# 2019 RI SURF

RI Consortium for Coastal Ecology Assessment, Innovation, & Modeling

RI NSF EPSCOR

**HTTPS://WEB.URI.EDU/RINSFEPSCOR/**

## Buoy aren't you glad I checked the model?

Baylor Fox-Kemper (Brown University)
Lew Rothstein (University of Rhode Island)

**Project Location:**
Brown University

**Project Description:**
This project will involve examining temperature, salinity, and velocity data from buoys, boat profiles, and shuttle data in comparison to the Ocean State Ocean Model. We will also go out on the Bay and examine one site in detail, collecting new data!

This is an important part of both the modeling and data center aspects of the EPSCoR project.

*This project involves* ***both field & lab/computer work***

**Required/preferred skills for student applicant:**
Matlab, R, or python a plus.

**Student transportation needed for project?**
No
None, except getting to Brown most days.

# Neural Networks and You: Using Satellite Data and Machine Learning for Ecological and Earth System Models

Christopher Horvat (Brown University)
Sarah Cooley (Brown University)
Johnny Ryan (Brown University)
Aakash Sane (Brown University)

**Project Location:**
Brown University

**Project Description:**
Climate and ecosystem models operate on a discretized grid, and so are only explicitly "correct" at simulating physical processes above the spacing of that grid, which in many cases may be kilometers or higher. All of the physical processes active on smaller scales than the model grid are "parameterized", which means their bulk effect on larger-scale things is captured within a simple set of equations that influence the larger-scale physics. Yet as computing power has increased, the climate model grid scale has been pushed to higher and higher resolutions (lower and lower grid spacings). Now, some of these physical processes are resolved.

As an example: consider the iceberg. Some icebergs might be 10 kilometers wide. In the past, climate models with grid spacings of 1 degree (roughly 100 kilometers) would not be able to simulate individual icebergs, and all of the effects of icebergs on the ocean were parameterized. As computing power has increased, climate models are frequently run with spacings of 10 km or less. Now, some of these icebergs should be clearly visible!

For many types of scientific problems, called multi-scale or fractal problems (like iceberg size), increasing the resolution of our models can cause issues: some of the physics now is larger than the scale of the model but some of it is not! Models must now parameterize the sub-grid-scale physics at the same time as they explicitly model the larger scales. Successfully creating a model parameterization that does this is a real challenge!

Enter machine learning. Neural networks are a growing and increasingly useful way of taking a physical system that is complex, multi-scale, and crosses the grid scale and developing parameterizations of those physics. The SURF student will be tasked with learning about neural network approaches to climate models and model parameterization, and then employing them in one of several potential areas. Two are listed below, but with an interested student we can come up with many more!

(1) Blooms in the Narragansett Bay (with Baylor Fox-Kemper, Aakash Sane) - from space, we can observe highly complex ecological patterns that span many scales. By combining the satellite measurements with simple models of nitrogen and carbon uptake, and comparing to high-resolution model runs, we will create a simple regional model parameterization that describes the influence of these localized multi-scale events on hypoxia within the Bay.

(2) Sea ice in the Arctic Ocean (with Johnny Ryan, Sarah Cooley) - sea ice is a composite material made of individual pieces, called floes. Yet the bulk impact of the size of these floes is unknown because floes

can range from millimeters to hundreds of kilometers across. Our project will involve creating a neural net that takes low-resolution satellite data (as in a climate model) and parameterizes sea ice melting and loss.

*This project involves **both field & lab/computer work***

**Required/preferred skills for student applicant:**
A desire to learn new things!

General scientific computing skills - familiarity with a common scientific programming language will be necessary (MATLAB, for example).

Optional but not necessary - some experience with machine learning - a course, a youtube tutorial, etc.

**Student transportation needed for project?**
No

# Assessment of microplastics load discharged into Narragansett Bay through wastewater treatment plants

Gerald John (Bryant University)
Dan McNally (Bryant University)
Christopher Reid (Bryant University)

**Project Location:**
Bryant University

**Project Description:**
Plastics are ubiquitously present in the environment related from food packages, shopping bags, household items such as toothbrushes and pens, and personal care products. The global annual production of plastics exceeds 300 million tons. Plastic debris are exponentially increasing in the environment since their first production about 75 years ago. Microplastics (MP) are plastics that are less than 5 mm or smaller in diameter, and they are formed by degradation of plastic wastes through mechanical and/or photo-oxidative pathways. There are sufficient scientific evidences that MPs are harmful to the aquatic organisms. Furthermore, there is ample scientific evidence that MPs absorb and accumulate high concentrations of toxic organic pollutants and play a vital role in facilitating bioaccumulation of several toxic contaminants.
Narragansett Bay plays a vital role in the economy of the State of Rhode Island. The presence of MPs in the bay as well as the water bodies that drain into the bay region are not well documented. While there are many sources for introduction of MPs into the water bodies, wastewater treatment plants (WWTPs) are considered as one the primary sources of MPs. There are two major WWTPs that discharge their effluent into Narragansett Bay – Field's Point and Bucklin Point. Both the WWTPs are equipped with primary and secondary treatment facilities. The mass of MPs will be monitored in the influent and effluents of primary and secondary treatment facilities. MPs that are collected will be further characterized using FT-IR and pyrolysis GC-MS to determine the chemical composition of MPs. The outcome of this environmental monitoring study will help to assess the amount of MPs load discharged into Narragansett Bay through these two WWTPs.

*This project involves **both field & lab/computer work***

**Required/preferred skills for student applicant:**
Preference will be given to the students who have taken the following courses
- Water and wastewater treatment process
- Organic Chemistry

**Student transportation needed for project?**
No

# Assessment of biofilm communities in continuous and fragmented environments

Christopher Reid (Bryant University)
Vinka Craver (University of Rhode Island)

**Project Location:**
Bryant University

**Project Description:**
Biofilm formation on instrumentation deployed in the marine environment is one of the biggest challenges of long term monitoring activities. It is well known that microbial diversity determines the biomechanical and physicochemical properties of biofilm as well as response to antibiofilm strategies. As part of the RI C-AIM sensor development effort microfluidics-based devices are currently in development. These devices are not larger than a couple of centimeters and some of their features (microchannel and microwells) are in the order of tenths of microns. Biofilm formation studies have been performed using different size samples up to 6 cm, however to our knowledge only small size ranges (less than 5 mm) have evaluated the effect of sample size on composition and biodiversity of biofilm. This project will focus on identifying the differences in the marine microbial species that colonize varying  Polydimethylsiloxane (PDMS) surface areas using quantitative PCR and next generation sequencing

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
-basic microbiology skills
-some experience in handling DNA (preferred but not essential)

**Student transportation needed for project?**
No

# Stable isotope labeling of the zooplankton Oxyrrhris marina to track lipid metabolism

Christopher Reid (Bryant University)
Susanne Menden-Deuer (University of Rhode Island)

**Project Location:**
Bryant University

**Project Description:**
Fatty acids are important lipid compounds that are used as building blocks for the majority of lipid classes and serve as valuable source of energy. The mechanism of trophic upgrading by protozoans may bridge the gap of essential nutrients between higher trophic levels. Given the importance of heterotrophic dinoflagellates such as O. marina to trophic upgrading and providing essential nutrients to higher trophic levels, an understanding of the changes to the lipid profile under varying availability of prey can provide insight into the nutritional quality available for higher trophic levels in the food web. This project will focus on further investigating lipid upcycling in O. marina through the use of stable isotope labeling of prey (S. ceriviseae). Isotopic labeling of O. marina lipids will be monitored by GC-MS allowing the tracking of prey-based lipids as they are modified to long chain fatty acids and alcohols. Lipid metabolism in O.marina during starvation will be further investigated using this strategy

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
basic microbiology skills

**Student transportation needed for project?**
No

# Effects of changing phenology on the predatory role of gelatinous predators in the Narragansett Bay

Sean Colin (Roger Williams University)
John Costello (Providence College)

**Project Location:**
Marine Biological Laboratory, Woods Hole, MA

**Project Description:**
Several species of gelatinous predators have been shown to have top-down influences on the zooplankton community of the Narragansett Bay. The temporal occurrence of the different gelatinous species, including Mnemiopsis leidyi, Aurelia aurita, Cyanea sp. and Chrysaora quinquecirrha, throughout the year is an important determinate of the zooplankton prey field encountered by the predators. Since feeding rates of gelatinous predators varies greatly among prey types the predatory, and ecological, impact of the different gelatinous predators will likely be influence by the prey assemblage available. This is important because the phenology of gelatinous zooplankton in the Narragansett Bay has been shown to be altered due to climate change and this has been shown to change the ability of gelatinous predators to impact copepod prey populations.

Therefore, in an effort to assess the potential ecological impacts of changes in the phenology gelatinous predators (and their prey) we will conduct predator-prey experiments to quantify how changes in prey assemblage affects the feeding rate and prey selection of different gelatinous predators found in Narragansett Bay. Specifically, we will use novel high-speed imaging techniques to video and quantify the outcome of individual predatory-prey interactions of different predator species provided different prey assemblages. By quantifying the accumulation of individual predatory prey events we will be able to quantify feeding rates, prey selection and the underlying mechanisms that lead to gelatinous predators having different ecological impacts.

Students involved in the project will design and conduct experiments using high-speed video techniques. They will then use video analysis tools to quantify the predator-prey interactions that occur with the different prey assemblages.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Students should have strong quantitative and Excel skills.

**Student transportation needed for project?**
Yes

# Genetic diversity and high-throughput genotyping in an estuarine fish, Fundulus heteroclitus

Jeffrey Markert (Providence College)

**Project Location:**
Providence College

**Project Description:**
Genetic diversity is a key predictor of population health in changing environments because it generates the phenotypic diversity needed to adjust to new challenges (pollutants, disease, and changes to the physical environment). In diploid species, genetic diversity also provides a buffer against problems associated with inbreeding depression and related processes.

Over the past few months I have started a collaboration with colleagues at the Environmental Protection Agency's Atlantic Ecology Lab in Narragansett RI. We are developing a large set of Single Nucleotide Polymorphism (SNP) markers for use on the widely distributed coastal fish species Fundulus heteroclitus (aka. killifish or mummichog). This fish is of particular interest because has evolved to thrive in highly polluted bays and estuaries, and much is has been discovered about the biochemical pathways that make this possible.

The SURF student selected for this project will be focused on detecting genetic differences among coastal populations using Providence College's high throughput Fluidigm genotyping system. The student will be involved with sample collection, DNA extraction, genotyping, and population genetic analyses.

*This project involves **both field & lab/computer work***

**Required/preferred skills for student applicant:**
In this kind of work, organization is key. Large numbers of samples will be processed and analyzed, and quality control is of primary importance in order to produce impactful, high-quality science. Patience and willingness to cheerfully explore a variety of approaches will also be an asset.

The student will learn DNA extraction methods, field sampling techniques, genotyping techniques, and data analyses.

**Student transportation needed for project?**
No
In general, the mentor can provide transportation to both field sites and collaborating laboratories. However a license to drive and eligibility to operate Providence College vans is helpful (though not absolutely required).

# Preferences for Residential vs. Community Solar Programs in Rhode Island

Suchandra Basu (Rhode Island College)
Katherine Lacasse (Rhode Island College)

**Project Location:**
Rhode Island College

**Project Description:**
This survey project examines the drivers and barriers of households' interest and intention to switch to solar, through residential vs. community solar adoption programs. It will specifically examine how individuals' personal experience of climate change and concerns about land-use surrounding Narragansett Bay influence their support for a transition toward a more sustainable energy future. As part of a collaborative team, the SURF fellow will participate in the following duties during Summer 2019: (1) researching and maintaining a database of households who are to receive the survey, (2) creating and mailing survey packets, (3) entering data from surveys into spreadsheet, (4) simple statistical analysis of data, (5) writing simple research summaries, (6) conducting reviews of literature, (7) assisting with design of follow-up research project.

Students will gain skills involved with conducting survey research. They will learn how to use Qualtrics online survey tool, create and manage data sets, conduct and interpret basic statistical analyses on Stata and/or SPSS, and write research summaries. They will experience working as part of an interdisciplinary team and gain knowledge regarding psychological and economic factors that predict household's support and participation in residential solar energy programs.

*This project involves **both field & lab/computer work***

**Required/preferred skills for student applicant:**
Student should be willing to travel to homes to drop-off and pick-up surveys, as well as communicate with homeowners about the survey. Student should have completed a research methods or an upper level statistics course in economics, psychology, or another related social science discipline. Knowledge of Stata and/or SPSS is useful but not required.

**Student transportation needed for project?**
Yes

## Polymer Recycling Methods and New Polymer Materials

Elizabeth Kiesewetter (Rhode Island College)

**Project Location:**
Rhode Island College

**Project Description:**
This proposal seeks to develop new, more effective, chemical recycling methods and new materials which will lessen environmental damage; this constitutes a change in human behavior. The goal of this project is to develop, from renewable resources, plastics that are fully biodegradable and infinitely recyclable in a cradle-to-cradle fashion. Plastics are entering the ocean at alarming rates, causing considerable damage to points of entry, like Narragansett Bay. Recycling plastic waste is one option to mitigate the damage from these materials; however, recycling rates are very low, and conventional recycling technology often results in downgraded material whose journey to the landfill is only delayed. Despite the problems associated with plastics, humanity's rate of plastic production continues to grow. Solving the plastic problem is of vital importance to Rhode Island and its 400 miles of coastline, and we seek to develop comprehensive approaches to mitigate plastic waste at every chance that it may accumulate. We will use fundamental studies of catalysis and materials science as our primary tools to develop biorenewable and degradable polymer materials that are complementary in properties to existing plastics.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
completed organic chemistry and the associate lab courses

**Student transportation needed for project?**
No

## Effects of temperature on metabolism and muscle function of Narragansett Bay fish species

Anabela Maia (Rhode Island College)

**Project Location:**
Rhode Island College

**Project Description:**
The effects of climate change are particularly strong in estuarine habitats where animals are already exposed to a variety of stressors, including other anthropogenic pressures and changes in salinity. Summer temperatures in Narragansett Bay have seen a steady increase in the last decades, with even more pronounced temperature increases over winter months. Most fish are not able to regulate their body temperature and their metabolism is likely to be strongly affected by temperature fluctuations. In general, higher temperatures accelerate biological processes and can lead to faster growth, however they can also induce stress and leave less energy available for maintenance, immune response and reproduction. Temperature optima vary widely between different species and increases in temperature are likely to change the fish composition of Narragansett Bay. We are already seeing changes in population dynamics of black sea bass and scup, which have been increasing in abundance. Species like silver hake and little skate have been identified as more likely to be negatively impacted, while the effects of warming temperatures in spiny and smooth dogfish populations are complex. We aim to understand how the metabolic demands of these six species change under different temperatures by measuring basal and standard metabolic rates, that is the oxygen consumed during both rest and normal swimming activity. Swimming in fishes is a costly activity and is powered by body undulations and fin musculature. We will also look at muscle contraction through electromyography to determine changes in muscle recruitment that are likely affecting overall metabolism. We expect to see that species that are able to change muscle recruitment in a way that minimizes energy requirements at higher temperatures are more likely to outcompete species that have muscle function optimized for lower temperatures. We hope to predict which species are more likely to be negatively, positively or neutrally impacted based on their energy budgets and muscle function.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Preferred skills: knowledge of fish husbandry; some physiology background (e.g. animal or human physiology course)

**Student transportation needed for project?**
No

# Ecology and evolution of cyanobacteria and viruses in Narragansett Bay

Marcie Marston (Roger Williams University)

**Project Location:**
Roger Williams University

**Project Description:**
Viruses are one of the most abundant entities in the ocean. Interactions between viruses and their hosts can influence the morality, composition, and evolution of host communities; yet the long- term dynamics of viral-host interactions in marine communities are not well understood. This research project focuses on cyanophages, viruses that infect and subsequently kill Synechococcus species. Synechococcus are unicellular photosynthetic cyanobacteria that are important contributors to primary productivity in coastal marine ecosystems. In this study, we will be examining the abundance and diversity of cyanophages and Synechococcus spp. in Narragansett Bay. We will isolate cyanophages from diverse locations in the Bay, analyze how they interact with their hosts, and determine their genotypes using conserved marker genes. In addition, we will investigate the types of genes that may be involved in Synechococcus-cyanophage interactions. The overall goal of this project is to understand both the long-term genomic dynamics of viral-host interactions and how environmental conditions, such as increasing water temperatures and nutrient levels, might influence these interactions. This study will provide baseline data about the ecology and evolution of viral – host interactions in Narragansett Bay that could be used to assess future impacts of climate change on viral and cyanobacterial communities in the Bay.

*This project involves* ***both field & lab/computer work***

**Required/preferred skills for student applicant:**
Completion of a Genetics Course with Lab.
Experience with PCR, DNA isolation and sequence analysis.

**Student transportation needed for project?**
Yes

# Combined Infra-Red and Electrochemical Detection of Key Ions in Seawater

Clifford Murphy (Roger Williams University)

**Project Location:**
Roger Williams University

**Project Description:**
This project will be a continuation of the chemosensor development that was performed last summer to produce metalloporphyrin modified transmissive conductive electrodes for seawater analysis of key analytes including nitrate, nitrite, and phosphate ions. Initially produced were iron (III), ruthenium (III) and zinc (II) metalloporphyrin electrodes which would show colorimetric responses to ions in seawater, but the responses were non-specific. Electrochemical response was promising, particularly for nitrate and nitrite ions in seawater with strong responses to both with iron (III) metalloporphyrin, while the ruthenium (III) metalloporphyrin had a strong response to nitrite ions and zinc (II) metalloporphyrin was largely insensitive to both nitrate and nitrite ions.

Moving this project forward will focus on work along four thematic areas:

* Area one - artificial seawater controls; our previous work was with added analyte to filtered Narragansett bay seawater, which proved difficult when our phosphate analyses rapidly crashed (out) into the solubility limits. We have purchased rigorously ASTM standardized artificial seawater to help assess sensitivity to phosphate ions in this media and to confirm prior metalloporphyrin responses to analytes.

* Area two - independent confirmation of analyte binding via DRIFTS analysis. Last year Roger Williams University with Dr. Stephen O'Shea's leadership acquired Diffuse Reflectance for Infrared Fourier Transform Spectroscopy accessory for our existing FTIR spectrometer. This allows for rapid measurement of opaque and powdered samples without specialized sample preparation. It offers high sensitivity and is suitable for analyzing our chemosensor substrates as the completed electrode or scraped off into a powder post seawater analysis. Electrodes produced and utilized in seawater analysis can be subject to DRIFTs analysis to confirm the specificity of responses, while relying on the electrochemical drift of the binding potential to determine the concentration of analytes in seawater.

* Area three - extend the breadth of metalloporphyrin electrodes with new metal centers. Currently our access to specific detection of analytes is by the aggregate response of several electrodes to seawater samples and relying upon differences between the iron (III), ruthenium (III) and zinc (II) responses. Other metal centers of interest for this analysis are copper (II), cobalt (II), and manganese (II) as metalloporphyrins. This aids our research twice over. First, we may need several different candidates of metalloporphyrin to determine phosphate sensitivity having not yet detected phosphate specifically in seawater. Second, ruthenium (III) is a particularly expensive metal if this analysis is to become a regularly utilized device. More earth abundant metals such as copper and cobalt are preferable for cost and sustainability if their sensitivity is suitable for these analyses.

* Area four - continued development of the hand-held electrochemical sensor for seawater analysis. This project originated as an adaption of a thiocyanate in seawater chemosensor to combat cyanide

fishing, and part of the work included an electrical engineer to help fabricate a handheld device suitable to replicate the electrochemical analysis performed in the laboratory. Last year I did advertise to the engineering department this would continue to be an active aspect of our research, but had no suitable takers. I will continue to advertise this aspect of the research to interested students with more of an engineering than chemistry background.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Ideal candidates for the construction of metalloporphyrin modified electrodes will have completed either organic chemistry (2 semesters) or analytical chemistry (1-2 semesters) by summer 2019, with preference for students who have done both. The laboratory work involves chemical purification by distillation and/or chromatography, chemical synthesis, analysis of products by UV-Vis, FTIR, NMR (proton and carbon), and cyclic voltammetry.

Ideal candidates for the hand-held electrochemical sensor would be students of engineering with a specialization in electrical engineering and having successfully completed courses in electronics and circuit design by the summer of 2019.

**Student transportation needed for project?**
No

# Sediment Depth Profile of In-Situ Anion ($NO_3^-$ and $PO_4^{3-}$) Assisted Attenuated Remediation of Halogenated Hydrocarbons

Stephen O'Shea (Roger Williams University)

**Project Location:**
Roger Williams University

**Project Description:**
Segmented, Rhizon filtered sediment core interstitial pore water are be characterized to elucidate natural biotic and abiotic attenuated remediation degradation pathways of halo-carbons (HCs). This work has important implications from both a climate perspective and for what it tells us about the HCs biogeochemical cycling and their release into the ecosystem. Comparative solvent solid phase extraction techniques; Soxhlet and microwave protocols of whole wet sediments are to be investigated by GC/MS to determine the volatile and semi-volatile array of organics present to infer the chemistry of the environment. Sediment efficacy of HCs transformative potential of autoclaved to oven dried samples are compared deriving *in-situ* abiotic or biotic pathways by HPLC-IC GC/MS headspace and $^{13}C_2$ NMR. The mechanistic HCs degradation pathway can be confounded by oxidation-reduction potential (ORP) of the environment and its pH, clarifying in-situ metal oxidation states and the potential microbial consortia activity. Catabolic oxidants and the bacterial succession order, following the submergence of sediment pore water, directly matches the order of decreasing potential for the corresponding redox posing ($NO_3^-$ and $NO_2^-$)couples. Measuring a site's in-situ capacity (soil/water) for transformation directly by treating it with a $^{13}C$ labeled HC substrate that is capable of undergoing the fundamental processes of oxidation, reduction, and substitution allows the chemistry that occurs to characterize the site. Both the nature and rates of these transformations can be assessed utilizing carbon labeled $^{13}C_2$ substrates, $^{13}C$ nuclear magnetic resonance spectroscopy analysis and head space gas chromatography/mass spectroscopy.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Completion of Organic Chemistry sequence and Analytical courses

**Student transportation needed for project?**
No

# Passive device to quantify microplastic contamination

Jennifer Pearce (Roger Williams University)

**Project Location:**
Roger Williams University

**Project Description:**
We will use a lattice-Boltzmann based simulation to optimize the design of a microfluidic chip to detect microplastic particles on the order of micrometers. These particles are hard to detect because of their size. We will use diffusiophoresis and thermophoresis to separate the particles from other objects found in samples, such as phytoplankton, that are the same size as the microplastics. The simulation has already been used to describe the separation of particles using thermophoresis, and we will add diffusiophoresis into the model to enhance the separation we have already achieved.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Experience with Matlab
Experience with compiling and running code

**Student transportation needed for project?**
No

# Organic synthesis of pyrrole- derived metal complexes and binding of pollutant ion

Lauren Rossi (Roger Williams University)

**Project Location:**
Roger Williams University

**Project Description:**
Bioinspired catalysts have been developed to reduce highly oxidized pollutant ions, such as nitrate ($NO_3^-$). Our aim is to apply synthetic methods to form organometallic complexes, to assess the stability of such complexes, and evaluate the complexes' ability to detect/ reduce nitrate ions within aqueous samples, such as that of the Narragansett Bay ecosystem.

This project involves primarily lab work.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Prior laboratory experience with organic chemistry techniques is valued.

**Student transportation needed for project?**
No

## Diagnostic laboratory technical skill development and research

Roxanna Smolowitz (Roger Williams University)
Allex Gourley (Roger Williams University)

**Project Location:**
Roger Williams University

**Project Description:**
The Aquatic Diagnostic Laboratory routinely conducts diagnostic disease testing on submitted specimens including shellfish and some fish. This student will participate in necropsies, PCR and qPCR disease determination (using methods already developed and helping to develop new qPCR methods) as well as preparing tissues for histological examination and conducting ISH staining. We are currently studying 3 diseases in bivalves including: Bonamia exitosa, a protozoan infections of oysters (*in situ* staining methods); protozoan infections of sea scallops (*in situ* staining and qPCR development) and hemocytic tumors in hard clams (laboratory transmission studies will occur this summer).

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
This student needs to have a very good background in genetics and hopefully microbiology or virology. The student should be detail oriented and willing to work with others in the laboratory.

**Student transportation needed for project?**
No

# Nanostructured Electrochemical Sensor for Seawater Nutrients Detection

Bernard Munge (Salve Regina University)

**Project Location:**
Salve Regina University

**Project Description:**
An alternative approach to SERS is electrochemical detection. Nanostructured sensor surfaces will be specifically designed and coupled to microfluidic sample delivery system for electrochemical detection of $PO_4^{3-}$, $NO_3^-$ and $NO_2^-$ in seawater samples. This project aims to advance the EPSCoR C-AIM research themes: "What new innovations in sensors are needed to improve the collection of data on the physical, bio-geo-chemical, and ecological processes as well as anthropogenic stressors (e.g., pollution) that are impacting Narragansett Bay?" and will be undertaken in collaboration with Dr. Yi Zheng (University of Rhode Island, Department of Mechanical and Systems Engineering). A number of strategies have been used for Phosphate determination including calorimetry, electrochemistry, and fluorescence emission spectroscopy. On the other hand, most nitrate detection methods indirectly measure nitrate by first converting it to nitrite. This conversion is mostly commonly facilitated by copperized cadmium columns. The use of toxic cadmium columns can be avoided by using UV radiation to convert nitrate to nitrite, but this technique is not suitable for on-site measurements. The most ubiquitous spectroscopic technique is the Griess Assay, a reaction that produces a colored azo chromophore whose concentration can be used to infer nitrate concentration. Nitrite detection methods include fluorescence spectroscopy, absorption spectroscopy, and Raman spectroscopy. These techniques rely on the conversion of the ion to an optical signal. Although highly accurate, spectroscopic techniques require expensive and time consuming of-site analysis and are therefore not suitable for use in resource limited areas. Moreover, optical methods unlike electrochemical detection techniques present a major challenge when used in turbid water samples. Microfluidic devises (Lab –on-chip) coupled to electrochemical detection are an ideal means for rapid on-site measurements as they allow for miniaturization and automation of laboratory based protocols, leading to the development of simple, low cost, portable, compact devices. The use of microliter volumes results in a reduction in reagent consumption, waste production and analysis time compared to standard lab protocols. The nanostructured electrochemical sensors will be fabricated on our in-house screen printed electrode (SPE). In contrast to most lab based electrochemical procedures, the mass production of SPE sensors could provide a more economically viable and technologically realizable platform for commercial exploitation.

Students will be exposed to various research techniques including electrochemical sensor development, microfluidic fabrication (Salve and URI), screen printing, synthesis of nanoparticles, spectroscopic characterization and surface characterization (URI). Students will also learn how to analyze and present their research work enhancing their written and communication skills. An integral part of students training also involve doing literature searches, analyzing and presenting the journal articles retrieved from various data bases such as scifinder scholar, acs.pubs.org, www.sciencedirect.com etc.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Students should have completed at least a year of college chemistry (General Chemistry I & II with labs)

**Student transportation needed for project?**
Yes

# Recovery and identification of marine microbes from Narragansett Bay and assessment of their potential for biofilm formation in single and mixed culture models.

Anne Reid (Salve Regina University)

**Project Location:**
Salve Regina University

**Project Description:**
The recovery of marine microbes in pure culture remains a challenge, as these microbes are found in low abundance, do not grow readily on standard growth media, and often rely on interactions with other microbes for growth and viability. Studying the microbes found in Narranganestt Bay will help us understand how microbial population vary in response to climate change, and may lead to the identification of biomarkers for monitoring the health of our local marine ecosystem.
During the SURF 2018 season, culture conditions (for instance filtration of seawater and plating on marine agar, or dilution to extinction in marine broth) were identified which resulted in recovery of marine microbes. While a number of isolates have been recovered, we will continue to sample water from various sites in Narragansett Bay and to recover additional microbes using these previously-established protocols. This continued sampling will enable us to assess stability of microbial populations in select areas over time, as well as expand the limited sampling range studied in year 1. These recovered microbes will be identified by PCR amplification of barcode genes (16S rRNA for bacteria, ITS for fungi) and Sanger sequencing. Stock cultures of these isolates will be preserved in glycerol, and these microbes will be assessed for their ability to form biofilms.

Biofilm formation will be assessed under aerobic and anaerobic conditions using a standard microtiter plate assay. Both single-species and mixed-species biofilms will be studied – selection of microbes for these assays will be guided by literature analysis of known or suspected cooperative interactions between microbes. Microbes in the biofilm will either be quantified indirectly by staining with crystal violet, or serially-diluted and directly enumerated. In addition to biofilm formation in polystyrene plates, biofilm formation will also be assessed on coupons of PMDS, a material to be used in the biosensors being developed by researchers in thrust 3. The PMDS coupons will also be imaged by confocal microscopy in order to understand the size, spread and architecture of the biofilms produced on this type of material. An understanding of how biofilms form and which microbes can contribute will provide us with information that can guide strategies to mitigate biofouling of the sensors.

It is well-understood that only a fraction of the microbes in a marine environment can be recovered in laboratory culture. As such, the microbes isolated above represent a small portion of the total microbial communities in the waters of Narragansett Bay. Next Generation Sequencing will be deployed to gain a broader understanding of the microbial communities in these waters, and to understand how our isolates fit into the larger network of microbes in these samples. Total genomic DNA will be isolated from seawater samples and the 16S rRNA barcode for bacteria will be amplified by PCR. DNA libraries will be prepared and analyzed by NGS on an Illumina MiSeq (housed at Salve Regina University). Data will be analyzed using an established QIIME2 pipeline, and the bacterial populations from different sample sites and different sampling seasons (samples collected during year 1 and 2) will be compared in order to gain a better understanding of the stability and composition of the Narragansett Bay microbial communities.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
The following skills are preferred, but not required
-training will be provided to the successful candidate(s)
-preparation of agars and broths for bacterial culture
-aseptic technique and culture of microbes
-basic molecular biology skills (use of pipettor, agarose gel electrophoresis, PCR)

**Student transportation needed for project?**
Yes
-student will need to collect water samples at several sites over the summer (frequency: no more than once/week)
-if student does not have access to own vehicle, alternate arrangements can be made – a student should not be swayed from applying even if they do not have their own vehicle

# Modeling the metabolism of important planktonic species in Narragansett Bay

Keith Thompson (University of Rhode Island)

**Project Location:**
University of Rhode Island

**Project Description:**
Microbial plankton communities in the Narragansett Bay (NB) play important roles in primary production, nutrient cycling, and interaction with eukaryotic hosts of the higher trophic levels. A large-scale modeling of the metabolic activity and function of these planktonic communities requires the identification of key functional species and the establishment of high-resolution models for these species. In this project, students will obtain trainings in metabolic pathway annotation, genome-scale modeling, and command-line bioinformatics tools. The students will first identify key functional species from the NB community based on 16S rRNA gene sequencing. Then, molecular pathway models will be constructed for individual species using our in-house software, PSAMM. The effects of changes in temperature and nutrient availability on the metabolism will then be investigated using thermodynamics-based flux analysis approaches to derive functional mechanisms of the organism under changing environmental conditions. The development and analysis of these models will be an important step forward in investigating ecological functions in the bay and how these functions may be affected by changes in temperature and nutrient availability.

*This project involves **primarily lab or computer work***

**Required/preferred skills for student applicant:**
Course preparations in microbiology, biochemistry, or related fields. Familiarity with using command line applications on the computer is preferred but not required.

**Student transportation needed for project?**
Yes
The student would require transportation to the main URI campus. There are RIPTA busses available that run throughout the day between the two campuses.

## Physiology of the sulfur-oxidizing awning clam

Roxanne Beinart (University of Rhode Island - GSO)

**Project Location:**
University of Rhode Island-Bay Campus

**Project Description:**
Awning clams (Solemya velum) are subtidal clams found in Narragansett Bay that host symbiotic chemosynthetic bacteria in their gills. These clams and their symbionts oxidize hydrogen sulfide, removing a toxic gas that is naturally produced in coastal sediment. Thus, Solemya velum is facilitating other organisms in their habitats, like seagrass or other animals, by removing this toxic chemical. The student joining this project will work with the Beinart lab to conduct physiological experiments with S. velum in order to measure sulfur oxidation rates, as well as to test whether S. velum has an effect on nutrient cycling. Students will assist with fieldwork to collect living clams, and work with the Beinart lab to set-up an experimental system for measuring metabolic rates in this clam. Finally, work may include measurement of experimental water chemistry for sulfide and nutrient concentrations.

*This project involves* ***both field & lab/computer work***

**Required/preferred skills for student applicant:**
Background in biology, chemistry, and/or marine biology preferred. Interest or experience with the set-up of aquarium or aquaculture systems may be useful, but is not required.

**Student transportation needed for project?**
Yes
It would be useful for a the student to have a car to access local fieldwork sites for the collection of clams, but is not required.

# Narragansett Bay Fishes: Who is Eating Who?

Austin Humphries (University of Rhode Island)
Jeremy Collie (University of Rhode Island - GSO)
Kelvin Gorospe (University of Rhode Island)
Maggie Heinichen (University of Rhode Island - GSO)

**Project Location:**
University of Rhode Island-Bay Campus

**Project Description:**
A fundamental question in the ocean is Who Eats Who? This process shapes the marine foodweb and thus is important information for ecologists and fisheries scientists alike. For example, how are we to know what the impact of a fishing regulation on striped bass will do for menhaden populations if we don't know how many menhaden they eat? Only with this knowledge can we better understand how things like increasing sea surface temperatures or management policies impact the marine foodweb and ecosystem. Our project will seek answers to this seemingly straight-forward question of Who Eats Who so as to better inform foodweb models for Narragansett Bay. This research will include some combination of literature review (computer-based work) and targeted diet study (field and lab-based work) of fish species that have little to no diet data. Students can expect to spend their time interacting with graduate students, a postdoc, and faculty members at various capacities.

*This project involves **both field & lab/computer work***

**Required/preferred skills for student applicant:**
Proficiency with Microsoft Excel and experience searching and reading scientific literature. Past experience in the lab and field (on boats) is also desirable. A strong willingness to work independently as well as with others.

**Student transportation needed for project?**
Yes
Ability to get to Wickford to the Cap'n Bert for the fish trawl on Mondays is desirable.

## Dynamics of the plankton community in various marine ecosystems

Pierre Marrec (University of Rhode Island - GSO/Bay Campus)
Heather McNair URI GSO hmcnair@uri.edu

**Project Location:**
University of Rhode Island-Bay Campus

**Project Description:**
The student will have a choice to participate in one or several ongoing research projects in the Menden-Deuer Lab with a focus on plankton population dynamics in terms of abundance, distribution, growth and grazing rates. Various aspect of the plankton dynamics could be addressed as:

- The function of planktonic food webs and rates in response to change in the physical and biogeochemical environment in coastal ecosystems (NES-LTER project).

- Or the role of herbivorous protists in relation to transfer of organic matter to depth in pelagic ecosystems (NASA EXPORT project).

The student will be exposed to a range of microbiological and oceanographic techniques and will have access to numerous lab facilities. The student will also take part in the development of new experiments. There is an opportunity to participate in few sampling of the Narragansett Bay Estuary.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Autonomy in a lab environment. Interest in quantitative techniques. High level of motivation. Professionalism and reliability.

**Student transportation needed for project?**
Students must be able to come to Narragansett Bay Campus.
Some bus service is available with RIPTA.

# Evaluating the skill of a biogeochemical model of Narragansett Bay

David Ullman (University of Rhode Island - GSO)

**Project Location:**
University of Rhode Island-Bay Campus

**Project Description:**
Project Description

This SURF project will be focused on evaluating the results of a computer model of the circulation and biogeochemistry of the Narragansett Bay region. For the results of this model to be useful, they must be compared with observations to evaluate how well the model performs. The student working on this project will statistically compare outputs of the model with field observations of the same quantities in order to evaluate the skill of the model in simulating physical and biological processes. The project will provide the interested student with the opportunity to write computer programs in MATLAB and thus gain valuable computer programming experience.

Project Significance

The coupled simulation of ocean circulation and lower trophic level ecology will contribute on a fundamental level towards the RI C-AIM goal of improving and evaluating ecosystem models of Narragansett Bay. The coupling of an advanced biogeochemical model optimized for inner shelf and estuarine systems with an existing ocean circulation model of the region will provide a powerful tool for the understanding of ecological processes in the Bay, both at the present time and under future climate change scenarios.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Because numerical circulation/biogeochemical models produce very large datasets, computer programs are needed to process and analyze the results. The interested student will preferably have at least moderate computer skills and the desire to improve them.

**Student transportation needed for project?**
No

# Enhancing the Narragansett Bay Observatory with Unmanned Underwater Vehicles (UUVs)

Mingxi Zhou (University of Rhode Island - GSO)

**Project Location:**
University of Rhode Island-Bay Campus

**Project Description:**
The project is to enhance the Narragansett Bay Observatory with unmanned underwater vehicles (UUVs). The goal is to collect high resolution spatial and temporal hydrographic measurements between existing surface buoys. Hence, we could advance the understanding and modeling of the biological-chemical-physical relationship in the bay. The prospective candidate will be trained to operate a portable UUV, and will conduct UUV deployments on the water.
There are two options for research focuses.

1) For "data" focused option, the student will
   a. work on developing a toolkit (API) for data processing, analysis, and visualization
   b. work with other scientists and students quantify the modeling improvement of having the UUV data
   c. work with other members in the lab on new bio-chemical sensors integration for UUV.

2) For "engineering" focused option, the student will
   a. explore acoustic-based navigation or terrain-based navigation for the UUV
   b. validate and characterize sensor performance, e.g., accuracy and uncertainty, in labs or field experiments
   c. implement the navigation algorithm on the UUV, and test it in the open water.

*This project involves **primarily field work***

**Required/preferred skills for student applicant:**
1) For the "data" focused option, the student is expected
   a. familiar with the MATLAB tools or other equivalent programming software, e.g., Python, Scilab,
   b. having the fundamental knowledge of oceanography,
   c. willing to work on the water,
   d. excellent writing skills for generating documents and manuals.

2) For the "engineering" focused option, the student is expected
   a. familiar with c++ programming language on embedded systems,
   b. having hardware experience in embedded system (Linux OS) or micro-controller (Arduino),
   c. familiar with communication protocols, such as URAT, SPI, or TCP/IP,
   d. having equipment experience in oscilloscope, multi-meters, and soldering,
   e. knowing ROS, MOOS, or have worked on other robotic platforms will be considered as an asset.

**Student transportation needed for project?**
No

# Algae-Surface Enhanced Raman Spectroscopy (A-SERS) based Detection of Nitrates and Phosphates in Water

Arijit Bose (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
Excessive levels of nitrates and phosphates in water, coming from agricultural or wastewater runoff and by flooding, create large algae blooms. Dissolved oxygen levels then drop precipitously, affecting all aquatic life. Additionally, many of these algae, such as red tides, are toxic to humans. Accurate detection of nitrates and phosphates in fresh or ocean water remains a challenge. We propose a novel natural bio-accumulation technique that exploits the ability of algae to draw in nitrates and phosphates as nutrients to detect these ions in water.

Surface Enhanced Raman Spectroscopy (SERS) active nanoparticles fabricated in our laboratory have been used to detect nitrate ions in salt water. Ulva spp algae (sea lettuce) will be immersed in a suspension of these particles. This weed is native to salt water and is known for high and rapid nutrient uptake. The particles will enter into the leaves as they draw in surrounding liquid as a part of their normal metabolic cycle. When these doped Ulva spp leaves are exposed to water 'contaminated' with sodium nitrate, they will draw the nutrient solution into their individual cells, exposing them to the SERS-active particles in those locations. The sea lettuce cells concentrate nutrients and act as natural filters, thus removing any macroscopic 'debris' that can confound the analysis. They also have natural anti-biofouling properties. These algae leaves will then be examined in a Raman microscope using near-IR laser excitation (785nm; NIR penetrates through biological material), and, using data from a calibrated system, the concentration of the nitrates can be determined quantitatively. Since each ion has a distinct Raman signature, this approach will be highly specific, allowing quantitative detection of phosphates as well.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
At or beyond sophomore level in engineering, chemistry, or other science disciplines. High degree of motivation.

**Student transportation needed for project?**
None

# Investigating human use of coastal resources along Narragansett Bay

Tracey Dalton (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
SURF students would be involved in two projects collecting data on human use of coastal resources along Narragansett Bay. The first project builds on an on-going C-AIM effort to better understand how people are using public access sites along Narragansett Bay, and what they think about the environmental, social, and physical conditions at these sites. In addition, the project explores how conditions are allocated among coastal sites and among different groups of people. For instance, are conditions, like healthy water quality or ease of access, equitably distributed among public access sites throughout the Bay? The second project focuses on how a sub-set of coastal users (recreational fishermen) will be affected by a proposed habitat enhancement project (i.e. installation of artificial reef modules) at Sabin Point, a public access site along Narragansett Bay. For both projects, students will work on a team to conduct in person structured surveys at public access sites along Narragansett Bay. Days/times will be randomly selected during the summer. Each survey is expected to last about 10 minutes.

*This project involves **primarily field work***

**Required/preferred skills for student applicant:**
We seek students that feel comfortable working on a team and talking with coastal users at public access sites. Students who speak Spanish are encouraged to apply.

**Student transportation needed for project?**
Yes
Students will travel to sites, including Sabin Point, throughout the project to conduct in person surveys.

## Women in marine science

Tracey Dalton (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
Women continue to be under-represented in many marine science and technology fields (Cervia and Biancheri 2017). Researchers have shed light on some reasons why there are so few women in science and engineering occupations (AAUW 2010). Students and faculty at URI have teamed up with collaborators at WHOI and the MIT Sea Grant program to contribute to this growing body of research by investigating women in coastal and marine science. In this project, SURF students will work on a team to conduct face-to-face interviews with women coastal and marine scientists, with a particular emphasis on those working on research in and around the Narragansett Bay and watershed. This study will explore what motivates women to pursue coastal and marine science, and the experiences they have had that they find unique to a woman's experience in coastal and marine science. Findings of this study will provide insights into more effective strategies for recruiting and retaining women in the coastal and marine science workforce.

*This project involves* ***both field & lab/computer work***

**Required/preferred skills for student applicant:**
We seek a SURF student who would feel comfortable working as part of a team and talking with scientists about their experiences and opinions. As part of the project, the SURF student would also help to transcribe digitally-recorded interviews.

**Student transportation needed for project?**
Yes
The SURF student would need to travel to conduct the interviews. Interviews would be conducted at higher education institutions, state and federal agencies/labs, and other venues throughout Rhode Island.

# Assessing changes in coastal ecosystem engineers and associated communities in Narragansett Bay

Lindsay Green-Gavrielidis (University of Rhode Island)
Niels Hobbs (University of Rhode Island)
Carol Thornber (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
Habitat-forming seaweeds, such as rockweeds (Order Fucales) and kelps (Order Laminariales), are ecosystem engineers that form dynamic habitats in cool-water regions and support complex food webs. Rockweeds, such as Fucus spp. and Ascophyllum nodosum, are dominant, temperate seaweeds in the intertidal and shallow subtidal of rocky shorelines, while kelps form complex habitats in the subtidal. Changes in the distribution or abundance of habitat-forming seaweeds can have dramatic consequences for the associated food webs and ecosystem health. Here, we propose to assess the current health of economically and ecologically important habitats in Narragansett Bay by surveying the fish, invertebrate, and seaweed communities through a combination of traditional methods (e.g. random quadrat sampling) and a novel video transect method at sites dominated by rockweed or kelp and for which we have historical records. SCUBA surveys will be conducted at 24 different sites throughout Narragansett Bay in order to characterize the current status of these habitats. We will identify collected seaweed and invertebrate specimens in the laboratory and prepare samples for stable isotope analysis. Analysis of the video transects will also be conducted in the lab. By comparing the current communities with historical data collections, we can identify large-scale changes in these habitats. In order to determine potential changes in these communities in the face of local and global anthropogenic stressors, we must assess changes that have already occurred.

*This project involves **both field & lab/computer work***

**Required/preferred skills for student applicant:**
We are looking for students that can assist in field work, sample identification, and video transect analysis. Open water SCUBA or AAUS research diving certification with a minimum of 10 open water dives in southern New England is highly preferred. Required skills for this project include an ability to work carefully and independently, comfort in working outside in inclement weather, ability to work with microscopes (primarily dissecting) for long periods of time, a flexible work schedule as some weekend work may be required, and a familiarity with Microsoft Excel. It is preferred, but not required, that the student has experience in identifying marine macroalgae (seaweed) and/or invertebrates.

**Student transportation needed for project?**
No

## A Cradle-to-Cradle Approach to Bio-renewable Plastics

Matthew Kiesewetter (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
This proposal seeks to develop new, more effective, chemical recycling methods and new materials which will lessen environmental damage; this constitutes a change in human behavior. The goal of this project is to develop, from renewable resources, plastics that are fully biodegradable and infinitely recyclable in a cradle-to-cradle fashion. Plastics are entering the ocean at alarming rates, causing considerable damage to points of entry, like Narragansett Bay. Recycling plastic waste is one option to mitigate the damage from these materials; however, recycling rates are very low, and conventional recycling technology often results in downgraded material whose journey to the landfill is only delayed. Despite the problems associated with plastics, humanity's rate of plastic production continues to grow. Solving the plastic problem is of vital importance to Rhode Island and its 400 miles of coastline, and we seek to develop comprehensive approaches to mitigate plastic waste at every chance that it may accumulate. We will use fundamental studies of catalysis and materials science as our primary tools to develop catalytic methods of depolymerization to regenerate monomer that can be used for the generation of new plastic, as opposed to virgin feedstocks.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Completion of organic chemistry 1 and 2 and the associated laboratory course(s).

**Student transportation needed for project?**
No

## Biofilm growth on marine environments

Kayla Kurtz (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
Biofilm formation on instrumentation deployed in the marine environment is one of the biggest challenges of long-term monitoring activities. It is well known that microbial diversity determines the biomechanical and physicochemical properties of biofilm as well as response to antibiofilm strategies. As part of the RI C-AIM sensor development effort, microfluidics-based devices are currently in development. These devices are not larger than a couple of centimeters and some of their features (microchannel and microwells) are in the order of tenths of microns. Biofilm formation studies have been performed using different size samples up to 6 cm, however to our knowledge only small size ranges (less than 5 mm) have evaluated the effect of sample size on composition and biodiversity of biofilm. We will use multimodal imaging to assess biofilm growth on materials used for the manufacturing of microfluidics sensors to be deployed in marine environments and biofouling agents common to Narragansett Bay.

*This project involves* ***both field & lab/computer work***

**Required/preferred skills for student applicant:**
Chemical and biological laboratory experiences.

**Student transportation needed for project?**
Yes

# Paper-based devices for nutrient detection in real-world environments

Mindy Levine (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
There are a number of nutrients in marine environments, including nitrate and phosphate, that have to be within certain levels in order to ensure a healthy ecosystem. Too little of these nutrients means that organisms can't access what they need, and too much means that certain organisms will grow rapidly and disrupt the delicate ecosystem balance. Commercially available methods to detect nitrate and phosphate exist, but can be tedious to use and/or suffer from other serious drawbacks. Our group has developed new paper-based devices that turn color in the presence of nitrate and phosphate, and can be used for the rapid detection of these nutrients in real-world environments. We are now ready to use these devices to test broad varieties of water samples at locations throughout Rhode Island, to validate the device performance and obtain important information about the ecosystem health.

*This project involves* ***both field & lab/computer work***

**Required/preferred skills for student applicant:**
A willingness to work with others and openness to learn new things.

**Student transportation needed for project?**
No

# Colorimetric Detection Methods for Nitrate and Phosphate Monitoring Using Hand-Held, Portable Devices

Mindy Levine (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
The detection of certain key nutrients in marine environments can provide important clues about the overall health of an ecosystem, with too much or too little of these nutrients indicating significant problems with the ecosystem, and the ideal amount necessary for a healthy ecosystem to continue to function. We are developing sensitive, selective, and portable ways to detect two of these key nutrients, nitrate and phosphate, using color-changing functionalized paper combined with an integrated smartphone app that will enable effective detection.

*This project involves* ***primarily lab or computer work***

**Required/preferred skills for student applicant:**
Willingness to learn new things and work as part of a collaborative team

**Student transportation needed for project?**
No

## Understanding effects of ecological changes on recreational and commercial fishing

Sonia Refulio Coronado (University of Rhode Island)
Emi Uchida (University of Rhode Island)
Hirotsugu Uchida (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
The objective of this project is to gain an understanding of how fishermen and the fishing communities are adapting to ecological changes in the New England region. As one of the first steps, the student will work in a team of faculty and students to conduct a literature review, conduct focus groups, identify and analyze existing data, design and test a possible new survey instrument.

*This project involves* ***both field & lab/computer work***

**Required/preferred skills for student applicant:**
Required skills:
- Be able to handle data sets as well as create graphs and tables using Excel
- Be interested in and comfortable talking to fishermen, government agencies, and other stakeholders
- Have a basic understanding of resource economics
- Excellent written and oral communication skills
- Be able to collaborate in a team, have good work ethics, and learn independently

Preferred skills:
- Elementary statistics would be helpful

**Student transportation needed for project?**
Yes
The student may need to travel in-state and to New England states to conduct interviews.

# Multiplexed Optical Detection of Heavy Metal Contaminants in Plants

Daniel Roxbury (University of Rhode Island)
Mitch Gravely (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
Current methods to detect heavy metal contaminants in soil and plant samples involve bulky and expensive equipment, i.e., atomic absorption spectroscopy (AAS) or inductively coupled plasma-mass spectroscopy (ICP-MS), prohibiting their use in portable on-site testing. Single-walled carbon nanotubes are an ideal candidate in the construction of next-generation sensors. Their intrinsic fluorescence is exceptionally photostable, with emission properties that are responsive to single molecules. It has been demonstrated that the fluorescence from nanotubes responds to the presence of heavy metal ions. Additionally, in the near infrared imaging window of 900-1400 nm, there exist >20 species (chiralities) of nanotubes that can be separated from a mixture, functionalized, and utilized for multiplexed optical sensing. Here, we will create a family of functionalized nanotubes to quantify concentrations of heavy-metal contaminants that have accumulated in plant samples. Nanotubes appropriately functionalized with small-molecule or aptameric chelators of heavy-metal ions will have the capacity to simultaneously monitor bulk concentrations of up to 20 distinct species of heavy metal contaminants. Upon specific binding of a heavy-metal ion to the chelator-nanotube complex, a characteristic red-shift is expected in the near-infrared emission spectrum due to perturbations in the localized dielectric environment of the nanotube. By sequentially separating by nanotube species and conjugating specified chelating agents, we propose to engineer specificity and selectivity to the optical nanosensors.

*This project involves **primarily lab or computer work***

**Required/preferred skills for student applicant:**
Optical microscopy
Plant biology
General laboratory skills (pipetting, weighing, etc.)

**Student transportation needed for project?**
No

## Determining how echinoderms respond to a high $CO_2$ world

Coleen Suckling (University of Rhode Island-Kingston Campus)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
Our oceans are absorbing anthropogenic $CO_2$ and this process disturbs the chemical balance of seawater, removing vital carbonate ions required to scaffold calcium carbonate structures in many marine invertebrates (coined Ocean Acidification). Consequently, calcifying organisms are predicted to struggle under a future climate of high-$CO_2$. For populations to persist, organisms must be able to successfully develop and reproduce. Considering the timescales over which climate change is occurring, marine organisms will experience changes across years and decades. Consequently, during this time, animals will be developing, maturing and populating future generations. Few studies have considered these adult conditioning methodologies, and fewer have incorporated responses across several generations, a vital step in understanding how animals will cope and persist under a future climate.

Here is a unique opportunity to address these information gaps by measuring the reproductive success of first and second generation (F1 and F2 respectively) sea urchins bred under year 2100 $CO_2$ conditions. Coleen Suckling currently has histological slides of the gonad tissue of these urchins and this project will digitally record and archive these slides using light microscopy and digital imagery. Then these slides will be subject to image analysis (using Fuji, also known as ImageJ) to determine the reproductive stage of the animals (e.g. mature or spent) and to identify how nutrient loading and reproductive effort (i.e. egg size and numbers) are being prioritised. This project will contribute new information to this research field and will be applied to collaborative reproductive kinetics work with the University of Bangor's (UK) School of Ocean Sciences faculty and research students. Furthermore gonad and skeletal samples will also be similarly assessed from starfish exposed to a RI C-AIM climate change project to determine how energy is prioritised between calcification and reproductive effort.

In addition there will be general animal husbandry duties of various marine organisms within the Bay Campus Aquarium linked to various research projects within the field of aquaculture and climate change research (e.g. RI C-AIM funded projects). There will also be some general preliminary experimental trials to potentially be involved in and some general laboratory duties (e.g. assisting in equipment sourcing and processing) which provide an opportunity to expand general research and laboratory experience and skill sets.

This is an exciting opportunity to gain hands on experience with active C-AIM projects and facilities, to become familiarized with complex research issues and research tools. The student will work within the RI C-AIM's project community and their active projects which fall into several of their foci which include: i) Assessing biological and ecosystem impacts; ii) predicting ecosystem response through integration, and iii) visualization and imaging.

*This project involves* ***both field & lab/computer work***

**Required/preferred skills for student applicant:**
Reliable, driven, problem solving and enthusiastic students are strongly encouraged to apply.

Any skills of microscope photography, image processing/analysis, aquarium and/or husbandry skills would be beneficial but full training will be provided where required to expand and exercise the student's skill sets.

**Student transportation needed for project?**
Yes
The student would need to be able to periodically visit the Bay campus aquarium in order to conduct animal husbandry duties.

# Dynamics of eastern oyster-associated bacteria in the Narragansett Bay, RI

Ying Zhang (University of Rhode Island)
Zachary Pimentel (University of Rhode Island)

**Project Location:**
University of Rhode Island-Kingston

**Project Description:**
The eastern oyster, a species of high ecological and economic value, has been shown to harbor communities of bacteria distinct from those found in the water column. Previously, we have identified core groups of bacteria that are associated with different tissue types of the oysters. In this project, we aim to explore the abundance and distribution of these core bacteria among the water column across different depth and locations of the Narragansett Bay (NB). Students will receive trainings in field sampling and various molecular technologies, including DNA extraction, PCR amplification, and amplicon library sequencing. Additional opportunities will be provided for the students to gain skills in high-performance computing and molecular sequencing data analysis. This research will further our understanding of the prevalence and fluctuation of the oyster-associated bacterial species in the NB. It will also provide new insights into the origin and dispersal of the host-associated bacteria.

*This project involves **both field & lab/computer work***

**Required/preferred skills for student applicant:**
Course preparations in microbiology, biochemistry, or related fields. Prior experiences with DNA extraction and PCR is preferred but not required.

**Student transportation needed for project?**
No

## Lab-to-field: Nanostructured sensors for monitoring pollutants in coastal ecosystems

Geoff Bothun (University of Rhode Island)
Timo Kuester (University of Rhode Island)

**Project Location:**
University of Rhode Island - Kingston

**Project Description:**
Small, low cost sensors are needed to improve our ability to detect and monitor environmental pollutants that harm coastal ecosystems. Critical to the success of any sensor is the ability to integrate it within existing instrumentation that is used in the field to monitor coastal ecology. Through this project, students will translate experimental research on nanostructured sensors and device design to field research where the sensor devices are connected to buoys and/or autonomous vehicles. The nanostructured sensors will be created using gold and silver nanomaterials to provide sensitive detection of nitrogen and phosphorus, both nutrient pollutants, via Surface Enhanced Raman Spectroscopy (SERS). Specific goals of this work will include designing and characterizing nanostructured sensor elements, integrating these elements into 3D printed devices and with field instrumentation, and optimizing sensor design by engineering selective surface coatings.

The proposed project directly addresses the need for new, innovative sensors that can be integrated within existing ocean instrumentation for improved data collection. The testbed for these sensors will be Narragansett Bay and provides an excellent opportunity for student training in research translation.

*This project involves **both field and lab work***

**Required/preferred skills for student applicant:**
Engineering or physical science background preferred.

**Student transportation needed for project?**
No

# Long-term shifts in plankton communities in and around Narragansett Bay

Tatiana Rynearson (University of Rhode Island)

Project Location:

University of Rhode Island- Bay Campus

Project Description:

Plankton communities serve as the fuel for the rest of the marine food web. They undergo dramatic changes on time scales of weeks to decades. Join the Rynearson lab to help unravel how plankton communities in and around Narragansett Bay are changing. There are opportunities to work with the Narraganset Bay Long-term Time Series, including weekly sampling of Narragansett Bay plankton from a research vessel. There is also the potential to work with a newly launched time series that samples coastal waters right outside Narragansett Bay, including a research cruise on the R/V Endeavor.

This project includes computer and lab work with some field work.

Required/preferred skills for student applicant:

Students should have taken an introductory statistics course, interest in the quantitative analysis of data sets, interest if not experience using the software package R, a background in ecology, and a willingness to participate in fieldwork.

Student transportation needed for project?

No

# Examining the dynamics of diatom population dynamics and diatom species that cause harmful algal blooms in Narragansett Bay

Alexa Sterling (University of Rhode Island)
Dr. Bethany Jenkins (University of Rhode Island)
Matt Bertin (University of Rhode Island)

**Project Location:**
University of Rhode Island

**Project Description:**

In Narragansett Bay, we're interested in members of a group of floating unicelluar algae (phytoplankton) called diatoms. Some members of this group in the genus *Pseudo-nitzschia*, can produce a potent neurotoxin called domoic acid that causes harmful algal blooms when it bioaccumulates in small animals is transferred up the food chain or in shellfish eaten by humans. To learn more about the dynamics of this harmful species we are also comparing it to dynamics of non-harmful bloom forming species and environmental factors in Narragansett Bay such as nutrient concentrations and temperature. This SURF project will involve active field sampling and collection of water samples and accompanying metadata from several sites in Narragansett Bay. In the laboratory, water samples will be filtered for DNA analysis in order to examine the species composition of diatoms including *Pseudo-nitzschia*, and isolating *Pseudo-nitzschia* and establishing laboratory cultures for lab experiments. The cultures of isolates growing in the lab will be identified through molecular techniques such as Sanger sequencing. The student will examine the sequencing results and phylogenic relationships between the diatoms and cultured representatives.

Responsibilities will include: Water sample collection and accompanying metadata in the field, water sample processing in the laboratory, DNA extraction, sequence analysis to identify phytoplankton and bacteria cultures, sterile media preparation, dissecting scope work to isolate single cells, phytoplankton cultivation and growth monitoring, experimental design and testing (hypothesis, control/treatment, etc.), research notebook maintenance.

This project involves ***both field and lab work***

**Required/preferred skills for student applicant:**

- Required qualifications include familiarity with basic data analysis skills (e.g. electronic data recording, graphing data)
- Preferred qualifications include basic microbiology and aseptic laboratory technique experience, some command line computational skills, familiarity with R.
- No prior field experience required, but student should be aware some water sample collections may occur while on a small boat offshore and involve moving 10 L carboys of water.

**Student transportation needed for project?**
Not a requirement, but might be helpful