All Projects
(updated 2/6/15)

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4. Augmenting shell calcification in farmed shellfish.

5. Enhancing oyster settlement for aquaculture and restoration through the application of a unique underwater soundscape.

6. Impacts of changing balances of CO_2 and CH_4 on seabed microbial ecosystems

7. Experimental sea level manipulations in coastal marshes

8. The genomics of Green Macroalgal Blooms

9. Population genetics of the Green Crab due to predation

10. Tracking harmful algal blooms in Narragansett Bay via ecological and aerial technology approaches

11. Development of metalloporphyrin functionalized transmissive conducting electrodes for photo- and electrochemical detection of thiocyanate in marine environments

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18. Gene expression changes due to climate change in a marine invertebrate

19. Is a common sub-tropical species becoming more common in Rhode Island?

20. Impacts of anthropogenic nutrient pollution on coastal marine invertebrate greenhouse gas emissions

21. Bermuda Seaweed Project

22. Understanding the evolution of parasitism in red algae

23. NAD Salvage pathway preference in marine organisms

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24. The effect on microbial populations by contaminates in Blackstone River sediment under changing climatic conditions

25. Heat Shock Proteins in *G. demissa* as Indicators or Climate Change in Narraganset Bay

26. Population growth of the ctenophore *Mnemiopsis leidyi* in relation to temperature and prey availability

27. Effect of legacy pollutants on microbial communities in Narragansett Bay watershed

28. Causes of long-term declines of coral reef fish populations

29. Will consumer driven die-off and sea-level rise synergistically destroy Narragansett Bay salt marshes?

30. Biochemical and behavioral analysis of AdhE enzymes from *Entamoeba* spp. in resisting environmental stresses (climate change) in marine and fresh water protists

31. Transmission electron microscopic examination of leukemia-like circulating cells from diseased hard clams for evidence of viral infection

Projects by Primary Mentor Institution

Brown University

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Bryant University

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Providence College

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Rhode Island College

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Roger Williams University

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Salve Regina University

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9. Population genetics of the Green Crab due to predation

University of Rhode Island

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Project Code: 1

Project Title: Temperature-mediated changes in blue crab *Callinectes sapidus* abundance in the Narragansett Bay and its trophodynamic effect on winter flounder *Pseudopleuronectes americanus* populations

Project Mentor(s): David Taylor (Roger Williams University)

Project Description:
There is growing concern over declining winter flounder (*Pseudopleuronectes americanus*) populations in southern New England estuaries, including the Narragansett Bay (RI, USA). Although overexploitation was paramount in their initial population decline, several other factors could continue to adversely affect winter flounder recruitment, and thus keep adult populations at depressed levels. The precipitous decline in winter flounder abundance in the Narragansett Bay, for example, coincides with a significant warming trend in northern-temperate estuaries. Elevated temperatures, in turn, may intensify the predator-induced mortality of juvenile flounder by increasing the metabolism and consumption rate of local predators. Moreover, subtle increases in temperature may cause a poleward shift in the distribution of more southerly-located species, including the blue crab (*Callinectes sapidus*); hence, resulting in a spatio-temporal overlap with juvenile winter flounder in the Bay and newly established competitive and/or predator-prey interactions.

The decline in winter flounder abundance in Narragansett Bay, coupled with changes in climatic conditions, has raised the question of whether these previously overexploited stocks can recover in the face of altered trophic dynamics. To this end, the primary objectives of the proposed research are twofold: (1) assess the functional significance of Narragansett Bay as habitat for juvenile winter flounder and blue crabs, and therefore quantify the spatio-temporal overlap between species, and (2) examine the putative biotic interactions between winter flounder and blue crabs using conventional stomach content analysis and biochemical techniques, i.e., polymerase chain reaction (PCR)-based molecular methods for detecting prey DNA. The products of this research may identify an important source of mortality for winter flounder in the Narragansett Bay, and further explain how temperature-mediated changes in trophic dynamics prevent flounder stocks from recovering to historical levels.

Project Significance:
This proposal directly addresses the overarching theme and specific research questions identified by the RI NSF EPSCoR: “What are the impacts of climate change on marine life?” and “How are the structure and function of coastal marine food-webs being redirected in response to climate change?”

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

Required/preferred skills:
Ability to work well in groups and under adverse weather/field conditions

Students involved in this project will use/learn the following techniques:

- Field techniques: sampling biota via beach seines and otter trawls; experience with small boat handling; measuring environmental variables
- Laboratory techniques: PCR analysis; fish and crab dissections; stomach content analysis; otolith extractions
- Data analysis: ArcView GIS mapping; statistical analysis via SAS

Project Code: 2

Project Title: Trophic-level responses to climate driven sea level rise and associated abiotic conditions

Project Mentor(s): Jameson Chace (Salve Regina University) & David Borkman (URI-GSO)

Project Description:
Ecological theory predicts that organisms are most abundant within the optimal range of limiting physical conditions. In the intertidal zone, small fish and invertebrates are sensitive to temperature change. Changes in water temperature with climate change will stress some populations causing an evolved response or migration. The project measures those conditions today and builds a model to predict the abundance and distribution of these organisms with sea level rise based on abiotic tolerances, substrate availability, and projected marine productivity. These organisms form the foundation of the food web for sea ducks, cormorants, loons, grebes, gulls and terns of the near shore marine coastal environment. Changes to the distribution, abundance and timing of prey availability will have a cascading effect through the marine trophic community resulting in changes in the abundance and distribution of these birds. Based on current modeling of habitat use by invertebrates, small fish, and predatory birds, we will model community level changes predicted with a warming climate and sea levels rise.

Project Significance:
Sea level rise will cause a change in the near shore substrate, of which we can measure and model. Habitat selection of small fish and invertebrates along the rocky shore of Newport Neck is not well known, yet changes to the prey base is predicted to affect higher trophic levels. Climate change will affect nutrient loading, flushing rates, salinity and temperature in upper Narragansett Bay where species zones of tolerance are already at threshold levels. Species-specific responses are independent but affects trophic level dynamics across the ecosystem.

This project involves **primarily field work**

Required/preferred skills:
A student having completed their Sophomore year in Environmental Science or Studies. Having successfully completed some laboratory coursework. Prior field experience, especially work with boats is a plus, but not required. Flexible hours - field work is dependent on good weather and we work when the seas are calm (at whatever day or time that may be). Ability to swim is required

Students involved in this project will use/learn the following techniques:

- Small boat handling
- Repeated measures of quadrat sampling for intertidal invertebrates
- Near shore trapping of lobster, crabs and small fish
- Quantifying benthic invertebrates using Ponar-grab sampler
- Quadrat sampling of sub tidal, intertidal and super tidal substrate
- Quantifying foraging behavior of sea ducks, cormorants and gulls
- Quantifying phytoplankton and zooplankton type and abundance
- Measuring water quality (nutrient loading, E. coli contamination, temperature, salinity, D.O.)
- Using GPS and GIS to map and model near shore sea level rise impacts
- Statistical Analysis of spatial and temporal population responses.

Project Code: 3

Project Title: Narragansett Bay apex predators' response to toxic chemicals and climate change

Project Mentor(s): Rebeka Merson (Rhode Island College) & Diane Nacci (EPA)

Project Description:
This project addresses questions about the resilience and adaptation of cartilaginous fishes (sharks, skates, and rays) to chemical pollutants in the face stressors and impacts of climate change. My research program focuses on molecular, biochemical, and morphological responses in marine predators (sharks, skates) exposed to chemical pollutants.

Project Significance:
At this time no data exist about climate change-related impacts on marine apex predators; this project aims to advance knowledge of their resilience and sensitivity to persistent bioaccumulative toxicants. Chemical loading in Narragansett Bay is predicted to rise with increasing frequency of heavy precipitation events associated with climate change.

This project involves **primarily lab work**

Required/preferred skills:
- Preferred: Enthusiasm, flexibility, able to collaborate in student groups, good communication skills, takes initiative
- Required: Motivation, basic knowledge of molecular biology (central dogma), excellent work ethic, problem solving skills

Students involved in this project will use/learn the following techniques:
- Nucleic acid and protein purification
- Polymerase chain reaction
- *in situ* hybridization
- western blotting
- light microscopy
- marine animal husbandry
- routine laboratory activities (e.g., making buffers, maintaining laboratory notebook, lab etiquette).

Project Code: 4

Project Title: Augmenting shell calcification in farmed shellfish.

Project Mentor(s): Dale Leavitt (Roger Williams University)

Project Description:
Laboratory and field experiments to measure the uptake and processing of a proprietary feed additive to be delivered as a food particle to filter-feeding bivalves and to assess its capacity to alleviate reduced shell calcification in rapidly growing shellfish.

Project Significance:
Shell calcification is an important issue associated with ocean acidification impacts on bivalve mollusk metabolism. This work will test our capacity to augment the food intake of selected commercially important bivalves to enhance calcium carbonate uptake and utilization. This strategy may be one means to counter impacts of climate change on shellfish culture to enhance food security in a changing environment.

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

Required/preferred skills:
- Familiarity with shellfish biology.
- Awareness of shellfish culture techniques.
- Good analytical skills.

Students involved in this project will use/learn the following techniques:
- Particle counting (Coulter Counter)
- Atomic Absorption Spectroscopy
- Shellfish nursery culture

Project Code: 5

Project Title: Enhancing oyster settlement for aquaculture and restoration through the application of a unique underwater soundscape.

Project Mentor(s): Dale Leavitt (Roger Williams University) & Dave Moretti (Naval Undersea Warfare Center)

Project Description:
One bottleneck to hatchery oyster production for restoration is the efficiency of completing settlement in competent oyster larvae. We propose to investigate the capacity of underwater sounds, characteristic of established oyster beds, to enhance the settlement behavior of hatchery-reared oyster larvae onto substrate destined for aquaculture and for environmental restoration.

Project Significance:
As our environment changes over time, human intervention may be required to counter changes in terms of shellfish population structure and distribution. To that end, shellfish restoration is a viable means to address population changes. This work will enhance our capacity to produce oyster spat-on-shell in shellfish hatcheries as a first step in advancing oyster restoration actions.

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

Required/preferred skills:
Familiarity with shellfish culture techniques.

Students involved in this project will use/learn the following techniques:
- Underwater sound recording and acoustic manipulation.
- Shellfish hatchery techniques.

Project Code: 6

Project Title: Impacts of changing balances of CO_2 and CH_4 on seabed microbial ecosystems

Project Mentor(s): Dawn Cardace (University of Rhode Island)

Project Description:
This work relies on modeling microbial metabolic responses to increasing CO_2 and CH_4 gas contents in seabed environments, simulating biological responses to gas hydrate decomposition in the seabed, a likely result of continued warming. The researcher will learn to use modeling tools to represent current ocean conditions, then will simulate CO_2 and CH_4 seabed release and the impacts on microbial metabolisms.

Project Significance:
Environmental stresses on marine microbes include gradual and abrupt changes in ambient geochemistry that are driven by climate change. The researcher will address one aspect of these anticipated changes by focusing on gas hydrate reactions.

This project involves **primarily lab work**

Required/preferred skills:
Preferred qualifications: GEO103 (URI…or similar course) & GEO320 (URI…or similar course)

Students involved in this project will use/learn the following techniques:
- Content knowledge to be gained: ocean chemistry, gas hydrate structure and stability, carbon cycling, CO_2 and CH_4 dependent metabolisms.
- Skills: Modeling via Geochemists Workbench and/or Primer

Project Code: 7

Project Title: Experimental sea level manipulations in coastal marshes

Project Mentor(s): Serena Moseman (University of Rhode Island)

Project Description:
Student will work with Prof. Moseman-Valtierra to design and deploy experimental sea level manipulations in coastal marshes and track responses of soils, plants, and biogeochemical processes.

Project Significance:
This study will advance our ability to predict sea level rise impacts on coastal ecosystem biogeochemistry by optimizing field manipulations.

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

Required/preferred skills:
Introductory biology and ecology, general chemistry courses; willingness to work under hot conditions, variable hours, ideally able to lift heavy objects, walk long distances, not afraid to get dirty

Students involved in this project will use/learn the following techniques:
- soil and plant field methods
- porewater collection
- nutrient analysis
- experimental design
- basic statistical data analyses

Project Code: 8

Project Title: The genomics of Green Macroalgal Blooms

Project Mentor(s): JD Swanson (Salve Regina University) & Carol Thornber (University of Rhode Island)

Project Description:
Two species of the macroalgal genus *Ulva*, *Ulva compressa* and *Ulva rigida*, are the most abundant species in harmful macroalgal blooms in Narragansett Bay, RI. These dense aggregations of algal biomass can have significant ecological and economic impact on coastal communities and have increased in both size and duration over the past several decades. This study seeks to identify a link between temporal changes and gene expression potentially causing bloom behavior.

To this end we have collected tissue from key points in the bloom cycle for each species and sequenced their transcriptomes using Next Generation Sequencing. In addition, we have completed annotating the resulting transcriptomes. We intend to use these transcriptomes for two major purposes 1) we intend to data mine these data to identify genes that can be implicated in the underling triggers for these blooms and verify them in vivo using qPCR. 2) We will also mine these transcriptomes for microsatellite regions that could provide useful DNA markers from which we will be able to monitor the population dynamics of blooms through the 2015 summer.

Project Significance:
The activities proposed here represent a low-risk, high-reward opportunity to identify and characterize novel genomic-level regulators that control algal blooms responding to seasonal temperature, light, and nutrient fluctuations potentially indicative of climate change. Ulva blooms have significant negative ecological and economic impacts on coastal communities, including in Narragansett Bay, RI. However, little data exist on the population dynamics, genetic makeup, and underling functional genetics that link harmful algal bloom development to potential impacts from climate change.

This project involves **primarily lab work**

Required/preferred skills:
Must have completed Bio 1 and 2

Students involved in this project will use/learn the following techniques:
- Transcriptome data mining
- RNA extraction
- cDNA amplification
- qPCR
- PCR
- DNA Extraction
- DNA Quantification
- Gel Electrophoresis
- Flow Cytometry
- Data analysis and interpretation

Project Code: 9

Project Title: Population genetics of the Green Crab due to predation

Project Mentor(s): JD Swanson (Salve Regina University)

Project Description:
The Green Crab (*Carcinus maenas*) the Asian Shore Crab (*Hemigrapsus sanguineus*) are both considered significant invasive species in the United States. However, ecological studies in the Narragansett bay RI, have indicated that the Green crab population has recently declined whereas the Asian Shore crab population has increased. To this end, we hypothesize that if the Green Crabs are inbreeding due to competition with the Asian Shore crab decreasing their population size. This in turn will be manifested over time by a decrease in heterozygosity.

We have already initiated this study during the Summer 2014, and this project will add an expansion to our current data set. To this end, crab legs will be removed from 5 coastal regions located around Aquidneck Island in Narragansett Bay, RI in order to extract their DNA. Six microsatellite markers will be used to examine the genetic diversity of the Green Crab to determine what may be the possible genetic implications resulting from the decrease in their population.

Project Significance:
The activities proposed here present an opportunity to study the genetic effects of an introduced species that is predated by another species. As climate change occur, the abundance of these organisms will vary providing additional stressors to the population. This study will test to see how stressed the population is and provide a predictor of its survivability in the future.

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

Required/preferred skills:
Bio 1 and 2

Students involved in this project will use/learn the following techniques:
- Collection
- DNA Extraction
- PCR
- Gel electrophoresis
- Data analysis and interpretation

Project Code: 10

Project Title: Tracking harmful algal blooms in Narragansett Bay via ecological and aerial technology approaches

Project Mentor(s): Lindsay Green (University of Rhode Island) & Carol Thornber (University of Rhode Island)

Project Description:
This project will be conducted under the guidance of Dr. Lindsay Green (URI), Dr. Carol Thornber (URI) and Dr. Stephen Licht (URI). We are currently investigating the formation and regulation of algal blooms in conjunction with developing aerial technology. The fellow's project will involve frequent fieldwork to conduct surveys of, and experiments on, bloom physiology and development, as well as work with image analysis and aerial photography. The student will spend the significant time at URI Kingston, at the URI Marine Life Sciences Facility (URI/Narragansett), and at field sites in Narragansett Bay.

Project Significance:
Blooms of macroalgae (seaweed) frequently occur in estuarine systems worldwide. Macroalgal blooms can cause serious ecological and economic impacts on nearshore marine communities and are thus of considerable interest to scientists, managers, and coastal human populations. As climate change occurs, the magnitude and duration of blooms is predicted to increase, which may also have strong impacts on the structure and functioning of coastal marine food webs. This project will investigate the responses of these blooms to different climate change scenarios, on both ecological and molecular levels.

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

Required/preferred skills:
Required skills for this project include an ability to work carefully and independently, comfort in working outside in inclement weather, a valid driver's license and vehicle, a flexible work schedule as some weekend work may be required, and familiarity with Microsoft Excel. It is preferred that the student has experience in identifying marine macroalgae (seaweed).

Students involved in this project will use/learn the following techniques:

- Learn how to identify bloom-forming algae using morphological and likely molecular approaches, algal culturing techniques and ecological field protocols.
- Gain extensive experience setting up, maintaining, and analyzing data from laboratory-based seawater experiments.
- Work collaboratively with ocean engineers (Dr. Licht's lab) on this project.

Project Code: 11

Project Title: Development of metalloporphyrin functionalized transmissive conducting electrodes for photo- and electrochemical detection of thiocyanate in marine environments

Project Mentor(s): Clifford Murphy (Roger Williams University)

Project Description:
Detection of aqueous thiocyanate is important both for its direct action as a toxin and as a metabolite of toxin cyanide that is excreted as thiocyanate by fish. Current state of the art in thiocyanate detection requires sample preconcentration and preparation to reduce or remove interferant anions such as halides and thiosulfate. Detection of thiocyanate is then achieved via ion exchange chromatography or spectrophotometry. There is a need for a chemosensor for thiocyanate that is portable, sensitive, and selective in the marine environment for field detection and monitoring.

Our objective is to create covalently bound metalloporphyrin layers on tranmissive conducting electrodes (fluorine-doped tin oxide, FTO) for photometric and electrochemical detection of thiocyanate. By using a variety of metal centers (iron, manganese, zinc) their varied sensitivity to thiocyanate in the presence of other anions will lead to an aggregate detection method that is both specific and senstive to thiocyanate.

Project Significance:
Rhode Island enjoys a significant recreational and commerical boating industry. Copper thiocyanate is commonly used abiotic ingredient to antifouling paints and coatings. Thiocyanates can also be deposited in the sediment from other industrial processes or commonly used herbicides. As water temperatures rise, either seasonally or as a result of climate change, thiocyanate can leach more readily into the marine waters. This project presents the first steps in creating a field suitable chemosensor for monitoring thiocyanate levels.

This project involves **primarily lab work**

Required/preferred skills:
Students applying to this project will have completed a full year of organic chemistry and a full year of general chemistry at minimum. Experience with inorganic or analytical chemistry would be a plus, but not required.

Students involved in this project will use/learn the following techniques:

- Students taking part in this project will continue to develop general research skills in terms of lab notebook keepings, handling and reporting of data, laboratory safety, and presentation skills in both oral and written formats.
- Students will develop specific skills in terms of material science (FTO substrate prep, characterization by contact angle measurements), organic synthesis (Schlenk technique, microwave synthesis, characterization by NMR, elemental analysis, thin-layer chromatography, UV-Vis spectrophotometry). Prepared materials will be characterized for their sensitivity to thiocyanate by electrochemical (impedence, cyclic-voltammetry) and spectrophotometric (UV-Vis absorbance, fluoresence) methods.

Project Code: 12

Project Title: How does invasive species introduction affect carbon cycling in coastal marshes?

Project Mentor(s): Rose Martin (University of Rhode Island) & Serena Moseman-Valtierra (University of Rhode Island)

Project Description:
Coastal marshes are critically important providers of ecosystem services including coastline protection, larval fish habitat, and potentially climate change - mediating carbon storage. However, as a result of anthropogenic impacts including nutrient pollution, a warming climate, and exotic species invasion, coastal marshes are experiencing a myriad of biogeochemical changes that may alter ecosystem service provision. The objective of this ongoing study is to quantify impacts of the invasion of *Phragmites australis*, an introduced grass, on carbon cycling in coastal wetlands. Field research will focus on measurement of greenhouse gas fluxes and soil and plant variables from *Phragmites* and native vegetation zones in Rhode Island coastal marshes, and the opportunity for some genetics work (looking at microbial communities involved in the greenhouse gas fluxes being measured) will be available to students. Students will also learn appropriate statistical techniques for analyzing collected field data.

Project Significance:
This project will help to provide data on greenhouse gas fluxes and other soil and vegetation characteristics to help address the question of how Phragmites australis invasion will affect the carbon storage potential of coastal wetlands.

This project involves **primarily field work**

Required/preferred skills:
Willingness to work (and sometimes get dirty!) in marshes; Openness to learning new techniques

Students involved in this project will use/learn the following techniques:

- Use of cavity ringdown spectroscopy greenhouse gas analyzer
- Use of equipment for measuring soil characteristics in the field and lab: salinity, pH, oxidation/reduction, moisture content, organic content
- Statistical methods for data analysis (ANOVA, regression analysis)
- Potential for genetics lab work (on occasion)

Project Code: 13

Project Title: Greenhouse Gas Emissions from Field's Point Wastewater Treatment Plant

Project Mentor(s): Elizabeth Brannon (University of Rhode Island) & Serena Moseman-Valtierra (University of Rhode Island)

Project Description:
This goal of this project is to investigate the emission of three greenhouse gases (nitrous oxide, carbon dioxide, and methane) from biological nutrient removal at the Field's Point WWTP in Providence, RI. Nutrient removal is crucial to maintain the health of the bay water, but may also cause emissions of these three harmful gases. The project will investigate the daily and seasonal variability of the emissions as well as examine potential mechanisms for nitrous oxide emissions.

Project Significance:
Excess reactive nitrogen in the coastal environment has serious consequences including eutrophication, hypoxia, loss of biodiversity, and habitat degradation. Therefore, removal of nitrogen from wastewater before it enters the bay is crucial. However, the removal process may lead to unwanted emissions of three potent greenhouse gases. Greenhouse gases play a critical role in maintaining Earth's temperature by trapping heat in the atmosphere, but rapid and significant increases in the concentrations of greenhouse gases are driving global climate change. Determining the magnitude of the greenhouse gas emissions from the WWTP as well as potential mechanisms will help to optimize nitrogen removal while minimizing greenhouse gas emissions.

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

Required/preferred skills:
Undergraduate should be willing to participate in field days at the WWTP throughout the summer.

Students involved in this project will use/learn the following techniques:
Undergraduates will assist with water sample collection and greenhouse gas measurements at the WWTP in Providence. While in the field, they will have the opportunity to work with a new real time greenhouse gas analyzer. In the lab undergraduates will assist with analyzing the collected samples on a gas chromatograph and spectrophotometer. Towards the end of the summer undergraduates may assist with an isotope labeling experiment to examine mechanisms of nitrous oxide production.

Project Code: 14

Project Title: Public Outreach Video: Recounting Water Resource Values and Restoring Migratory Fish Runs

Project Mentor(s): Caroline Druschke (University of Rhode Island)

Project Description:
This public outreach project works to preserve and enhance New England heritage assets by linking the past, present and future values of the region's rivers and migratory fish runs. The faculty mentor and SURF fellows will work with NOAA staff, a professional videographer, and local historians to do research and writing to contribute to a video highlighting the vital role of New England's rivers as both natural resource and cultural assets. The geographical scope of the video will be rivers and watersheds linked to Rhode Island's coastal waters. Through compilation of existing reports and original archival research and interviews with key stakeholders – including long-time local residents, tribal members, community activists, municipal decision-makers, and other stakeholders – the video will feature the unique regional culture that formed around New England's rivers. Topical areas will potentially extend from the importance of Native Peoples fishing and resource uses; to the dams and mill villages that developed prior to or as part of the Industrial Revolution; to the recreation, community-resiliency, and ecosystem services that result from present-day and future dam removals. In unfolding and promoting the history of the region's mill villages and placing that history within a broader temporal context, this project will serve as an invaluable public outreach tool linking historic mill villages with important river restoration benefiting our Nation by restoring healthier fish populations and creating more informed and resilient New England communities.

Project Significance:
This project directly addresses Q.4 "How can scientific findings and forecasts in the area of climate variability and marine life be made more accessible to the public through a variety of media?" SURF students will conduct original historical and qualitative research related to migratory fish runs, historic mill villages, and contemporary dam removals and place that work in a larger context of community resilience in the face of climate variability and change. Their work will contribute to a video project that disseminates that research to a large, public audience through NOAA's distribution network.

This project involves **primarily field work**

Required/preferred skills:
Strong communication skills; interest in estuarine systems and migratory fish; interest in public outreach and science communication

Students involved in this project will use/learn the following techniques:
- historical, archival research
- textual analysis
- qualitative interviewing
- script writing
- public outreach
- science communication

Project Code: 15

Project Title: Science Communication Outreach about Coastal Storm Impacts in National Parks

Project Mentor(s): Caroline Druschke (University of Rhode Island)

Project Description:
SURF students will work with the faculty mentor to develop a variety of science communication public outreach materials about coastal storm impacts and current post-Hurricane Sandy research in east coast National Parks. Products might include infographics, lesson plans, podcasts, resource briefs, and social media content that work to explain storm impact research, stewardship, planning, and decision-making and their relevance to the general public.

Project Significance:
This project directly addresses Q.4 "How can scientific findings and forecasts in the area of climate variability and marine life be made more accessible to the public through a variety of media?" SURF students will work to translate biophysical and ecological research related to coastal storms in National Parks into publicly accessible documents and media. These materials will be disseminated to a wide public audience impacted by climate variability and interested in its impacts on marine life.

This project involves **primarily field work**

Required/preferred skills:
Ability to work both independently and collaboratively (required); strong communication skills (preferred); interest in coastal processes (preferred); interest in public outreach and science communication (preferred)

Students involved in this project will use/learn the following techniques:
- textual analysis
- interviews
- writing
- science communication
- document design

Project Code: 16

Project Title: Coastal Restoration Case Studies from the Ocean State

Project Mentor(s): Caroline Druschke (University of Rhode Island)

Project Description:
The SURF student will work with the faculty mentor to create a series of case studies about coastal restoration projects in Rhode Island that synthesize information about partners, funding, habitat, and public stakeholders. These case studies will be shared with state legislators and members of the general public to learn from coastal restoration successes.

Project Significance:
This project directly addresses Q.4 "How can scientific findings and forecasts in the area of climate variability and marine life be made more accessible to the public through a variety of media?" The SURF students will work to collect and highlight information about research and management related to coastal restoration and resilience. That information will be delivered to decision-makers and the general public.

This project involves **primarily field work**

Required/preferred skills:
Ability to work both independently and collaboratively (required); strong communication skills (preferred); interest in coastal restoration (preferred); interest in public outreach and science communication (preferred)

Students involved in this project will use/learn the following techniques:
- archival research
- qualitative interviews
- writing
- document decision
- science communication

Project Code: 17

Project Title: Feeding and aggression behaviors of local mysid shrimp

Project Mentor(s): Maia Bailey (Providence College) & Jeffrey Markert (Providence College)

Project Description:
Mysid shrimp are an important part of the Narragansett Bay ecosystem providing an important food source for game fish; however, we know very little about what ecological forces control their population numbers and stability. We are currently characterizing feeding and aggression behaviors in two local mysid species, Americamysis bahia and A. bigelowi, in the lab in order to understand their ecological roles and cycles and hope to add temperature and salinity treatments as part of these investigations this summer.

Project Significance:
This research will establish baseline information for understanding how these important members of the local food web behave under a range of stresses including abiotic, temperature and salinity, and biotic, intra- and interspecific competition in the lab. By establishing these baseline expectations, we can monitor natural populations and better predict their responses to stresses caused by climate change.

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

Required/preferred skills:
Familiarity with aquarium system care.

Students involved in this project will use/learn the following techniques:
- capturing, identifying, and culturing mysid species
- running and refining behavioral assays
- data collection and statistical analysis.

Project Code: 18

Project Title: Gene expression changes due to climate change in a marine invertebrate

Project Mentor(s): Steve Irvine (University of Rhode Island)

Project Description:
Ciona intestinalis adults will be reared at control conditions and at conditions simulating ocean warming and acidification. Gonads will be dissected and protein extracted and sent to the Brown Epscor Proteomics Center to be analyzed using liquid chromatography/mass spectroscopy. The data will be analyzed to determine which proteins are up or down-regulated in the different conditions. Relative fecundity of animals at different conditions will also be tested. Protein expression and fecundity changes, if detected, will be compared to infer possible physiological stresses on the reproductive system of the animals.

Project Significance:
Protein expression profiles are readouts of the physiological state of an organism. New technology enables global assessment of protein expression in detail at low cost. The aim is a pilot project to determine if protein expression changes can be detected when the ascidian *Ciona intestinalis* is reared at temperature and pH levels consistent with projected ocean warming.

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

Required/preferred skills:
Preferred: experience with protein extraction

Students involved in this project will use/learn the following techniques:

- Aquarium setup and animal care at the EPSCoR Marine Life Sciences Center at URI Bay Campus.
- Dissection and protein extraction in the lab.
- Analysis of proteomic datasets.

Project Code: 19

Project Title: Is a common sub-tropical species becoming more common in Rhode Island?

Project Mentor(s): Jeffrey Markert (Providence College) & Elisabeth Arevalo (Providence College)

Project Description:
One consequence of climate change is that both the distributions of organisms and their phenology will change. We plan to focus on understanding key aspects of these change on *Americamysis bahia* a ‘model organism’ that has been extensively used in both toxicology and conservation biology studies. Historically, *A. bahia* has been common in the warm waters of the Gulf of Mexico, with occasional appearances in the cooler waters in Rhode Island estuaries. Last summer, our EPSCoR funded team sampled the waters off Charlestown, RI from May through August. To our surprise, we found that *A. bahia* was quite common during our collecting trips.

The goal of this SURF proposal is to conduct a series of follow-up studies on this observation using several techniques. The primary question is whether apparent *A. bahia* collected in northern estuaries are closely related to those from the Gulf Coast. We propose to address this with several distinct approaches. First, estuarine habitats in RI and elsewhere will be systematically sampled in order to further define the distribution of *A. bahia*. Second, we will take advantage of Providence College’s extensive bio-imaging facilities to confirm morpho-species identities. We will also use DNA sequencing, microsatellite genotyping, and (potentially)high-throughput SNP analysis (using PC’s Fluidigm genotyping system) to determine evolutionary affinities between populations sampled and Gulf Cost animals. Finally, we will use our recirculating marine system to conduct a series of mate-choice studies to determine whether northern and southern forms represent distinct species under the Biological Species Concept.

Project Significance:
A. bahia used to be rare in RI waters. Our project will ultimately address the 'evolutionary potentials' issue by providing data to determine a) whether native *A. bahia* are simply becoming more common or whether the recent collections are immigrants from the gulf coast. Longer term, we hope to include museum materials in our analyses so that we can track changes in this group over time.

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

Required/preferred skills:
Reliability, organization, enthusiasm, and a strong interest in ecology and evolution.

Students involved in this project will use/learn the following techniques:
- Field sampling, including the management of collections and geographic information
- Laboratory culture and behavioral techniques
- Molecular laboratory approaches including DNA extraction, PCR, genotyping and sequencing.

Project Code: 20

Project Title: Impacts of anthropogenic nutrient pollution on coastal marine invertebrate greenhouse gas emissions

Project Mentor(s): Melanie Garate (University of Rhode Island) & Serena Moseman-Valtierra (University of Rhode Island)

Project Description:
Carbon dioxide (CO_2) and nitrous oxide (N_2O) are potent greenhouse gases (GHGs) that trap heat in the atmosphere and are one of the main contributors to climate change. Coastal zones are known to limit the amount of GHGs to the atmosphere through carbon sequestration. Tropical wetlands, mangroves in particular, can store approximately 1,023Mg carbon per hectare. Due to their large carbon stocks, mangrove disturbance has the potential to emit CO_2 to the atmosphere. Further, recent studies have shown significant evidence that N_2O is emitted from coastal zones when excess anthropogenic nutrients in the form of nitrogen (N) are added and where macroinvertebrates are present in large abundances.
Several studies to date have focused on soil N_2O fluxes in coastal systems rather than examining sources of these emissions from a community based approach by including marine fauna, which are an integral part of the oceanic benthos. The dominant benthic macrofauna of coastal areas are filter and deposit feeders including bivalves in temperate zones and crabs in tropical mangroves. These organisms have the potential to produce ecologically relevant N_2O emissions due to ingestion of denitrifying bacteria that live within the sediment and water column. Thus, these organisms have the potential to increase N_2O emissions from mangroves directly through their respiration and indirectly by altering sediment properties, which is then exacerbated by excess N in the system.

The goal of this study is to discern how nutrient pollution affects carbon sequestration and GHG fluxes from coastal sediments, including those produced by sediment modifying deposit-feeding invertebrates in temperate areas of New England and a contrasting tropical system in a fringe mangrove in Puerto Rico. Through a combination of lab work and fieldwork, the student will have the possibility to examine how N_2O is emitted from coastal marine invertebrates through molecular or isotopic studies. Students with research diving certification are strongly encouraged to apply.

Project Significance:
Our research deals with anthropogenic changes to the marine environment and the potential responses and feedbacks on invertebrate production of greenhouse gases. These potent gases are responsible for changes in climate.

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

Required/preferred skills:
Research SCUBA Diving certified

Students involved in this project will use/learn the following techniques:
- Invertebrate sampling by scuba diving
- greenhouse gas analysis
- water chemistry analysis
- statistical analysis

Project Code: 21

Project Title: Bermuda Seaweed Project

Project Mentor(s): Chris Lane (University of Rhode Island)

Project Description:
Despite its distant location from North America and its tropical summer temperatures, Bermuda's small size at present supports only ca. 450 species of red, brown and green seaweeds, and endemism among these groups is reportedly less than 3%. The small size of the total flora make it possible to completely assess this archipelago's algal diversity over a short time period; a project that would be near impossible for larger-sized, and more diversely populated, islands in the Caribbean.

We seek motivated students to help with the molecular characterization of seaweed samples and assist in the analysis of evolutionary relationships among Bermuda seaweeds.

Project Significance:
The islands of Bermuda are ideally located for marine biodiversity assessment studies, because the isolated archipelago is at the interface of tropical and warm temperate biogeographic zones. This makes the island a sentinel for climate change.

This project involves **primarily lab work**

Students involved in this project will use/learn the following techniques:
- DNA extraction
- PCR
- DNA sequencing.

Project Code: 22

Project Title: Understanding the evolution of parasitism in red algae

Project Mentor(s): Chris Lane (University of Rhode Island)

Project Description:
Red algal parasites are ideal model organisms for investigating the origins of a parasitic life-style for two important reasons. First, most red algal parasites share an immediate common ancestor with an extant free-living red algal species, which is almost always their host, earning them the title adelphoparasites (adelphose is the Greek term for "kin"). Because of this sister-species relationship between parasite and host, a single pair of organisms can provide direct comparative data on the cellular and genomic changes occurring early in the evolution of a parasite, as well as information on host/parasite co-evolutionary dynamics. Second, hundreds of independently evolved red algal parasites have been described, all with varying degrees of divergence and relationship with their hosts, providing an enormous amount of comparative data with which to test mechanistic hypotheses.

Project Significance:
Population dynamics of red algal parasites are currently unknown, as is their reaction to environmental change. This project will seek to better understand population-level connectivity, based on DNA sequencing.

This project involves **primarily lab work**

Students involved in this project will use/learn the following techniques:
- PCR
- DNA sequencing
- interpretation of genomic data

Project Code: 23

Project Title: NAD Salvage pathway preference in marine organisms

Project Mentor(s): Karen Almeida (Rhode Island College)

Project Description:
Nicotinamide dinucleotide (NAD) is central to metabolism and therefore critical for cellular survival. Thus organisms have evolved complementary pathways to ensure an adequate supply of NAD. Biosynthetic pathways have developed to generate NAD from digested amino acids in the de novo pathway or to salvage an array of NAD metabolic intermediates. For *E. coli* entry into the NAD *de novo* pathway uses multiple enzymes to convert tryptophan into the nicotinamide derivative called quiolinic acid (QA). QA is decarboxylated and phosphoribosylated with the enzyme quinolinate phosphoribosyltransferase (nadC) to yield nicotinate mononucleoside (NaMN). Entry into the NAD salvage pathway can be accomplished through nicotinate or nicotinamide, generated either in dietary sources of vitamin B3 (niacin) or through the action of NAD consuming enzymes such as PARP1 or SIRT1 microbial homologs. Interestingly, the processing of the entry molecule, nicotinic acid (NA) is different from the entry molecule, nicotinamide (NAM) even though the structural difference is a single amine group. NA is phosphoribosylated with the enzyme pncB while NAM is phosphoribosylated with the enzyme nadV. The NaMN product of phosphoribosylating enzymes nadC and pncB has one of two fates: conversion to NaAD by the enzyme nadD before being amidated to NAD with the action of nadE or amidation to NMN by the enzyme nadE before becoming NAD with the action of nadM. Furthermore, NAM can be directly deamidated to NA with the activity of pncA. NAM metabolism may be a deciding factor in determining the salvage pathway choice. Although the presence of NAD biosynthetic pathways is universal across organisms, the individual strategies to accomplish this are not. The genomes of many microbes contain a nadV homolog but lack a homolog for the deaminase pncA. Others rely on the pncA route to regenerate NAD. Still others contain homologs for neither gene and a few contain homologs for both genes. Therefore, although there are several overall strategies used to maintain sufficient NAD concentrations within an organism, the specific pathway for an organism must be evaluated individually. This study will analyze the NIH genomic database to compile an up-to-date assessment of the 260 published marine micro-organism for their strategies to maintain adequate NAD levels.

Project Significance:
Marine microbes account for a large percentage of the marine biomass and play many roles in the marine environment including being the base of the food chain. Many of these organisms influence the concentrations of calcium carbonate and dimethyl sulfide in the oceans and thus they influence climate change. A better understanding of the central metabolite NAD in marine microbes will give insight into global climate change.

This project involves **primarily lab work**

Required/preferred skills:
Introductory biochemistry

Students involved in this project will use/learn the following techniques:
- This is primarily a computational project to evaluate the NAD biosynthetic pathways for known marine microbes so the techniques learned will include DNA and protein sequence analysis, sequence alignments, BLAST searching, and protein visuallization software .

Project Code: 24

Project Title: The effect on microbial populations by contaminates in Blackstone River sediment under changing climatic conditions

Project Mentor(s): Dan McNally (Bryant University)

Project Description:
Blackstone River sediment is known for its hydrocarbon and heavy metal contamination. The fate and transport of these contaminates are influenced by changing climatic conditions. The bio-availability and degradation potential of the hydrocarbons will be determined by delineating and quantifying the contaminates in the river sediment, identifying and quantifying types and populations of bacteria in the contaminated sediment, and conducting degradation studies.

Project Significance:
The Blackstone River, once labeled the "most polluted river in America", is a source of contamination to Narragansett Bay. The fate and transport of these contaminates are influenced by changing climate conditions, which will ultimately have an affect on the food webs.

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

Required/preferred skills:
none

Students involved in this project will use/learn the following techniques:
- analyze hydrocarbons (PAH) using a GC/MS
- analyze heavy metals using an ICP/MS
- determine the bacterial type and population using plating techniques
- determine PAH degradation potential by conducting degradation experiments
- simple statistical analysis of the data
- data compilation and interpretation
- reporting meaningful data

Project Code: 25

Project Title: Heat Shock Proteins in *G. demissa* as Indicators or Climate Change in Narraganset Bay

Project Mentor(s): John Williams (Rhode Island College)

Project Description:
This work began three years ago as an EPSCoR SURF project. Samples of *G. demissa* are collected from four established collection sites around Narragansett Bay. Ambient water and air temperature are recorded at collection and water samples are taken. The gill tissue is removed, homogenized, centrifuged and analyzed by gel electrophoresis, Western blotting and antibody staining to determine expression of Hsp70. Expression of heat shock proteins (Hsp's) in intertidal ectotherms occurs during summer and unseasonably warm weather. We can also heat acclimate the live mussels in the lab at 40°C and observe changes in Hsp70 expression relative to specimens kept at 18°C and those dissected on site at the ambient environment's temperature. We have observed different expression of Hsp70's at each temperature.

Project Significance:
Monitoring the temperature using *G. demissa* as a sentinel species and comparing absolute values and trends with climate records of past decades will reference the data to the present. This project began what can be a long-term study in which several generations of undergraduate and graduate students will participate to generate significant climate-change monitoring data.
We are developing 1) a research protocol that can be carried into the future by undergraduate scientists and their mentors, 2) data for comparison with the historical record, 3) data that may allow for projections to future climate regimens in the Bay.

Hsp's are chaperon proteins whose expression is a survival response that protects constitutive proteins from denaturing and removes irreversibly damaged ones from the cell. Earlier seasonal appearance, later subsidence and higher amounts of expression of Hsp's are indicators of temperature elevation in the aqueous environment. In addition to threatening survival of the extant individual organisms this may also put evolutionary pressure on populations to which they cannot viably respond if the rate of increase and the elevation in temperature are too high. This could lead to extinction ultimately, and, in the meantime, to a decrease in a bottom of chain food and nutrient source. In any case, organisms under stress are compromised, and the various stress responses that have evolved over time are not likely to be effective against a permanent, and, on a geological time-scale, rapid shift to a higher average temperature. Global warming and climate change may be moving much faster than evolutionary change can adjust to them, and not just for the animals in this study.

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

Required/preferred skills:
Students who have worked on this project have been biology or chemistry majors who have completed at least two years towards their bachelor's degree. All happen to have taken organic chemistry lecture and lab with the PI, but this is not a requirement.

Students involved in this project will use/learn the following techniques:
Locating field sites and collecting sample organisms, managing live organisms in a salt water aquarium, gel electrophoresis, Western blot analysis, antibody staining, dissection and extraction of Hsp's from tissue samples, helping to manage the lab supply chain, keeping an inventory of supplies and ordering apparatus and chemicals for the project, using and modifying experimental techniques found in the research literature, reading and assessing published work related to this project.
Project Code: 26

Project Title: Population growth of the ctenophore *Mnemiopsis leidyi* in relation to temperature and prey availability

Project Mentor(s): Jack Costello (Providence College) & Sean Colin (Roger Williams University)

Project Description:
Evaluate the importance of temperature and prey availability on population dynamics of the ctenophore *Mnemiopsis leidyi*. This will involve extracting, analyzing and publishing data from a large dataset taken in Narraganset Bay, RI. The student will be part of each of these components. Qualifications include the ability to work with data sets, then organize and present results of the investigation.

Project Significance:
The ctenophore *Mnemiopsis leidyi* has become a dominant component of the Narragansett Bay planktonic community as well as in its invasive range around the world. Our chief question is this: As temperature regimes alter in coastal systems such as Narragansett Bay, how will this predator respond and how will those responses affect the zooplankton community that is essential for marine community function? Using a remarkably complete data set from Narragansett Bay, we are in a favorable position to address these questions.

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

Required/preferred skills:
A science major, preferably biology.

Students involved in this project will use/learn the following techniques:
Data set organization, information extraction, basic population modeling, data presentation and manuscript preparation

Project Code: 27

Project Title: Effect of legacy pollutants on microbial communities in Narragansett Bay watershed

Project Mentor(s): Christopher Reid (Bryant University)

Project Description:
This study proposes to look at the systematics of historic river sediment contamination of the Blackstone river, its transport and effects on the freshwater and intertidal microbial communities. This work is tied to Dr. Parmentier's work on the Providence River and metal contamination into the intertidal regions of Narragansett bay. This year's work will focus on refining our analytical tools to identify degradation products of textile dyes in river sediment and investigate the distribution of these compounds between the sediment and bulk water. This project will continue to develop methods for the analysis of carcinogenic amines from river sediment and the evaluation of the microbial community from these contaminated sites. The link between industrial waste and antimicrobial resistance will be investigated.

Project Significance:
This project will investigate the impact of historical industrial waste contamination in the Blackstone River on the microbial community. Climate change forecasts for the Northeastern U.S. predict increased precipitation and more severe storm events. This will result in a greater influx of fresh water into Narragansett Bay, in many areas carrying high contaminant loads from inland sites or flushing contaminants from near shore contaminated sites. This transport of historic industrial waste and its degradation products from the Narragansett watershed into the bay and shore communities could have dramatic consequences for marine and human life in and around the bay. This project will look the effect legacy pollutants to the microbial communities in the Narragansett Bay watershed and how changes in mobilization and availability of these pollutants are affected by climate change.

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

Required/preferred skills:

Students involved in this project will use/learn the following techniques:
- molecular biology
- field sampling
- metal analysis by ICP
- gas chromatography

Project Code: 28

Project Title: Causes of long-term declines of coral reef fish populations

Project Mentor(s): Graham Forrester (University of Rhode Island)

Project Description:
Most Caribbean fishes have been in population decline since the 1990s. The students would participate in an experimental project designed to isolate causes of long-term change in the abundance of small reef fishes. The goal of the SURF project is to examine the causes of decline in small reef fishes by repeating experiments first conducted in the 1990s. Comparing the results of past and present experiments will allow us to infer which causal factors have changed since the 1990s.

Project Significance:
Coral reef communities are being progressively altered by a mix of local and global human activities, the most important of which are overfishing and climate change. Understanding the relative effects of different agents of change is important to design conservation strategies for reefs.

This project involves **primarily field work**

Required/preferred skills:
1) A passport and willingness to spend 4-6 weeks of the summer at a Caribbean field site
2) The ability to obtain AAUS research diver certification by June 2015. See http://www.gso.uri.edu/diving/index.htm for diving requirements. Applicants with current AAUS research diving certification and some experience (e.g. > 50 logged dives) may be preferred.
3) A strong academic background in ecology and marine biology, and an interest in marine conservation. Willingness to read primary scientific literature and contribute to project design.
4) Familiarity with the animals and plants that occupy Caribbean coral reefs is a plus but not essential. The ability to recognize coral and fish species visually may be preferred.
5) The ability to perform physically demanding field work for long hours each day in a team setting under sometimes stressful field conditions
6) An understanding of basic statistical principles and familiarity with MS Excel is preferable

Students involved in this project will use/learn the following techniques:
The project will include a mix of analyzing existing data that has been collected annually since 1992, and the collection of new data in the field during summer 2015. I will hold regular meetings with the SURF fellow(s) during which I will first assist with the location of primary research literature and help them write a short proposal outlining their project. I will provide training in data management and analysis. Fieldwork in the Virgin Islands will be for 4 weeks in late June/early July. I will be present at the field site working with the student full-time, every day. Before and during the trip I will provide training and supervision on methods for the safe performance of SCUBA-based research, following URI diving safety training procedures. Certification as an AAUS research diver is required before the trip. I will also help with graphical and visual presentation of the results, writing of the poster, and possible preparation of the results for publication.

Project Code: 29

Project Title: Will consumer driven die-off and sea-level rise synergistically destroy Narragansett Bay salt marshes?

Project Mentor(s): Mark Bertness (Brown University)

Project Description:
New England salt marshes are critical ecosystem service providers for coastal communities providing services ranging from storm protection and carbon storage to nursery habitats for commercially important species. Yet, they have been abused by humans since colonial times and currently face the biggest challenge to date. Overfishing has released burrowing herbivorous crabs from consumer control over the past two decades leading to an epidemic of regional salt marsh die-off and loss. Moreover, climate change driven sea-level rise is simultaneously threatening marshes with drowning. Rising sea level may also accelerate consumer-driven salt marsh die-off and synergistically destroy remaining salt marshes.

We propose a monitoring/experimental approach to addressing this problem by mapping and monitoring salt marsh die-off in Narragansett Bay and running a fully factorial field experiment to test the hypothesis that sea level rise will synergistically accelerate salt marsh die-off and loss. This research will address one of the most pressing problems for the current and long-term health of arguably the most ecologically and economically valuable component of New England estuaries.

Project Significance:
Our results to help to more accurately predict decadal marsh loss over the next century. We will work with local NPOs and management agencies to educate the general public about the eminent threat of salt marsh service loss and develop management strategies to mitigate and confront the loss of marsh services. This research and management collaboration will aggressively address the magnitude, mechanisms and potential human solutions to this pressing problem for the health of the most valuable component of New England estuaries.

This project involves **primarily field work**

Required/preferred skills:
Background in ecology, focus on a career in ecology/conservation biology, willingness to work long hours under sometimes difficult field conditions.

Students involved in this project will use/learn the following techniques:
Experimental field ecology techniques, data analysis, GIS mapping, scientific writing and communication.

Project Code: 30

Project Title: Biochemical and behavioral analysis of AdhE enzymes from *Entamoeba* spp. in resisting environmental stresses (climate change) in marine and fresh water protists

Project Mentor(s): Avelina Espinosa (Roger Williams University)

Project Description:
Amoebozoans include *Dictyostelium*, *Gymnamoeba*, and *Entamoeba*. Most amoebozoans are free living; few are parasitic. Little is known about the basic biology of marine and fresh water amoebozoans, their complex behaviors and interactions, or the effect of climate change on these unexplored groups. Chemical interactions that deter feeding on prokaryotic cells may be common, and may contribute to population- and community-scale processes, affecting trophic structure. Most of free-living protists are unculturable in the laboratory. The *Entamoeba* lineage is an ideal model to analyze comparative cell signaling between/among amoeba with morphological, multigene, and ecological studies in a laboratory setting. We hypothesize that chemical signaling between diverse *Entamoeba* will be limited because they live under different ecological conditions. Understanding chemical signaling at the unicellular level will help us understand the effect of environmental stresses, including climate change on fresh water, marine and parasitic marine protists. My laboratory works on enzymes required in anaerobic pathways.

Project Significance:
We would like to explore environmental stresses (temperature, pH, oxygen levels) on adaptive mechanisms for marine protists. By using laboratory strains of Entamoeba we propose to work on two aims:

1. Signaling mechanisms to survive stresses, like climate change by marine/fresh water protists (ongoing)
2. Explore mutations in AdhE enzymes on potential adaptive strategies under stressful conditions (temperature, pH or oxygen levels) as consequence of climate change.

This project involves **primarily lab work**

Required/preferred skills:
Interest, dedication. Molecular biology techniques are a plus but not required. Good academic standing

Students involved in this project will use/learn the following techniques:

- Culture of anaerobic *Entamoeba* strains
- Directed mutagenesis of adhe genes
- Cell aggregation using fluorescent dyes/microscopy
- Primer design, bioinformatics AdhE homologs
- Cloning, expression of mutant AdhE proteins
- Biochemical assays of AdheE
- Western blots

Project Code: 31

Project Title: Transmission electron microscopic examination of leukemia-like circulating cells from diseased hard clams for evidence of viral infection

Project Mentor(s): Roxanna Smolowitz (Roger Williams University)

Project Description:
In ectothermic animals annual cycles of disease occurrence and regression are common resulting in the need to "hunt" for the infectious agents that causes the disease (esp. one resulting in tumor formation and not just tissue destruction) at various times of the year. One of the first steps in understanding this leukemic-like disease is the evaluation of the circulating normal and neoplastic cells collected over different seasons for evidence of virus. This proposed project would examine archived and newly collected hemocytes (clam blood cells) that have been collected over at least one year of sampling) to describe the circulating tumor cells and normal cells at various times during the year and to look for replicating virus in circulating cells. Work would be conducted both at RWU and at the Marine Biological Laboratory, Woods Hole, MA. The student would work both in Smolowitz's RWU laboratory as well as at the MBL. Dr. Smolowitz is an adjunct researcher the MBL and has access to the laboratory of Dr. Alan Kuzirian, an expert in electron microscopy, and needed equipment such as an ultramicrotome, and a transmission electron microscope). Hemolymph samples archived over the past two years, and previous identified as leukemic or apparently normal, would be processed by the student using standard methods for Transmission Electron Microscopic evaluation. The student, with guidance, would examine the ultrathin stained sections using the electron microscope at the MBL and record, photograph and work with Dr. Smolowitz to interpret findings.

Project Significance:
Over the past five years, a novel leukemia-like disease that causes significant mortalities has become very common in Wellfleet, MA cultured hard clams, *Mercenaria mercenaria*). This latter disease is significantly impacting clam production and is driving many producers to give up aquaculture or revert to culture of eastern oysters on their leases. This new disease now occurs throughout Wellfleet Harbor, MA. More alarmingly, the leukemia-like disease caused significant mortality in cultured hard clams in another harbor, located miles away, which, two years previously had received "seed" clams from the infected Wellfleet Harbor area. It is unlikely that pollution is involved as the cause of the disease because the harbor is a very large estuary that undergoes 30 foot tides, thus there is more than adequate water exchange. It was originally hypothesized that the brood stock common to many of the aquaculturists, derived from one particular hatchery, was responsible for producing the hard clams that developed this disease. But recent work by Smolowitz (RWU) and D. Murphy (Barnstable County Extension Service and WHOI Sea Grant) strongly suggests the disease is caused by a new infectious agent. We demonstrated that "seed" from the suspect hatchery, as well as seed from 3 other hatcheries each from different states, all developed hemocytic neoplasia after 1 ½ year of growth in Wellfleet Harbor. The same seed when raised in other locations did not express the disease. If this disease is in fact caused by previously unidentified infectious agent whose appearance may be stimulated by environmental change, it would have far-reaching economic as well as disease implications for the hard shell clam industry (and wild clams) on the east and south U.S. coasts where hard clams are both indigenous and are aquacultured as human food. Histologically, no bacteria, fungus or other visible agent can be identified in affected clam tissues. Examination using transmission electron microscopy is needed.

This project involves **primarily lab work**

Required/preferred skills:
Previous experience sectioning tissue blocks on a microtome for either light or electron microscopic examination.

Students involved in this project will use/learn the following techniques:

- This student will learn how to process tissue for TEM examination, use an ultramicrotome to produce sections for examination, stain sections and use the TEM to examine, photograph and interpret findings in prepared sections.