RUTGERS

2022 RIOS REU Projects

Project Titles:

1. Dynamics of range shifts in fisheries; Are shifts permanent?

2. Characterization of hydrothermal discharge regimes

3. Mechanisms driving estuarine exchange

4. Investigation of small volcanic eruption mechanisms

5. The warming and melting Antarctic peninsula and the impacts on the polar food webs

6. Monitoring coastal water quality with ocean robots

7. Genetics of bivalve molluscs

8. Using newly available offshore buoys to evaluate the offshore side of the sea breeze

9. Response of an oceanic low-oxygen zone to cyclical climate changes during the Miocene (~14 million years ago)

10. A robot's view of our polar ocean ecosystem

11. Identification of different iron sources in the Amundsen Polynya, Antarctica

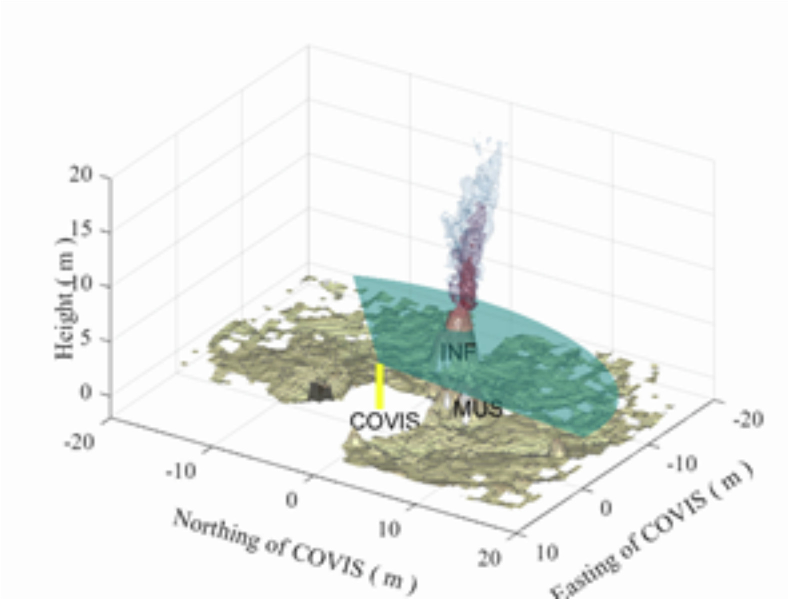
12. Shellfish ecology and pathology

1. Dynamics of range shifts in fisheries; Are shifts permanent?

Daphne Munroe, Haskin Shellfish Research Lab

The surfclam fishery has recently been catching clams off Virginia, grounds that have not been occupied for many years. It has been the paradigm that these southern grounds are no longer able to support fishable abundances of clams after temperature-driven clam mortality events were observed in the early 1990s. The re-appearance of fishable abundances may suggest that environmental conditions have returned that can support these populations, or that adaptation of the clams in that region to warmer water is underway. Alternatively, these clams may derive from a single large cohort that recruited there recently and survived to fishable sizes. This project aims to better understand how these clams are able to exist in this southern region, and whether they may be indicative of a more permanent recovery of that region. Biological samples will be taken to evaluate if these clams appear to be from a single cohort and whether they may be genetically distinct from the rest of the stock. Further, the temperature conditions under which these clams lived will be evaluated using growth rings in the shell and bottom temperatures.

2. Characterization of hydrothermal discharge regimes.
Karen Bemis, Department of Marine and Coastal Sciences
COVIS project site: https://vizlab.rutgers.edu/node/61



A team of scientists from Rutgers and UW have developed an acoustic imaging method (using the sonar system COVIS) to detect hydrothermal discharge, quantify volume or areal fluxes, and estimate heat contents. COVIS is currently deployed in the caldera of Axial Volcano off the west coast of North America (https://oceanobservatories.org/pi-instrument/cabled-array-vent-imaging-sonar-covis/). Related work uses in situ measurements (video, temperature, flow) to establish baseline and ground truth estimates of discharge area and heat transfer by hydrothermal fluids for selected regions.

Student projects could focus on one of two areas:

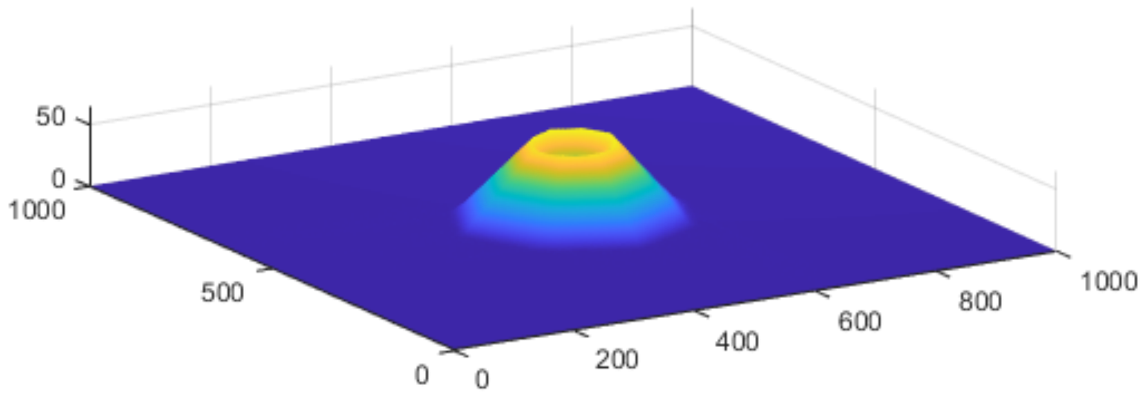
a) **Collation and analysis of in situ temperature data**. This project would involve collecting all the temperature measurement data, merging it with navigation data, and analyzing it for spatial and temporal gradients and fluxes. Data sets include ROV Jason temperature probe data from two field seasons and autonomous 1D vertical array data from several short and long term deployments.

c) **COVIS bathymetric processing**. This project would apply computer vision techniques to our acoustic imaging data to extract the seafloor location relative to COVIS. The starting point is either raw or gridded acoustic imaging data optimized for imaging hydrothermal plumes. The challenge is the low grazing angle with the seafloor spreads and complicates the seafloor signal.

3. Mechanisms driving estuarine exchange
Bob Chant, Department of Marine and Coastal Sciences

Estuarine systems are flushed by tides, winds and buoyancy driven circulation. Recent advances in estuarine physics have developed new methods to estimate the Total Estuarine Flow (TEF) by weighing transport as a function of salinity classes. This method is found to be advantageous over traditional methods because it highlights which salinity classes are involved in exchange processes. TEF analysis can be applied to both observations and model output and provides insights into estuarine residence time and the temporal and spatial structure of mixing. This project would use output numerical simulations of both realistic and idealized estuarine systems to quantify the total exchange flow, its variability and provide insights in to the spatial and temporal variability of mixing in the bay. Estimates of TEF from the realistic simulations can be put in in context with estimates made with shipboard and moored observations. Moreover, recent simulations run by our group have calculated the trajectory of particles that have been released within Delaware Bay and these too can be used to estimate flushing time of the bay based on the time-rate of change of particles in the bay. One goal of the project would be to link estimates of TEF to flushing times estimated the particles release experiments. Ideally the student would have experience with MATLAB or Phyton and comfortable working with large data sets and comfortable working with mathematical equations.

4. Investigation of small volcanic eruption mechanisms
[Karen Bemis, Department of Marine and Coastal Sciences]



A series of projects have investigated the mechanisms of small volcanic eruptions and how such studies can improve our understanding of eruption initiation. This series of projects seeks to understand how the morphology of volcanic edifices reflects syn- and post-eruptive processes. An ultimate goal is to infer typical eruptive conditions or processes from volcanic edifice populations in a localized region. Immediate projects could include

a. **Eruptive process model.** An existing 3D model uses ballistic, grainflow, and lava flow processes to model the growth of scoria cones (small explosive volcanoes). This project would likely involve running the existing model on Rutgers high performance computers. Extensions of the code to include additional processes or refine the existing processes could be pursued. Alternatively the project could focus on exploring the parameter space and running longer eruption durations.

b. **Automated morphologic analysis.** For both the synthetic volcanic edifices and actual volcanic fields, the basic data is elevation fields (aka DEMs). Analysis of growth processes requires the extraction of morphologic data. Recent and earlier publications have developed methods of automating the extraction of quantitative measurement of morphology such as volcano steepness and base contour concavity. This project would implement and apply such methods to either the synthetic volcano dataset or actual volcanos on DEM data.

c. **Tectonic context and connections.** This project would investigate tectonic and geochemical data available for volcanic populations for which morphologic data exists already. Main activities would be literature searches for existing data and building a database to match morphologic, tectonic and geochemical data. Analysis would focus on inferences of magma source depth, magma reservoir size, and magma supply rates for both historical and ancient eruptions.

d. **Historical eruption data compilation.** This project would use both published literature and internet sources (you tube videos etc.) to describe recent and historic eruptions in terms of eruption mechanisms (fire fountaining, strombolian, plinian), deposits produced (spatter, scoria, ash), land forms created (lava flows, cones), and cone or vent morphology.

5. The warming and melting Antarctic peninsula and the impacts on the polar food webs

Oscar Schofield
Rutgers Center for Ocean Observing Leadership; PAL-LTER

It has long been appreciated that polar ecosystems are strongly influenced by the presence of sea ice. Since the 1950's, in the West Antarctic Peninsula (WAP) atmospheric temperatures have risen significantly especially during the winter months. The has been accompanied with rapid sea ice decreases along the WAP. The WAP is characterized by a highly productive food web that appears to strongly regulated by the dramatic seasonality in the light, wind and presence/absence of sea ice. The changes in these physical factors ripple through the entire food web, from the phytoplankton to the penguins. We will be using a 30 time series data to study the food web and assess what changes we can detect as the system has undergone change over the last 3 decades. Come join to study a "canary in the cold mine" for ecosystem responses to climate change. Students will be immersed in a diverse data and will assess population changes over time.

6. Monitoring coastal water quality with ocean robots

Travis Miles
Rutgers Center for Ocean Observing Leadership

The Mid Atlantic Bight (MAB) is one of the most densely populated coastal regions in the US and is uniquely vulnerable to climate change, rapid sea level rise, landfalling coastal storms, and coastal pollution. Despite these pressures, the coastal ocean of the MAB is a significant economic driver for the New Blue Economy (https://oceanservice.noaa.gov/economy/blue-economy-strategy/) with lucrative recreational and commercial fishing industries, tourism, and expansive offshore wind development (22 GW over the next decade). To better understand these pressures and opportunities ocean observing systems have been increasingly used to collect baseline ocean data, monitor storm events, and observe changes to the coastal ocean. Rutgers, and the state of New Jersey, have been pioneering the use of autonomous underwater glider data to understand our coastal oceans. In this project the student intern will work with over 10 years of data collected by autonomous underwater robots to investigate changes in coastal ocean features, water quality (specifically dissolved oxygen, temperature, and salinity), and ocean mixing processes. The findings from this study will aid stakeholders in making informed decisions regarding coastal ecosystems, coastal resilience, offshore wind development, among many other regional activities.

7. Genetics of Bivalve Molluscs

Ximing Guo, Haskin Shellfish Laboratory, Rutgers University

Bivalve molluscs are descendants of a Cambrian lineage that have become well adapted to marine benthic life. They are widely distributed in world oceans and play important roles in estuary and coastal ecology. Many bivalves are also economically important species and support major aquaculture industries worldwide. Some bivalve species such as oysters are remarkably tolerant to environmental stresses including prolonged air-exposure, extreme salinity and temperatures. They lack adaptive immunity but thrive in microbe-rich environments as filter-feeders. Understanding the genetic bases of these adaptations has been a major area of my research. We conduct genetic studies to identify genes and genetic variations that affect the fitness and economically important traits such as disease resistance. We try to improve cultured stocks through selective breeding and other genetic manipulations. One genetic manipulation that has proven to be fruitful is the production of triploid (with 3 sets of chromosomes) oysters using tetraploids (with 4 sets of chromosomes). We breed and supply tetraploid oysters to the oyster industry for the production of triploids that are desired by farmers due to their fast growth and improved quality.

A RIOS student in my lab could conduct focused studies related to the genetics of diploid and polyploid oysters. Studies may include assessing the effects of various genetic changes such as inbreeding and polyploidy on the fitness of oysters. Students could learn how to spawn, culture, sample and evaluate experimental oysters, extract DNA, and conduct genotyping and other genetic analyses.

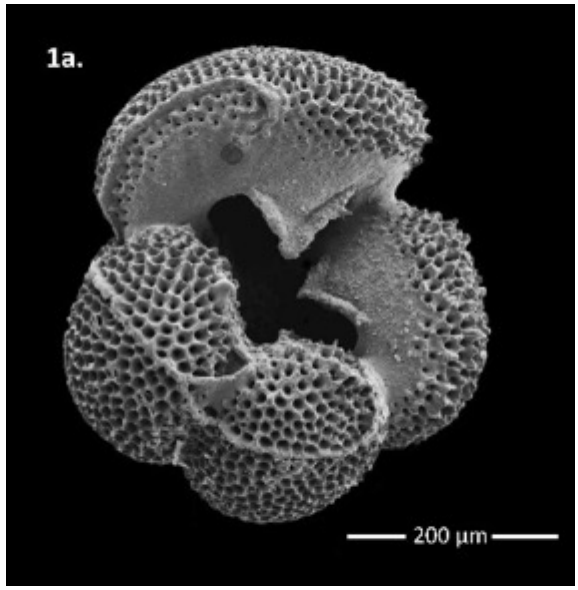
8. Using newly available offshore buoys to evaluate the offshore side of the sea breeze

Joseph Brodie
Rutgers Center for Ocean Observing Leadership

Observations of the wind profile offshore NJ are fairly rare, due to the cost and complexity involved in making such measurements; as a result, most of our knowledge about what the offshore side of a sea breeze looks like are based on modeling. However, the recent surge of development around offshore wind energy has resulted in newly available public datasets at buoys with wind lidars that are capable of measuring wind speeds at heights up to several hundred meters, along with surface atmospheric and physical ocean measurements. This allows us to be able to directly observe the offshore component of the sea breeze, as well as the ocean conditions connected to those sea breezes, such as cold coastal upwelling which can serve to intensify the land/sea temperature difference which drives sea breezes. A thorough understanding of this offshore component is essential to improving the accuracy of wind resource and turbulence assessments for the offshore wind industry.

A RIOS student working on this project will work with RUCOOL and our collaborators at the University of Delaware to help assess the winds throughout the planetary boundary layer at several offshore lidar buoys, as well as analyze the ocean conditions associated with observed sea breezes. This data will be used to conduct a validation of modeling data from the RUWRF atmospheric model. Additionally, this analysis could contribute to an assessment of the similarity of the sea breeze throughout the NJ/DE coastal zone.

9. Response of an oceanic low-oxygen zone to cyclical climate changes during the Miocene (~14 million years ago)
Yair Rosenthal and Anya Hess



The eastern equatorial Pacific is today home to the world's largest oxygen minimum zone (OMZ). It is an important area for global biogeochemical cycles and reaches oxygen concentration is too low for higher forms of life, including fish, to survive. In recent years, the OMZ has been expanding in response to global warming, but how it will change in the future is still an active area of research. We use the chemical composition of foraminifera (microfossils, like in the image shown here) from a deep-sea sediment core to understand how the OMZ responded to climate changes during the Miocene (~14 million years ago), which can help us predict how it might respond to future climate changes.

A potential REU student would work closely with graduate student Ms. Anya Hess, to study a shorter time interval (for example, one 400,000 year Milankovitch climate cycle) during the Miocene to understand how the chemistry, temperature, and ocean circulation changed in response to that climate forcing. This project will likely involve microscope work to select microfossils for analysis, as well as work in our geochemistry lab to analyze their chemical composition.

10. A robot's view of our polar ocean ecosystem.

Josh Kohut
Rutgers Center for Ocean Observing Leadership

Although krill aggregations occur throughout the Western Antarctic Peninsula, the distribution of penguin populations and their associated foraging areas are spatially coherent with canyons and nearshore deep bathymetry. These areas are characterized by elevated biomass, and labeled biological hotspots. Within these hotspots, penguin foraging locations may be highly variable in accordance with the small-scale patchy distribution of their prey. To better understand the physical biological coupling that sustains this hotpot, we deployed a polar ocean observatory, purpose-built to resolve the necessary spatiotemporal scales of this marine ecosystem. Ocean and ecological surveys conducted with underwater gliders and small boats were conducted within the footprint of a mooring array and a three-site High Frequency radar network recently introduced to the region.

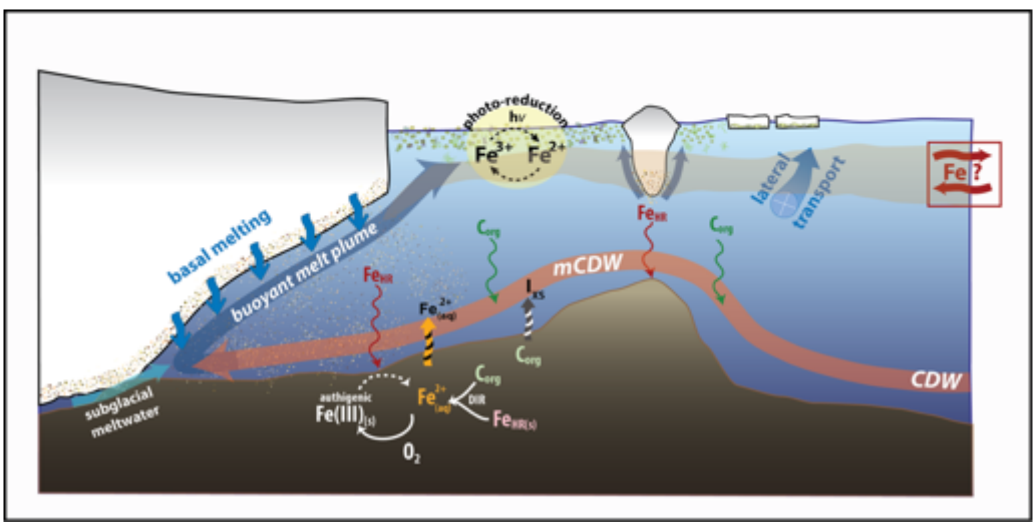
A RIOS student working on this project will explore these data to better understand how the polar marine food web interacts with local oceanography. This region has a range of water masses that interact and evolve throughout the summer growing season. Focusing on the available data gathered through our fleet of polar ocean robots, one can characterize the properties associated with the different water masses and determine if different components of the polar food web select for specific water masses. To do this, you will learn about the local polar oceanography and ecology and learn the data tools to analyze and visualize your results.

11. Identification of different iron sources in the Amundsen Polynya, Antarctica
Silke Severmann and Rob Sherell

The Antarctic shelf is currently undergoing some of the fastest and most dramatic changes in the global ocean due to anthropogenic climate change. Iceberg calvings, such as the partial collapse of the Larsen ice shelf in 1995 and 2002, bear witness to the rapidly accelerated melting of the continental ice sheets. The retreat of ice sheets also has major consequences for global sea level rise, Antarctic ecosystems, biogeochemical cycles and the global carbon budget.

The availability of iron is a key component in the regulation of phytoplankton productivity and CO_2 drawdown via the biological pump. The Antarctic continental shelf is the most productive system in the Southern Ocean, although even here Fe can limit primary productivity towards the end of the growing season.

A prominent and important feature of the Antarctic continental shelf are polynyas − seasonally ice-free hotspots of biological productivity that develop within the ice pack during the austral summer. The Amundsen Sea polynya is the most productive per unit area of all known Antarctic polynyas. At the onset of the spring bloom, phytoplankton draw on the stock of Fe that has accumulated below the winter ice. However, to sustain high productivity throughout the growing season, continuous sources of Fe are required. Enhanced melting of ice sheets during the summer can increase Fe supply to the polynyas in multiple ways, including through subglacial meltwater, icebergs, and benthic efflux from glacial-marine sediments. The goal of this project is to identify different sources of Fe to the polynya by measuring the Fe-isotope composition of water column particles.



12. 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 propagation and 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 2022 RIOS intern would likely focus on factors controlling the distribution of horseshoe crab eggs. Delaware Bay hosts the world's largest spawning population of horseshoe crabs, and the eggs they lay on the beach are an important food resource for the rufa red knot, a threatened shorebird that migrates through the Bay each spring. Sea level rise and other anthropogenic factors may influence this critical predator-prey interaction. This project will investigate how beach habitat quality affects the relative abundance and distribution of horseshoe crab eggs on the beach and tidal flats. Anticipated work includes fieldwork at Rutgers Cape Shore Laboratory to assess habitat quality along 3.5 km of beach and tidal flats and labwork at Rutgers Haskin Shellfish Research Lab to count horseshoe crab eggs from sediment core samples.