RUTGERS

2023 RIOS REU Projects

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1. Rapid change in Antarctic coastal ecosystems in response to a changing climate

Oscar Schofield, Department of Marine and Coastal Sciences

This project will use a 30-year time series collected along the West Antarctic Peninsula which is experiencing some of the most rapid change on Earth. The changes are reflected in the ocean physics, chemistry and across the food web. The changes in the food web are exhibited from the phytoplankton, zooplankton, and penguins/whales. This project will focus on analyzing the linkages across the food web and its relationships to observed changes in the ocean physics and chemistry. This is critical as this area will serve as a model for how polar systems will respond to a warming planet.

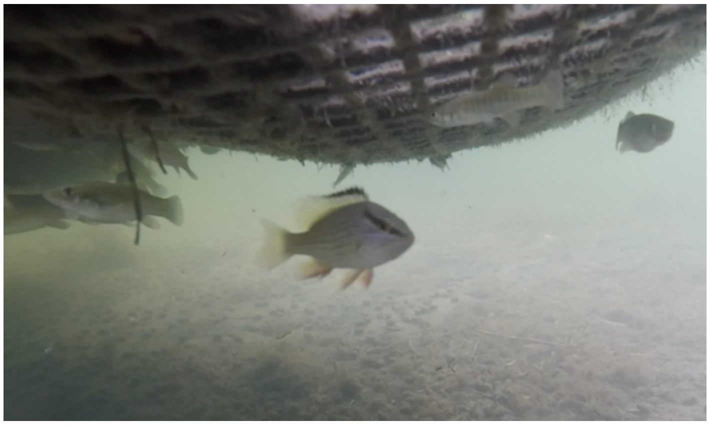
2. Estuarine transport processes.

Bob Chant, Department of Marine and Coastal Sciences

In the summer of 2023 Bob Chant's group will be conducting physical oceanographic studies of Delaware Bay Estuary and the Barnegat Bay/Little Egg Harbor system as part of two recently funded projects by the National Science Foundation. Both of these studies involve moored and shipboard observations of currents, salinity and temperature, drifter studies and use of idealized and numerical modeling efforts. The Delaware Bay project is focused on processes that tend to accumulate surface trapped material in mid-channel with an emphasis on tidal variability in cross channel flows. Our hypothesis is that competing processes tend to accumulate surface trapped particles in mid-channel which then impacts the along channel fate and transport of the surface trapped material, such as buoyant larvae and microplastics. The Barnegat Bay/Little Egg Harbor study focuses on tidal flows at the inlets and the tendency for these strong currents to drive a mean flow into or out of the system. Like many coastal lagoons the Barnegat Bay/Little Egg Harbor system is characterized by multiple inlets and the mean transport through the inlets may be the dominant mechanism that flushes these systems. A leading hypothesis of this study is that the mean flow due to tidal processes through an inlet is highly sensitive to details of the inlet morphology. Therefore, changes in inlet morphology, due to either natural or anthropogenic processes, may have a leading order impact on flushing time and thus water quality of coastal lagoons worldwide. Students involved in this research will participate in the field effort and have the opportunity to develop a project based on the field data and/or modeling studies.

3. Ecosystem services provided by shellfish farms

Daphne Munroe, Haskin Shellfish Research Lab



Shellfish farms are an ideal model system for studying the interaction of human and coastal systems. Farms provide jobs to coastal communities, depend on healthy, resilient coastal ecosystems, provide a plethora of ecosystem functions, and are the lowest impact form of animal-based food production. Farms commonly use structures in nearshore waters, including cages, bottom netting, or floating structures to prevent predators from accessing crops. These farm structures often provide habitat for fish and invertebrates – yet the specific nature of these interactions is poorly quantified. This project will perform field experiments at shallow-water shellfish farms in coastal bays as a model system to study habitat provisioning. Understanding this complex interaction is crucial for farm siting and management decisions that will ensure continued health of nearshore ecosystems. Likewise, with a global human population in excess of 7.5 billion, continued development of marine farms and healthy local food production is a cornerstone for future human health. This project will involve a combination of field, lab, and data work.

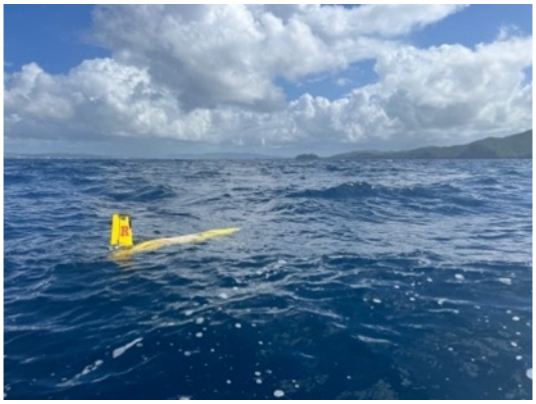
4. Advancing survey methodology for evaluating the impacts of windfarm construction on fisheries resources

Douglas Zemeckis and Jason Morson, Department of Agriculture and Natural Resources and Haskin Shellfish Research Lab

Rapid development of offshore wind is occurring off the northeast U.S. in response to demands for renewable energy. It is critical that we evaluate the impacts of this development on marine resources and ecosystems. We are currently pilot testing methods for evaluating how windfarm construction will impact fisheries resources that associate with different forms of structured habitats (e.g., shipwrecks, reefs, and wind turbines). Chevron traps, a type of trap commonly used in other parts of the coastal U.S. to sample structure-associated species, are being deployed at planned windfarm locations off New Jersey before, during, and after windfarm construction. However, since this sampling gear has not been used in this region previously, we need to know how well it samples the fish in this region. To evaluate what proportion of fish that come near the traps are actually retained within the trap, we are attaching GoPro cameras to the traps and pointing them at the trap opening. This project will analyze this GoPro video and compare fish counts from the video to counts of fish retained in the Chevron traps. Results from this project will aid in our understanding of this surveying method and the utility for evaluating the impacts of windfarm development on fisheries resources.

5. Robots in the storm

Travis Miles, Department of Marine and Coastal Sciences



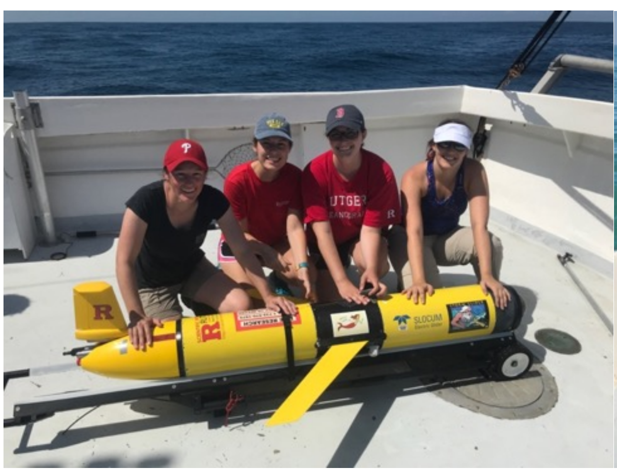
Tropical cyclones are one of the costliest and deadliest natural disasters on the planet. The ability to forecast tropical cyclone (TCs) intensity days ahead of landfall has improved in recent years, however intensity forecast errors remain large. The primary controls of the intensity of mature TCs are vertical wind shear, dry air intrusion, and the fluxes of enthalpy and momentum between the surface ocean and atmosphere. The ocean can evolve rapidly beneath TCs and feedback on storm intensity causing rapid intensification or weakening. Working with Assistant Professor Travis Miles and the Rutgers University Center for Ocean Observing Leadership the RIOS participant will utilize ocean observing networks including autonomous underwater robots, remote sensing, and ocean and atmospheric model output to study upper ocean processes that occur as landfalling hurricanes cross our continental shelves.

6. Autonomous observations of coastal shelf ecosystem processes

Grace Saba, Department of Marine & Coastal Sciences, Rutgers University

On the continental shelf off New Jersey, the ocean is characterized by remarkable variability across time scales from days to seasons to decades. This drives an equally variable ecosystem from primary producers to highly migratory fishes and marine mammals. To observe this variability and understand the connections between physics, chemistry, and multiple levels of biology, our team is conducting a comprehensive "ecoglider" program that will use autonomous underwater vehicles (AUVs) called gliders to provide a dataset of necessary oceanographic and ecological parameters that will inform the responsible development of offshore wind in the region and provide valuable information relevant to ongoing environmental and ecological change in this productive ecosystem. These AUVs are being deployed seasonally to collect high-resolution data throughout the water column. Deployed gliders include a full complement of available sensors to simultaneously map oceanographic and ecological variables from phytoplankton to marine mammals, including water depth, temperature, salinity, pH, optical properties including chlorophyll-a, and dissolved oxygen. Ecological sensors include a passive acoustics sensor for marine mammal monitoring and detection, multi-frequency echo sounders for active acoustic detection of pelagic fish, and acoustic telemetry receivers to track tagged species moving through the region.

A RIOS student with this research theme could participate in glider deployments and recoveries and utilize the collected glider data to answer research questions focused on exploring overlaps between oceanographic features and distribution of fishes and marine mammals.



7. Environmental stress and the Atlantic Surf Clam

Daphne Munroe, Haskin Shellfish Research Lab

The Atlantic surfclam (*Spisula solidissima*) is a widely distributed clam species, found from the Gulf of St. Lawrence, Canada to North Carolina, USA. In 2021 the surfclam was the largest commercial clam fishery in the USA by weight; however, the habitat of this economically important species is being impacted by changing marine conditions. Marine shellfish are susceptible to environmental stressors, including warming ocean temperatures and ocean acidification. Ocean temperatures are rising along the Atlantic coast of North America at a rate higher than that of the global average, and these warming temperatures are a likely cause of shifting surfclam distribution both northward and into deeper, cooler waters. Additionally, acidified conditions may cause physiological stress for surfclams, both reducing growth rates and contributing to increased mortality rates. Although the effects of temperature and acidification stress have been studied in the surfclam, it is important to consider the combined effects of these stressors as they occur simultaneously in natural habitats.

The goal of this project is to use laboratory experiments with surfclams to better understand the impacts of combined high temperature and acidified water on surfclam physiology, growth, and survival. By combining the results of this experiment with observations of marine temperature and pH, as well as predicted conditions, we hope to contribute to our understanding of where surfclams can be sustainably fished and farmed.

8. **Searching for catastrophic glacial floods in sediment cores from the Northwest Atlantic Ocean**

Aiden Starr and Natalie Umling (Sikes Lab), Department of Marine and Coastal Sciences

At the end of the last ice age, rapid melting of ice sheets over North America caused catastrophic floods, washing eroded sediments into the Atlantic Ocean. These were recorded as bright red sediment layers across the Northwest Atlantic, resembling the Canadian red sandstone from which they were eroded. Characterizing the transport and extent of these red glacial outburst layers across the region can help us better understand the timing and nature of the demise of North American ice sheets under a warming climate. In this project, the RIOS student will work in the Sikes Lab to prepare samples, and conduct laser grain-size analysis across several glacial outburst events in a sediment core recovered during the 2022 'PUFINS' expedition to the Scotia Shelf (https://sites.rutgers.edu/pufins-at-sea/). The student will also help to interpret X-ray Radiographs and sediment composition in the context of regional stratigraphy to build a picture of glacial outburst floods as we transitioned out of the last ice age. The Sikes Lab is actively involved in climate research in the North Atlantic and Southern Ocean and the student will be working with Postdoctoral researchers Dr Aidan Starr and Dr Natalie Umling.

9. Shellfish ecology and pathology

David Bushek, Haskin Shellfish Research Laboratory

Shellfish are important components of coastal ecosystems and economies. They create habitat, protect shorelines, filter water and support fisheries and aquaculture. Major challenges to their persistence include climate change, sea level rise, habitat loss, overfishing and disease. My lab investigates how shellfish respond to these challenges and what can be done to enhance their populations for their ecological value while developing sustainable fisheries and aquaculture.

Multiple opportunities are available for RIOS students to participate in ongoing projects investigating shellfisheries, shellfish aquaculture, living shorelines and the ecology of selected shellfish diseases. Interns would experience daily life at a research station as they gain experience in both field and laboratory investigations. A 2023 RIOS intern would likely focus on climate change impacts with respect to shellfish population dynamics, temporal and spatial patterns of shellfish pathogens, or assist with developing and evaluating living shoreline strategies that incorporate shellfish such as oysters or mussels. Increasing temperatures and sea level rise are changing host-parasite interactions and the latitudinal ranges in which they interact. Understanding how these interactions are changing and will continue to change is important to both our fundamental understanding of shellfish ecology and how to manage and protect shellfish resources into the future.

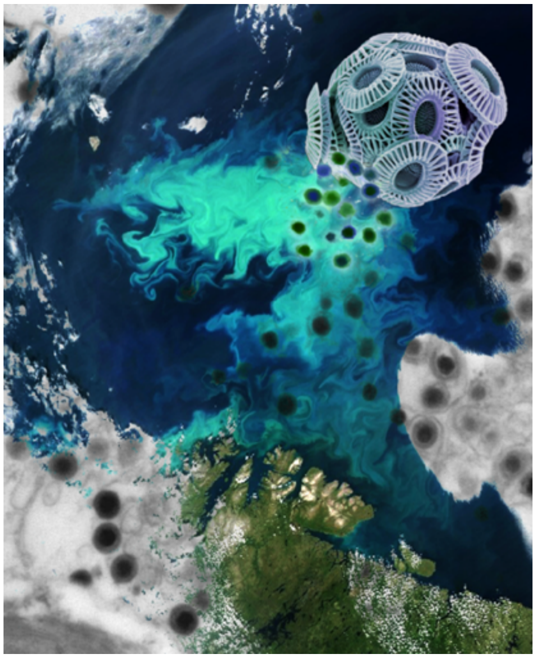
10. Overfishing or mother nature?

John Wiedenmann, Department of Ecology, Evolution, and Natural Resources

In the U.S., many populations of marine fish have exhibited large declines in abundance and have been declared overfished and in need of rebuilding. It has been widely accepted that such declines are largely the result of fisheries catching too much each year, called overfishing. However, for some populations, their abundance is largely driven by interannual changes in reproductive success, driven by environmental variability. For this project we will be analyzing data from a number of overfished populations to determine if the population declines were driven by catches being too high or by poor reproductive success. Findings from this work will have important implications for the management strategies aimed at rebuilding overfished populations.

11. The convergent impact of marine viruses, minerals, and microscale physics on phytoplankton carbon sequestration

Kay Bidle, Department of Marine and Coastal Sciences



Marine phytoplankton collectively account for more than half of global primary productivity. Sinking, aggregated particles of ballasted, marine phytoplankton export carbon from the surface to the deep-ocean and play a key role in the oceanic biological pump…the degree to which carbon in sinking particles can be sequestered in the deep ocean for hundreds to thousands of years. Immense spatial and temporal variability in productivity and export efficiency remain unexplained. Proposed research is part of a large NSF-funded 'Growing Convergence Project (one of NSF's 10-Big Ideas; https://www.nsf.gov/news/special_reports/big_ideas/) that converges biology, chemistry, physics, engineering, mathematics, and computational modeling at the intersection of two paradigms that describe how ecosystem interactions regulate the flow of carbon in the ocean…the 'ballast hypothesis' and 'virus shunt hypothesis' Our extensive lab- and field-based findings suggest that there are several, overlooked, ecosystem linkages and microscale physical regimes by which viral infection increases POC sinking flux and carbon sequestration to depth. These include enhanced particle aggregation, increased ballast production, and enhanced production of ballasted fecal pellets by zooplankton grazers. We suggest that these dynamic and coupled phytoplankton-pathogen-particle-predator linkages, which were traditionally thought to be independent and competing, coalesce in certain physical regimes to facilitate export fluxes and explain the high variability of POC export efficiency. Students will explore this idea using laboratory-based experiments on model host-virus (and possibly grazer) systems of diatoms and coccolithophores, the two phytoplankton groups that collectively account for ~98% of the estimated POC flux to the deep ocean. Experiments will quantify infection dynamics with particle formation/properties with microscale physics to help characterize and quantify links to each hypothesized export mechanism under field-relevant turbulent conditions. Engineering and analytical tools will be used to diagnose and track infection dynamics while characterizing and quantifying particle aggregation/disaggregation, sinking dynamics, grazing rates, biomineral composition and fecal pellet production under well-defined, microscale physical regimes.

12. Altered oceanic crust as archives of seawater chemistry

Danielle Santiago Ramos, Department of Marine and Coastal Sciences

The chemical composition of seawater holds important clues into the processes that cycle rocks and volatiles (including greenhouse gases) at Earth's surface, which have major implications for our planet's long-term climate stability. One of such processes is the hydrothermal alteration of oceanic crust by exchange with seawater along the flanks of mid-ocean ridges. These reactions are controlled by a number of factors, including the amount, temperature, and composition of the hydrothermal fluid. As a result, differences in the conditions of alteration can lead to significant spatial and temporal variations in the chemistry of altered rocks. In turn, the heterogenous nature of seawater-crust exchange hinders our ability to confidently determine the extent to which these reactions affect the chemistry of the oceans. To address this knowledge gap, it is crucial that we improve our ability to read the rock record by better understanding how the chemistry of altered crust relates to the variable conditions of alteration at the seafloor. In Summer 2022, I participated in an expedition to collect oceanic crust samples along a transect of the South Atlantic mid-ocean ridge system (see image above). The samples drilled from the ocean floor span a large range of crustal ages (6.6 to 61.2 million years old) and alteration styles, and our goal is to characterize the composition of a subset of these samples. The work will involve rock drilling, acid digestions and, time permitting, the interested student will also engage in sample analyses by mass spectrometry. Results from this project will help us to address the question of how different styles of alteration affect the composition of altered oceanic crust and, as a result, the chemical makeup of seawater.