinity gradient of each system. Restoration activity is occurring in this area and this information should provide relevant information for management of these systems.

Apparent oxygen utilization of Bear Point Bayou
*Anna Katharyne Millender**

Dissolved oxygen (DO), a major indicator of water quality, is also a critical component for the survival and success of aquatic organisms. A low concentration of dissolved oxygen for an extended amount of time (a condition known as "hypoxia") can cause changes in behavior, physiological stress, and even death, significantly disrupting an ecosystem's balance and functions. Hypoxia events occur when the measured oxygen concentration in the water falls below 2 mg/L. Two sites of Bear Point Bayou on the Gulf Park campus of the University of Southern Mississippi have been monitored for DO, pH, turbidity, nitrate and phosphate on a monthly basis for the past 12 months (and continues). The goal of this project is to calculate the apparent oxygen utilization (AOU) which estimates oxygen consumption by organisms in the water column and determine if water quality was more heavily impacted by biological vs. physical processes.

PLANKTON

Extreme weather effects on phytoplankton community composition in Galveston Bay, Texas: Visualizing ecosystem response
Rachel Windham; Kirana Berich; Katie Bowers; Tyra Booe; Hannah Lee; Allyson Lucchese; Amelia McAmis; Allison McInnes; Jamie Steichen; Antonietta Quigg

Global climate change has led to increased frequency of extreme weather events including droughts, floods and severe storms within the last century. In Texas, the greater Houston area has experienced multiple occurrences of such events within the last decade. The increasingly urbanized city of Houston is located within the watershed of Galveston Bay, an economically and ecologically important estuary on the northwest coast of the Gulf of Mexico. Extreme changes in freshwater inflow quality and quantity as a result of floods, droughts and storms (hurricanes) can impact the ecology of Galveston Bay. Monitoring campaigns designed to observe the extent of these ecological impacts have been conducted in Galveston Bay since 2010. Abiotic surface water quality parameters (temperature, salinity, dissolved oxygen, pH, conductivity, and water clarity) were assessed at discrete stations using a Secchi disk, refractometer and Hydrolab MS5 sonde. Water samples were collected for nutrient and phytoplankton pigment analyses. Phytoplankton community dynamics determined from these analyses serve as indicators of system-wide ecological response to changes in water quality. Contour maps facilitate the visualization of fine-scale gradients in each of the measured parameters along a transect from the San Jacinto River mouth to Gulf of Mexico throughout the period of study. Maps show that the ratios of pigments indicating Bacillariophyta and Dinophyta (estuarine and marine phytoplankton) compared to Chlorophyceae and Cyanophyta pigments (freshwater indicator phytoplankton) are largely influenced by both the magnitude and duration of freshwater inundation. Drought periods were dominated by Bacillariophyta. Prolonged flooding periods led to Chlorophyceae and Cyanophyta dominance in the northernmost stations of the transect which reflect that long-term climatological events can affect community-wide shifts. Ratios were nearly equal in the flooding period following a hurricane event supporting the assumption that Galveston Bay phytoplankton communities are resilient to short-term extreme weather events.

The effects of Hurricane Harvey on the phytoplankton community in Galveston Bay

Amelia K. McAmis; Jamie L. Steichen; Antonietta Quigg

Estuarine organisms are adapted to variable water quality conditions created in estuaries by various forces including: freshwater inflows, anthropogenic nutrient loading, tidal fluxes, ground erosion or urbanization, and even extreme events such as hurricanes. At the end of August (2017), Hurricane Harvey made landfall over the southeast coast of Texas as a category 4 storm, and arrived in the Galveston Bay/Houston area as a tropical storm; releasing 33 trillion gallons of water over four days. Following this flood event, salinities in Galveston Bay decreased to 2-7 psu near the Gulf of Mexico compared to 25-30 psu reported pre-Harvey. In this study, we analyzed the fluctuations of the phytoplankton community in response to the increased freshwater inflows. Cell abundances and community shift in five phytoplankton groups found in the Bay were analyzed at the following time points: 7 days pre-Harvey, and daily for the 4-28 days post Harvey. The relative abundance of the groups shifted in response to changing freshwater inflows. The dinoflagellate relative abundance decreased from 80% pre-Harvey to 5% four days following Harvey. Freshwater cyanobacteria comprised 70% of the community immediately following the flooding event. The chlorophyte population remained lower than 5% up to 26 days after the storm and then increased to make up 35% of the community which decreased back to <5% on day 27. Diatom abundance increased 11-13 days after Harvey to 90-95% of the community but decreased to about 48% following a Euglena bloom 14 days post-Harvey. Percent abundance data displayed another increase of diatom cells 20-28 days post-storm to make up 85-90% of the community. A comparison of percent abundance data pre-Harvey (65% diatom, 35% dinoflagellate) to the 28 days post-Harvey (80% diatom, 15% dinoflagellate, 4% chlorophyte, 1% Euglena) was performed. By our observation, it was determined that the phytoplankton community primarily returned back to a diatom dominant system a month after the end of the storm.

Spatial-temporal distribution of size-fractionated chlorophyll in three estuaries of the Texas coast with different freshwater inflow regimes

Tiffany L. Chin; Michael S. Wetz; Kenneth C. Hayes*

Research has shown the importance of freshwater inflow as a driver of estuarine biogeochemistry and planktonic production. On the Texas coast, a sharp coastwide freshwater inflow gradient exists, which leads to diverse estuarine conditions ranging from river influenced, low salinity systems to semi-arid, hypersaline systems. Few studies have compared water quality and phytoplankton communities in estuaries spanning this freshwater inflow gradient however. In this study, we compare water quality and size-fractionated chlorophyll within and between three estuaries that differ in the magnitude of freshwater inflow; San Antonio Bay (river influenced), Nueces-Corpus Christi Bay (limited river influence, strong ocean influence), and Baffin Bay (no major rivers, frequently hypersaline). Our goal is to understand how freshwater inflow affects the biogeochemistry, phytoplankton biomass and community composition in Texas estuaries. Preliminary findings show strong seasonal and spatial differences in chlorophyll within estuaries, as well as differences between the estuaries. This presentation will elaborate on these differences, as well as potential causes and implications for freshwater inflow management in Texas.

Role of diatom polysaccharide synthesis in diatoms and the associated bacterial in response to hydrocarbon exposure

Savannah A. Mapes; Manoj Kamalanathan; Meng-Hsuen Chiu; Hernando Bacosa; Kathy Schwehr; Shih-Ming Tsai; Shawn Doyle; Alexandra Yard; Carlos Vasequez; Laura Bretherton; Jason Sylvan; Peter Santschi; Wei-Chun Chin; Antonietta Quigg*

Diatoms are known to produce copious amounts of polysaccharide chrysolaminarin, especially during the stationary phase of their growth, however their exact role is still unknown. Diatoms also tend to secrete a significant amount of polysaccharide into the environment, which can serve as a good organic carbon source for several bacterial species. The 2010 Deepwater Horizon oil spill exposed the Gulf of Mexico to substantial amount of oil that had a severe effect on the phytoplankton community. Here, we study the role of chrysolaminarin in the growth and physiology of an oil sensitive diatom *Thalassiosira pseudonana* and how it shaped the surrounding bacterial community and their activity in the presence of hydrocarbons. We found that inhibition of chrysolaminarin synthesis had a strong negative effect on the growth and recovery of *T. pseudonana* in the presence of hydrocarbons. This negative impact was presumably through feedback inhibition of the electron transport between the two photosystems by accumulating monosaccarides. Inhibition of chrysolaminarin synthesis also influenced the bacterial community and their exoenzyme activity. An increased abundance of members of hydrocarbon degrader *Alcanivorax* genus and higher lipase activity was observed in response to inhibition of chrysolaminarin synthesis and the presence of hydrocarbon. This in-turn seemed to have favored biodegradation of hydrocarbon. Overall, chrysolaminarin synthesis played a significant role in the survival of *T. pseudonana* in presence of hydrocarbon and had a significant effect on the community composition and activity of the surrounding bacteria.

Comparison of seasonal abundances of pico- and nanoplankton in a South Louisiana estuary

Hans Joseph Prevost; Mrunmayee Pathare; Beth A. Stauffer*

Phytoplankton form the base of aquatic food webs and play an important role in carbon fixation and nutrient cycling. They are also among the first communities to respond to changes in environmental factors. The phytoplankton communities in the Atchafalaya-Vermilion Bay System (AVBS) have been quantified since 2016 to observe seasonal changes in abundance and community composition . Samples were analyzed using fluorometry to obtain chlorophyll a concentrations of the phytoplankton communities. Results from these analyses show overall dominance of the smaller size classes (< 20 µm) of phytoplankton throughout the year in this ecosystem. To further understand the composition and abundance of these small members of the plankton, preserved samples were analyzed using flow cytometry. These analyses allowed for enumeration of cells in different size classes (nano- and picoplankton) and functional groups (nanoautotrophs, nanoheterotrophs, picocyanobacteria, and picoeukaryotes) based on size and fluorescence. Picocyanobacteria had the highest abundances throughout the two year period with a maximum abundance in April 2017 and minimum abundance in January 2017. Nanoautotrophs showed the consistently lowest abundances, with minima in September 2016 and maxima in May 2017. Interestingly, however, nanoautotrophs showed the strongest correlation ($r = 0.76$) with the < 20 µm chlorophyll biomass throughout the study period. We are currently working to quantify how environmental factors (i.e. turbidity, nutrient availability, temperature, and salinity) may be influencing these members of the plankton community. Understanding these communities in the AVBS is needed, given their important roles in estuarine food webs and the potential for changes in their abundances to affect economically- and ecologically-important higher consumers.

SEAGRASS

Seagrass monitoring in the Pensacola Bay system: A partnership between citizens and the University of West Florida

Victoria Henry; Donald Fontenot; Barbara Albrecht; Rick O'Conner; Christina Verlinde; Jane Caffrey*

In the Pensacola Bay system, seagrasses are a dominant habitat in the shallow estuarine region, particularly in Santa Rosa Sound and Big Lagoon. Many aquatic animals use seagrass beds to feed, breed and seek refuge. In the summer of 2017 the University of West Florida (UWF), Escambia and Santa Rosa County Sea Grant Extension began a partnership to enlist citizens and UWF students to monitor seagrass beds. Each month during the growing season, local citizens identify seagrass species and use quadrats to estimate to coverage of seagrass and macroalgae at different locations in Big Lagoon and Santa Rosa Sound. They also collect water samples that are brought back to the laboratory at UWF where students measure salinity and total suspended solids (TSS). In 2018, salinity range was 10.13 to 25.89 for Santa Rosa Sound and between 15.8 and 27.1 in Big Lagoon. TSS during this year was usually below 8 mg/L in Santa Rosa Sound and below 19 mg/L in Big Lagoon. Seagrass coverage from 2017, by the citizen scientists, was comparable to earlier UWF data from 2016. The goals of this program are to develop an active community of citizen scientists and develop long term monitoring of seagrass habitats in the Pensacola Bay system.

Response of *Thalassia testudinum* to physical disturbance of Hurricane Harvey

Caitlin Mackenzie Young; Victoria M. Congdon; Kenneth H. Dunton*

Coastal ecosystems are vulnerable to temporary or even perpetual alteration following intense and severe meteorological disturbances. After Hurricane Harvey, a category 4 hurricane, hit the Coastal Bend of Texas in August 2017, physical damage to seagrass beds was quantified in preliminary assessments of percent cover and blade length in 16 permanent monitoring stations in Redfish Bay. Immediately following the storm (1-month post hurricane), sampled seagrass beds exhibited an average loss of almost 40% of *Thalassia testudinum* percent cover. The continuing response of *T. testudinum* to the intense winds and wave action brought on by Harvey was compared between two categories of impact based on initial seagrass percent cover loss: high-impact stations (greater than 60% cover loss) and low-impact stations (less than 25% cover loss). At these stations, seagrass beds were sampled again (3-months post hurricane) for *T. testudinum* percent cover, above- and below-ground biomass, leaf area (blade length and width), blade density and shoot density. Percent cover in high-impact stations increased from 1-month to 3-months post hurricane but was still significantly less than the percent cover of *T. testudinum* in low-impact stations at the 3-month mark. High-impact stations observed significantly less above- and below-ground biomass than low-impact stations. Lower shoot density and leaf area were observed in high-impact stations, likely from direct removal of seagrass during periods of high winds and wave action during the storm. Drift algae was present in 88% of high-impact stations and 50% of low-impact stations suggesting that physical removal of seagrass blades from the water column may allow for the establishment of other submerged aquatic vegetation. Continued, sequenced monitoring of these *T. testudinum* dominated beds may reveal the initial structural perturbations, such as the observed loss of *T. testudinum*, as significant factors in predicting the recovery of seagrass communities following severe storms and wind events.

Effects of a high-intensity disturbance event, Hurricane Harvey, on the biodiversity of seagrass epifauna in the Mission-Aransas estuary

Patricia Aileen Janssen; Lauren A. Yeager; Kenneth H. Dunton; Victoria M. Congdon*

Disturbance has long been recognized as a driving force of diversity within ecological communities. Hurricanes are a major natural disturbance that frequently affect coastal communities and can cause physical damage as well as changes in water chemistry due to large freshwater inputs. Seagrass habitats are an important coastal marine community that provide nursery grounds to many juvenile species, sequester carbon, and provide sediment stabilization. Seagrasses may be especially vulnerable to hurricane disturbance because they inhabit shallow water and soft sediments. Hurricane Harvey was a category 4 hurricane that devastated the Central Texas coasts on August 25, 2017. Following the hurricane, seagrass cover was reduced within areas that experienced the highest intensity winds, although losses in seagrass were patchy. The objective of this study was to examine whether these losses in seagrass cover had cascading effects on seagrass faunal communities. To conduct this study, push net surveys were conducted along replicate 10 m transects at 16 sites that varied in their degree of seagrass loss within the Redfish Bay, Texas in November 2017. It was found that species richness was higher at low seagrass cover sites, but overall faunal abundance and biomass did not vary predictably with seagrass loss. Higher species richness at low seagrass cover sites most likely occurred as a result of the hurricane bringing in some species that would not typically be found in the local seagrass communities and are more often associated with unvegetated habitat. Additionally, we detected a minor shift in seagrass community structure with 14% of the variation in community structure across sites explained by seagrass cover post-storm. These results suggest that the hurricane disturbance may not have caused large losses in seagrass community abundance or diversity, but rather resulted in shifts in composition of seagrass communities post-storm.

Long-term monitoring programs allow for assessment of Hurricane Irma impacts to South Florida seagrass communities

Sara S. Wilson; Bradley T. Furman; Margaret O. Hall; James W. Fourqurean

Hurricanes, typhoons and cyclones are some of the greatest environmental drivers of change in shallow benthic communities. This study investigates the impacts of Hurricane Irma on seagrass and macroalgal communities in South Florida, specifically Florida Bay (FB) and the Florida Keys National Marine Sanctuary (FKNMS), by leveraging multi-agency environmental monitoring data. Regular monitoring of these habitats has been performed since 1996, and we utilized these long-term datasets to investigate the hurricane impacts in the context of recent and historical ecological baselines for the system. Longitudinal analyses were performed to examine changes in total seagrass (TSG) and total calcareous green macroalgae (TCAL) density across regional zones from 2012-2017. Three types of seasonal analyses were also performed to confirm that any changes to the benthos post-Irma were due to hurricane impacts rather than seasonal variability. We found a significant decrease in TSG in the Lower Keys (Bayside) of FKNMS, and in Manatee Bay of FB relative to previous years, but no significant differences in TCAL were found in either system. Seasonal analyses confirmed that for both FB and FKNMS, impacts from Hurricane Irma were greater than those observed due to regular seasonal variability. Most seagrass declines in FKNMS were due to direct impacts (i.e., physical impacts), whereas seagrass mortality in Manatee Bay (FB) was indirectly linked to Hurricane Irma through hyposalinity and low dissolved oxygen resulting from stormwater drainage. Our study provides an example of a single storm unleashing both direct and indirect impacts to the benthic community in very different (and not all) areas of the same system. Our results offer a preliminary assessment of post-Irma seagrass status

and highlight the importance of long-term monitoring, not only as a historical benchmark, but also as the backbone for event-response monitoring in the aftermath of a disturbance.

Developing remote imaging methods for seagrass bed and soil carbon assessment

Ivy M. Hinson; Christopher A. Gabler; Abdullah F. Rahman*

Although seagrass beds provide many economically important ecosystem services worldwide, including mitigating the impacts of sea-level rise and enhancing commercial fisheries production, seagrass coverage is being lost at an average rate of 1.5% yr −1. The presence of excess atmospheric carbon and the resulting impacts make the capacity of seagrasses to sequester carbon of particular interest. Current seagrass coverage maps are generated by interpolating from samples taken by divers, making this method cost- and labor intensive. Recent research in resource management emphasizes the need for seascape-scale monitoring and planning. Remote sensing technology provides a versatile way for organizations to oversee large portions of landscapes, although the presence of water in coastal ecosystems provides unique challenges. Depth, water clarity, and water reflectance all influence the ability of sensors to provide valid imagery. The purpose of this project is to develop reliable, accessible methodology to assess seagrass coverage using aerial multispectral sensing techniques. Procedures for evaluating and mitigating the effects of water turbidity, water reflectance, and wave height will be investigated. The connection between canopy cover and belowground stored carbon is suspected but wide-scale data on this relationship is not readily available. The second goal of this project is to provide more comprehensive evidence for the link between seagrass coverage and stored belowground carbon so that carbon stocks may be reliably estimated using remote sensing.

A genetic analysis of the seagrass *Halodule wrightii* from Oso Bay, Texas

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Seagrasses are a relatively common group of rooted, marine angiosperms that provide essential habit for numerous commercially and recreationally important species. They also provide a number of freely available “ecosystem services” in the form of improved water quality, shoreline stabilization, and CO2 sequestration. Over the past several decades many species of seagrass have experienced decline and degraded environmental conditions across their range. A loss of seagrass can have severe impacts on marine biodiversity and the health of coastal ecosystems. Loss of diversity at the genetic level can also have major impacts, as various studies have shown a significant correlation between seagrass genetic (e.g. genotypic) diversity and resistance to environmental stress. *Halodule wrightii* is the most prominent species of seagrass on the Texas Gulf Coast. We used a DNA-based molecular marker assay to investigate genetic diversity in a population of *Halodule wrightii* from Oso Bay, near Corpus Christi, TX. We found low genotypic diversity (R = 0.20) and no evidence of a seed bank, but heterozygosity remains high (He = 0.73). Asexual reproduction appears to be the most common mechanism of reproduction in the northern portion of *H. wrightii*’s Texas range, though highly heterozygous genotypes appear to be favored.

SALT MARSH/MANGROVE/RESTORATION

Geochemical evaluation of salt marsh elevated with Best Use Dredge Material in Southeast Texas

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Subsidence of marsh land as well as eustatic sea level rise causes high marsh plants, such as *Spartina patens*, to be increasingly inundated with seawater. Longer periods of submersion promote sulfate reduction by microbes among the roots of these plants allowing sulfide to increase to phytotoxic levels. In 2005 and 2010, Best Use Dredge Material from local shipping channels was used to elevate areas within the Salt Marsh Bayou in Southeast Texas with the goal of returning function to these areas which were suffering the phytotoxic and erosive effects of increased water inundation. Here, porewater analytes (sulfide, ammonium, sulfate, nitrate, pH, salinity) and sediment redox, water content and ash free dry mass (AFDM, a proxy for organic content), were monitored in winter and spring of 2018, at unstable declining sites, healthy stable sites, and restored sites. Water content and AFDM were highest at unstable sites, and least at restored sites. Phytotoxic levels of porewater sulfide (>1.0 mM) were found to be typical at unstable marsh sites. Salinity, however, was lowest at these unstable sites (9.7 ± 1.6 ppt; n=30) compared the restored sites (15.0 ± 2.2 ppt; n=30), contradicting the assertion that salinity, and hence sulfate, drives greater sulfate reducer activity and sulfide levels. Restored sites had the lowest values of sulfate and sulfide, especially in winter. Ammonium concentrations at unstable sites were over 12 times greater than at restored sites in winter, but less so in spring as soil temperatures warmed. Lower pH from winter to spring implies greater decomposition as sediment warmed, suggesting that plant uptake of ammonium is a probable cause for reduced concentrations. Stable site values for geochemical parameters have been relatively intermediate. Overall, BUDM marsh restoration is reversing geochemical conditions from those of unstable declining marsh sites.

Do black mangrove and salt marsh vegetation provide different prey refuge values?

Rachael Marie Glazner; Anna R. Armitage*

Climate change is predicted to induce sea level rise and reduce the severity of freezing events on the Texas Gulf Coast; these changes are likely to lead to increased mangrove cover within the marsh-mangrove ecotone. The blue crab *Callinectes sapidus* is a commercially and ecologically important species within estuarine ecosystems along the Texas coast. It is a mobile invertebrate that feeds on a variety of organisms, and as an adult can be found foraging in both marsh and mangrove environments. A mobile prey item of the blue crab that is also found in marsh, mangrove, and open water habitats in Texas is the penaeid shrimp. The aim of this study was to determine if different vegetation types provide varying prey refuge values. Three habitat treatments were created within a 2-meter diameter tank. One treatment simulated mangrove pneumatophores, which were constructed from rigid wooden dowels. Another treatment contained plastic aquarium plants, which simulated flexible marsh grasses. The third treatment in the tank was a nonvegetated control. For each trial, five shrimp were placed in the tank for three hours. Five trials were conducted when the predator (*Callinectes sapidus*) was present, and five trials were conducted when the predator was absent. A GoPro Hero+ was mounted above the tank to record animal activity. Shrimp spent significantly less time in the mangrove treatment than the marsh treatment when the predator was absent, but the shrimp did spend significantly more time in the mangrove treatment than the marsh treatment when the predator was present. These results suggest that mangroves may provide more effective prey refuge than marsh vegetation.

A tidal mesocosm investigation elucidating the role of belowground warming on *Spartina alterniflora* and *Avicennia germinans* species interactions and growth responses

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Multiple studies have investigated the effects of atmospheric warming on mangrove range expansion into salt marsh; however, little is known about associated belowground processes in facilitating transgression. At the marsh-mangrove ecotone, we suggest that increases in estuarine water temperature may have pronounced effects on wetland soil temperature, thereby resulting in alteration of belowground biomass, biogenic accretion, plant productivity, species interactions, and plant community composition. To address this data gap, a tidal mesocosm experiment was established to investigate the effects of elevated seawater temperatures on key plant and soil responses. This design uses four vegetation treatments: *Spartina alterniflora* and *Avicennia germinans* grown both in monoculture and in mixture, plus unvegetated wetland soil. Unvegetated marsh soil and transplants of *A. germinans* and *S. alterniflora* were collected from areas adjacent to a companion warming experiment established at Guana Tolomato Matanzas National Estuarine Research Reserve, St. Augustine, Florida (GTM NERR). Semidiurnal tides were established to simulate the tidal frequency and and flooding depth at GTM NERR. Three estuarine water temperature regime treatments have been implemented to simulate current ambient seasonal water temperature fluctuations at GTM NERR plus two elevated water temperature regimes that range from approximately 2.5 to 5 degrees C above ambient temperatures in the summer and 5 to 10 degrees C above ambient temperatures in the winter. This type of controlled mesocosm approach in conjunction with companion field experiments can provide novel information on plant above- and belowground architecture and productivity, soil biogeochemistry, decomposition, and carbon dynamics that will advance our understanding of key environmental drivers of shifts in community composition and provision of ecosystem services under future warming scenarios.

The rate and trajectory of black mangrove (*Avicennia germinans*) recovery from a severe freeze event in Galveston, Texas

Jamie E. Thompson; Anna R. Armitage*

In the Gulf of Mexico, black mangrove (*Avicennia germinans*) populations have been expanding into salt marsh dominated areas. Typically, mangrove populations in the Gulf of Mexico are restricted by occasional severe freezing events, but the rate and trajectory of recovery by these mangroves following freezing temperatures is poorly understood. In January 2018, winter storm Inga affected Galveston, TX; temperatures were less than -4°C for several hours. These conditions induced widespread mangrove damage. To assess the rate and trajectory of freeze recovery, trees with partially damaged and fully damaged canopies were tagged and monitored from January to July 2018. Within the two damage classes, trees were also divided into three different size classes: small (shorter than 0.5 meters), medium (between 0.5 and 1.4 meters, and large (taller than 1.4 meters). Of the 56 trees surveyed, eight exhibited no new growth and are presumed dead; all but one of the trees that exhibited no new growth were fully damaged in January. Less than 10% of the trees were flowering but all those that were flowering had undamaged leaves after the freeze and were in the medium and large size classes. Trees that had 100 percent leaf damage in January recovered an average of 48.5% of their pre-freeze heights the following July, while trees that were partially damaged recovered 75.3% of their pre-freeze height. Despite the severity of the freeze event, which brought temperatures below the previously documented threshold for tree mortality, some recovery and flower production suggest that other factors play a role in mangrove survival and recovery following severe freeze events. Soil properties, population genetic

structure, and tree morphology should be analyzed to further study the resilience of mangrove individuals and populations to freeze events.

Shoreline stabilization potential of restored oyster reefs in Galveston Bay, Texas

*Erin A. Miller**

Coastal wetlands provide many services for the areas that surround them including structured habitat, water filtration through the sediment, and can dissipate storm surge effects. Increasing rates of wetland loss and loss of historic wetlands are causing concern in coastal communities. There has been increased efforts to restore and protect coast wetlands using living shorelines. One common method to first protect, and then facilitate wetland restorations, is to construct oyster reefs that can stabilize the shoreline. The objective of this study was to quantify the effects of restored subtidal oyster reefs on net sedimentation in the West Bay of Galveston Island. This data could help organizations with decision making regarding future projects as well as assist in acquiring funding in the future to sustain these projects. Sediment pins made of 7-foot-long PVC pipe were buried to a depth of 3 feet and an initial measurement of the elevation at the top was made to establish a baseline. These sediment pins were deployed at a restored oyster reef (n=6) and at a reference site (n=6), which lacks any restored reefs. Subsequent measurements of the sediment pin elevation, which were collected weekly between March-October 2018, provide a proxy for the net sedimentation in the area. Thus far, sedimentation rates have fluctuated less at the restored oyster reefs compared to the reference sites, with some interesting results at certain pin locations that have anomalous readings for their locations. The results of this study may be utilized to further direct management decisions for future restoration efforts of oyster reefs to further restore and protect coastal wetlands in the Galveston Bay system. Further research should include a longer study with a broader study area throughout the Galveston Bay ecosystem.

Effects of microbial amendments and plant diversity on dune restoration

Kerri M. Crawford; Michelle H. Bush; Hannah Locke; Noah C. Luecke

Sand dunes are important for protecting inland areas from flooding during storms and sustaining a diversity of plants and animals. However, sand dunes are often susceptible to both human and natural disturbance. Once dune vegetation is disturbed restoration is often necessary, but current restoration methods do not always lead to desired outcomes. In this project, we considered two aspects of restoration that may increase restoration success: soil microbes and plant diversity. Many plants rely on soil microbes to help them tolerate stressful conditions, but soil microbes are rarely considered during restorations. Furthermore, ecological theory predicts that plant mixtures should outperform monocultures, which are usually planted in restorations. We tested how plant diversity and soil microbes influenced restoration outcomes using experimental sand dune mesocosms where plant diversity (monoculture versus mixtures) and soil microbe (live native microbes versus a sterile amendment) treatments were fully crossed. Measured outcomes included plant biomass, soil aggregation, and colonization by native plants. Contrary to our predictions, preliminary data suggests that native soil microbes decreased plant performance. However, soil microbes may decrease competition between plant species, leading to greater diversity. The addition of soil microbes may also increase measures related to soil stability. Together, our results suggest that optimum restoration methods for sand dune restoration will depend on goals of the restoration, with soil microbes and plant diversity interacting in complex ways to influence restoration outcomes.

Ecosystem service logical models and metrics for Gulf restoration: Linking project outcomes to economic, health, and wellbeing benefits for people

Lauren M. Hutchison; Kara Coffey; Jill Hamilton; Sara Mason; Lydia Olander; Chris Shepard; Heather Tallis; Katie Warnell; Katya Wowk; David Yoskowitz

Billions of dollars will be spent on large-scale restoration of Gulf ecosystems over the coming decades, but there is no shared platform to guide assessment and reporting of restoration progress and effectiveness for the broad set of environmental, social, and economic goals. The diversity of these goals—including habitat restoration, water quality improvement, marine resource protection, community resilience, and economic revitalization—means a variety of metrics are needed to fully evaluate the effectiveness of restoration projects. A set of common restoration models and metrics relevant across projects, programs, and locations can facilitate effective project planning, evaluation, and measurement of success. This project will advance standardized metrics of restoration success by developing ecosystem service logic models with stakeholders from the five Gulf states, relevant federal agencies, and technical experts. Ecosystem service logic models trace the effects of restoration actions as they influence ecological and social systems to create important outcomes to people. In addition, evidence that accompanies these models can be used to clarify uncertainties that need to be considered and to identify critical research gaps. With local stakeholders and experts in each of the five Gulf states, we will develop site-specific ecosystem service logic models for restoration approaches commonly implemented across the Gulf. These will then be integrated into regional unified models that reflect the priorities of the local models. Using these regional models, priority metrics that effectively capture the outcomes of these restoration approaches will be identified. We will also assess the extent to which these metrics are already being monitored in the Gulf and where gaps in monitoring exist. We believe this project comes at a critical juncture for the Gulf and can help to inform investments in restoration so they will have the greatest possible positive impact on the Gulf economy, people, and ecosystems.

A black death? Can relic oyster shell be used in restoration efforts?

Rachel E. Sanchez-Ruffra; Marc H. Hanke*

For over a century, populations of the eastern oyster, *Crassostrea virginica*, have dramatically declined due to increased anthropogenic pressure and other various natural stressors. Periodic large-scale storm events are one natural stressor that can largely reduce oyster populations over a short period of time from freshwater inputs and the upheaval, and subsequent deposition, of sediment. In response, resource managers are tasked with mitigating the loss of this valuable resource through constructing new reefs or dredging practices, which upheaves buried shells for settlement substrate. These dredging practices expose 'black shell', which are oyster shells that have been buried by sediment in an anoxic environment. However, the capability of these entombed 'black shells' to facilitate oyster larvae recruitment once they have been exposed is relatively understood. The objective of this study was to determine how oyster larvae will recruit to fresh black shell and sun cured black shell compared to traditional sun cured oyster shells used in restoration efforts. On restored bagged reefs in Sweetwater Lake, Galveston, Texas, these three different treatments were deployed during the end of May and retrieved at the end of August. In addition to comparing differences in treatments, recruitment was compared to background densities of the restored reefs, to understand how shell type influenced recruitment of larvae, with taking into consideration population structure on each restored reef. The results of this study may be utilized to further direct management decisions for future restoration efforts after large scale storm events that sediment in oyster reefs.

NEKTON/INVERTEBRATES

Polychaetes tubes, turbulence, and erosion of fine-grained sediment

Amanda Michelle Kincke-Tootle; Kevin Briggs*

The role of polychaete tubes protruding through the benthic boundary layer in promoting or hindering erosion of fine-grained sediment was examined in laboratory experiments. Diver core samples of the top 10cm of sediment were collected west of Trinity Shoal off the Louisiana coast in 10-m depth. Some samples were sieved at a 0.5-mm to characterize the surficial macrobenthos and collect tubes created by macrobenthos for preservation. The remaining diver cores will be used in laboratory experiments conducted in a unidirectional flume. Tubes that were constructed by polychaetes, which comprised 70% of the species from the study area, were inserted in the core sediment surface and high-speed particle image velocimetry was used to determine the 3-D, 3-component fluid velocity at high temporal (100 Hz),and spatial (< 1mm vector spacing) resolution. The tubes that protruded above the boundary layer allowed vortices to be initiated. Tubes are made up of shell fragments and fine-grained sediment, allowing for some rigidity and resistance to the flow. Rigidity determines the resistance causing small-scale eddies to form. This turbulence incites erosion, allowing fine-grained particles to be suspended into the water and in some cases coarser particles to be mobilized. Less-rigid tubes succumb to the flow stream, allowing less eddies to form across the sediment boundary hindering erodibility and stabilizing the sediment. Results show that sediment dynamics are complicated by the effects of benthic biological activity

Mapping intertidal oyster reefs using side-scanning sonar and drone systems

George Guillen; Marc Mokrech

Oyster reefs provide environmental and economic services within coastal regions. Mapping the extent of these reefs and analyzing their composition can be highly beneficial for oyster management and restoration projects. This project examined the feasibility of the use of low-cost side-scanning sonar (SSS) systems and Unmanned Aircraft Systems (UAS) for mapping intertidal oyster reefs at two selected sites in Bastrop Bay and Bastrop Bayou complex following defined criteria that included the existence of intertidal oyster reefs and no aviation restrictions on the operation of UAS. The Hummingbird 1197c system was deployed when the minimum water depth was 2ft to allow vessel navigation and system deployment, while the UAS was deployed when shallow intertidal reefs were completely or partially exposed after meteorological events such as seasonal cold fronts which generate strong northerly winds produced water levels that were much lower than predicted low tide conditions. The SSS was used to collect bottom imagery that was processed using the SonarTRX platform to provide continuous coverage of the surveyed reefs. The UAS utilized during this study was used to collect visible images, which were post-processed using the Pix4D software to produce high-resolution orthoimages. The UAS images were superior to the side-scanning images in regards to quality, precision and the ability to differentiate reef composition. Classification techniques were used to identify different parts of the reef including exposed and submerged parts, while visual interpretation of images supported by field information on reef composition was used to classify different bottom categories (live and dead oyster, shell hash, mud bottom). We found that the UAS system is a useful tool for studying the distribution of intertidal reefs. However, the frequency of suitable meteorological and tidal conditions might limit the application of UAS systems for mapping intertidal reef.

Hunting for the elusive American Eel along the Texas coast

Justin Ray Hansen; Jenny Oakley; Stephen Curtis; George Guillen*

The American Eel (*Anguilla rostrata*) is a catadromous panmictic species that provides important fisheries along the northeastern United States. There have been recent unsuccessful attempts to request listing of this species under the Endangered Species Act (ESA). Within Texas, American Eel is considered a species of greatest conservation need. In order to assess the current status of American Eel in Texas, life history information including their distribution, abundance, habitat use, and population structure throughout the Texas coast is being gathered using historical data and extensive field surveys. The current research program provides the first comprehensive assessment of juvenile American Eel populations that utilize coastal estuaries. During this first year of the project (September 2017-August 2018), fish community surveys utilizing multiple collection methods including fyke nets were conducted several times a month at multiple strategic monitoring locations in the lower portions of the river drainages. Using data gathered during year one of the study, a more directed effort will be used in the second year to focus sampling efforts during those months when juvenile recruitment is observed. Water quality, hydrology, and macrohabitat data is being collected to help better characterize American Eel migration, distribution, and abundance patterns. These data will be used to assist resource management agencies in determining the conservation need of American Eel and direct future projects that may impact the well-being and longevity of this species.

Focused flows for natural hatcheries in Texas estuaries

Elaine Mae Kurr; Paul A. Montagna*

An estimated 95% of commercially and 85% of recreationally important species utilize estuarine habitats and coastal wetlands at some point in their life cycle. Many fish species rely on estuaries as essential nursery habitats for maintaining population size and health. These “natural hatcheries” require certain environmental conditions to be viable habitats for juveniles. This study examines the freshwater inflows needed to sustain natural hatcheries, especially in times of drought. The quantity of freshwater inflow becomes increasingly important during droughts, or low flow periods, when the demand for water increases and water supply to estuaries decreases. Three communities were studied; benthic infauna, benthic epifauna, and nekton survey data to determine if low flows can sustain ecological health in natural hatcheries during times of drought. Both benthic invertebrates, which are good indicators of estuarine conditions and inflow because of their connection to productivity and relative immobility, and fisheries data was used to evaluate ecosystem health and stability to determine if small amounts of freshwater can maintain vital habitat. The TPWD sampling is to monitor whole bay systems, so a scheme was devised to downscale TPWD data to the areas of interest which include Colorado-Lavaca Estuary, Guadalupe Estuary, and Nueces Estuary. Multiple stations were aggregated to create a general area of similar salinity conditions within each study site. A target species list was developed to focuses on those species of epifauna and fish that recruit to upper marsh habitats. As human population, coastal development, and climate change increase, planning for future freshwater fluctuations will help prevent the negative impacts of drought on the health and productivity of Texas estuaries.

Assessing utilization of an artificial reef complex and broad-scale movement patterns of juvenile red drum in lower Barataria Bay, Louisiana

David P. Behringer; James A. Nelson*

In Louisiana, coastal habitats that are essential for many fish species and productive fisheries are disappearing at an alarming rate. To mitigate habitat loss in coastal Louisiana, state agencies and conservation groups are conducting restoration and habitat creation projects, including the construction of inshore artificial reefs. Understanding how artificial reefs are used by juvenile red drum is of great importance to Louisiana fisheries, as red drum are highly targeted by recreational fishermen in Louisiana and across the Gulf of Mexico. To assess red drum use of Independence Island Reef, an artificial reef in Barataria Bay, LA, an acoustic telemetry array was used to track tagged juvenile red drum (n=15) from August 15, 2017 to April 25, 2018 at Independence Island and four adjacent habitat complexes. All but one fish were detected exclusively at the site where they were tagged. These results suggest that juvenile red drum in Barataria Bay have high site fidelity but are capable of traveling between habitat complexes within the estuary. Additionally, no fish were detected at the artificial reef sites. Based on this telemetry data, fish utilizing habitat complexes adjacent to Independence Island Reef do not use Independence Island.

Environmental drivers of histamine-producing bacteria in water samples and decomposing Spanish mackerel tissues

Ashley Frith; Kristín Björnsdóttir-Butler; Ruth H. Carmichael*

Histamine fish poisoning is one of the most common seafood-borne illnesses throughout the world. The illness occurs after human consumption of fish containing high concentrations of histamine. Illness has been attributed to extended storage of fish catches at temperatures above 4.4°C, allowing histamine-producing bacteria (HPB) to grow and convert free histidine in fish tissues to histamine. However, other variables that may affect HPB are not well studied and the exact mechanisms of poisoning remain uncertain. To determine how the levels and identity of HPB vary in the aquatic environment and, in turn, affect concentrations of histamine in fish tissues during decomposition, we enumerated and identified HPB in marine and riverine water samples as well as in Spanish mackerel tissues incubated at 4°C, 15°C, and 30°C. The HPB were enumerated using a 3-tube most-probable-number (MPN) real-time PCR method, and isolated bacteria were identified using both API and 16S sequencing. The concentration of HPB in water samples ranged from <0.001 to 93 MPN/mL, and preliminary results suggest that variations in marine HPB concentrations have strong linear relationships with water temperature and dissolved oxygen, but not pH nor salinity. HPB isolated from marine water samples include *Photobacterium damselae* and *Morganella morganii*, high histamine producers that have been previously isolated from Gulf of Mexico fish, while HPB isolated from riverine samples included less common high histamine producers *Plesiomonas shigelloides* and *Enterobacter aerogenes*. In mackerel tissues, early findings suggest that HPB levels are not evenly distributed across fish sections, regardless of incubation time or temperature. The results from this ongoing experiment will enhance our understanding of natural HPB populations and the mechanism of histamine production in fish, aiding the development of regulations for prevention of this illness.

Do sub-lethal amounts of pesticides alter the foraging and behavior of periwinkle snails (*Littoraria irrorata*)?

Taylor Clement; Allen Schaefer; Jennifer M. Hill*

Low concentrations of pesticides are entering coastal environments through run-off from agricultural fields and residential areas. Once in coastal communities, these low doses of pesticides may not kill marine species, but they may negatively impact their foraging and behavior. Periwinkle snails (*Littoraria irrorata*) are influential consumers in coastal marshes because they forage on *Spartina alterniflora* grasses and can drastically reduce marsh production unless limited by predation or non-consumptive predator effects. Overconsumption of *Spartina* grasses can result in a loss of many ecosystem services such as sediment trapping that builds marsh land and nursery habitats for fish and invertebrates. Despite their importance to the maintenance of marsh ecosystems, few studies have examined whether pesticides may affect periwinkle foraging or behavior. Our study objective was to determine if insecticides influence periwinkle snail foraging and behavioral responses. To accomplish this objective, periwinkles (4 per bowl) were exposed to sub-lethal concentrations of the pesticides Carbaryl and Fipronil and we measured the amount of *Spartina* consumed. We also measured changes in periwinkle behaviors such as climbing (number of snails out of water), the time for periwinkles to emerge from their shells, and their responses to predator cues. We hypothesized that higher concentrations of Carbaryl and Fipronil will result in decreased foraging of *Spartina* due to avoidance of the pesticide laden water and that responses to blue crab chemical cues will be reduced due to pesticide exposure. These results will demonstrate if low concentrations of pesticides may alter marsh productivity by altering consumer foraging behavior.

Can low doses of pesticides alter trophic interactions? The impacts of Carbaryl on blue crab (*Callinectes sapidus*) behavior and foraging

Allen D. Schaefer Jr; Taylor E. Clement; Nathan C. Hammond; Jennifer M. Hill*

Trophic cascades are important processes which regulate the structure and function of many marine communities such as salt marshes and seagrasses. The magnitude of these trophic cascades are dictated by a predator's ability to successfully locate and consume its prey (consumptive effects) and the ability of prey to avoid being consumed (non-consumptive effects). Thus, anthropogenic impacts or other stressors which alter predator and/or prey behavior can influence the outcome and magnitude of trophic cascades. Pesticides that target insects frequently end up in streams and estuaries in low, sub-lethal concentrations where they may impact the biological functions and behaviors of non-target organisms, such as blue crabs and other crustaceans. As keystone consumers, blue crabs play an important role in structuring estuarine communities by feeding on and controlling the densities of periwinkle snails, which consume significant amounts of marsh grass. Without predation, the consumption of grass by periwinkles could cause the loss of important salt marsh habitats and encourage coastal erosion. However, little is known about how pesticides may influence blue crab behavior or their ability to consume prey and cause trophic cascades. To understand how sub-lethal concentrations of pesticides affect blue crab foraging and behavior, we conducted laboratory assays measuring coordination, aggression, and foraging of blue crabs (*Callinectes sapidus*) exposed to four concentrations (0, 10, 20, and 50 μg/L) of the insecticide carbaryl over three days. Before and after exposure, we measured the crabs' positional righting time, interest in foreign stimuli, and the rate that crabs attack and consume periwinkles to simulate how pesticide exposure affects the crabs' survival rate and foraging. The results of this study will provide insight on whether pesticide concentrations

deposited in estuaries by the Mississippi River are significantly affecting the tropic interactions in estuarine ecosystems, as well as contributing to the coastal erosion in southern Louisiana.

OIL

Eastern oysters (*Crassostrea virginica*) as retrospective bioindicators to detect oil contamination in the marine environment

Kimberly Michelle Peter; Ruth H. Carmichael*

Bivalves are useful biomonitors because they assimilate particles from their environment into tissue and shell. To determine if bivalves assimilate oil-derived elements into their shells as a possible retrospective bioindicator of exposure to oil or other contaminants, we conducted a controlled laboratory experiment exposing juvenile oysters to various oil types and concentrations during a 4 month period. Oysters were exposed to one of six possible treatments: Macondo 252 source oil; weathered oil from surface water; highly weathered tarballs from local beaches; water collected from an industrialized area in the Mobile River, Alabama; spiked oil of known elemental concentration (positive control); and filtered artificial seawater (negative control). Trace element profiles from the shells of a subset of exposed oysters were obtained using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). To incorporate the effects of multiple stressors, oysters were exposed to locally relevant low salinity stress (14) or standard estuarine salinity (25). Biological response to oil exposure and salinity conditions was monitored by measuring oyster survival and growth throughout the experiment. Preliminary data suggest oil exposure during the study did not have a significant effect on oyster growth or survival. This research tests a new technique to improve detection and tracing of oil and other contaminants in coastal waters and could be applied to enhance existing monitoring programs for damage and recovery assessment.

Potential impacts of ocean acidification on diatom aggregation when exposed to crude oil

Jennifer Lynne Genzer; Antonietta Quigg*

Ocean acidification is caused by the absorption of atmospheric CO¬2 by seawater and could impact organisms that utilize inorganic carbon for photosynthesis. Diatoms, a group of silicifying phytoplankton, play a key role in the marine carbon cycle due to their high primary productivity rates, their worldwide distribution, and their contribution to marine snow formation through the production of extracellular polymeric substances (EPS) and transparent extracellular particles. These polysaccharide-rich compounds help to aggregate organic material and transfer nutrients and carbon through the water column to either be consumed or stored long term in the sea floor sediments. Diatom EPS production can also be a stress response from harmful substances, such as spilled oil. While little is known about the effects of oil spills on phytoplankton, even less has been studied about these events under ocean acidification conditions. Using *Thalassiosira pseudonana*, a small centric diatom, roller tank experiments were conducted to replicate aggregation and sinking through the water column. Six treatments with three replicates were used to examine ocean acidification and oil spills effects on *T. pseudonana* marine snow production: control, enhanced pCO2 level, water accommodated fraction of oil (WAF), enhanced pCO2 and WAF, diluted WAF chemically enhanced with Corexit (DCEWAF), and enhanced pCO2 and DCEWAF. Samples were taken from the parent treatment stocks at the beginning time point and after three days from all the replicate roller tanks. Measurements included physiological responses of *T. pseudonana*, changes in oil concentrations and components, and water conditions. The results of this

study will provide insights into how CO2 availability affects marine snow production and aggregation, and how phytoplankton may respond to harmful events such as oil spills in the future.

Effects of silica starvation on diatom *Phaeodactylum tricornutum* in the presence of oil and surfactant

Jessica Hillhouse; Talia Rodkey; Antonietta Quigg

The Deepwater Horizon oil spill released four million barrels of crude oil into the Gulf of Mexico, altering conditions and initiating physiological responses for phytoplankton. Diatoms are single-celled phytoplankton that have a silica frustule and are abundant in coastal environments. *Phaeodactylum tricornutum* is a marine diatom that has previously shown resiliency in the presence of crude oil and the surfactant used for remediation after the spill. The purpose of this study was to investigate the role the silica frustule plays in protecting *P. tricornutum* against the potentially harmful effects of crude oil and surfactants. *P. tricornutum* was cultured in f/2 media both with and without silica for five weeks. Both *P. tricornutum* cultures were then inoculated into four treatments: a control (f/2 media), a water accommodated fraction of oil (WAF), a chemically enhanced (with surfactant) WAF (CEWAF), and a dilute CEWAF (DCEWAF). Each treatment had a silica replete and deplete counterpart. The experiment was sampled daily for one week to monitor changes in cell densities, the concentration of oil, macromolecular composition of cells, and photosynthetic efficiency using fluorescence induction and relaxation (FIRe) curve parameters (Fv/FM, σPSII, ρ, and t1). Results showed oil concentrations decreased over time across all treatments. SEM image analysis showed frustule deformation (but not complete loss) in silica starved cultures. Further, growth rates were more affected than photosynthetic efficiency by the pollutants, and each silica deplete treatment deviated lower than its silica rich counterpart. Results suggest that *P. tricornutum* protect their photosynthetic apparatus against harmful conditions, suppressing growth rates until oil concentrations decrease and conditions return to normal.

Role of exoenzymes in marine snow formation in presence of oil and dispersant

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Marine snow are macroscopic aggregates that comprises of particles such as organic matter, dead and living microbes that sink through the water column providing carbon and energy to benthic ecosystems. The 2010 Deepwater Horizon oil spill contaminated the Gulf of Mexico (GoM) with an unprecedented amount of oil and large amounts of chemical dispersant were used as a remediation effort. Following this event, higher abundance of marine snow were observed in the Gulf suggesting oil and dispersant may have affected the process of marine snow formation. Moreover, higher concentrations of oil were associated with marine snow and nearly 1.8-14% of the oil spilled made its way to the sea-floor through its sinking process. Exoenzymes actively secreted by microbes excrete helps in breaking down exopolymeric substances to small monomers that provides nutrients (C, N and P) for microbial growth. Marine snow are hot-spots for exoenzymes activity that in-turn boost microbial activity. Therefore, we hypothesize that these exoenzymes might play a role in the formation and growth of marine snow. To study this, we conducted a time-course experiment using natural sea-water from GoM with and without chemical inhibitors of four major exoenzymes (α and β-glucosidase, alkaline phosphatase and leucine amino-peptidase) and exposed to oil and/or dispersant. Parameters such as exoenzyme activities, microbial growth and marine snow formation process were periodically monitored. These findings will be analyzed and the mechanism by which exoenzyme activity affected the marine snow formation process will be discussed.

The interaction of biofilm microbiomes, historic shipwreck preservation and the Deepwater Horizon spill

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Exposure to crude oil from Deepwater Horizon may have lasting impacts on the preservation of historic shipwrecks in the Gulf of Mexico. Submerged carbon steel structures, including shipwrecks, serve as artificial reefs which become hotspots of biodiversity in the deep-sea. Marine biofilms on submerged structures support settlement of micro and macro biota which enhance and protect against corrosion. Disruptions in the local environment, including those resulting from oil spills, may impact the role that biofilms play in preservation. To determine how the spill potentially impacted shipwreck biofilms and functional roles of biofilm microbiomes, experiments containing carbon steels disks (CSDs) were placed at five historic shipwreck sites located within and external to the seafloor footprint of the Deepwater Horizon spill and incubated for 16 weeks. Biofilms from CSDs and sediment and water microbiomes were collected and analyzed by 16S rRNA amplicon sequencing to describe communities and determine sources of taxa to biofilms. Metagenomes of biofilms were sequenced to compare differential gene abundances at spill impacted and reference sites. Biofilms were dominated by Zeta-, Alpha-, Epsilon- and Gammaproteobacteria. Sequences affiliated with the *Mariprofundus* and *Sulfurimonas* genera were prolific. *Roseobacter*, and *Colwellia* genera were also abundant. Sediment was the main known source of OTUs to biofilms. Differential abundance analysis revealed the two-component response regulator CreC, a gene involved in environmental stress response, to be downregulated at impacted sites compared to reference sites within the spill seafloor fallout plume. Genes for chemotaxis, motility and alcohol dehydrogenases were highly variable between reference and impacted sites. Metal loss on CSDs was elevated at sites within the fallout plume. Time series images revealed that metal loss at a heavily impacted site has accelerated since the spill. This study provides evidence that spill residues on the seafloor may impact biofilm communities and preservation of historic steel shipwrecks.

The impact of Hurricane Harvey on polycyclic aromatic hydrocarbons and alkanes in surface sediments of Aransas and Copano Bays in south Texas

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Hurricane Harvey directly passed over Aransas and Copano Bays, TX on August 25, 2017 with wind speed over 130 mph as a Category 4, which caused tremendous resuspension and sediment redistribution within the bays. Knowing how the sedimentary geochemistry was affected by this hurricane is important for evaluating the ecosystem impacts. Using surface sediments (top 5 cm) collected before (June) and after (October) the hurricane, we measured a series of geochemical parameters, including grain size, organic carbon and nitrogen content, polycyclic aromatic hydrocarbons (PAHs), total hydrolyzable amino acids (THAAs) and n-alkanes. The sediment grain size within the bays overall became much coarser post-hurricane with certain stations increasing over 100 microns in median size. Together with the OC content, concentrations of PAHs decreased from a range of 59 to 1605 ng g-1 to 19 to 204 ng g-1, and 80-100% of the decrease was attributed to the loss of low molecular weight PAHs (2-3 rings). Similarly, concentrations of n-alkanes decreased from 1.3-19.9 to 1.1-9.3 μg g-1 post-hurricane. However, there was no obvious trend among the different n-alkanes, unlike the PAHs. The coefficients of variation of PAHs and alkanes became smaller after the hurricane, indicating that organic composition of surface sediments was more homogeneous after the hurricane. Overall, PAHs and n-alkanes are strongly correlated with grain size in sediments, and these results suggest that the storm surge strongly

resuspended fine sediment particles that were concentrated in PAHs and alkanes, leading to the loss of these fine sediment particles and associated organic matter, either suspended in the water column or exported to coastal ocean. While some analyses such as THAAs are still ongoing, the preliminary data demonstrate the strong impact of Hurricane Harvey on sediment organic geochemistry of Aransas and Copano Bays.