Rhode Island NSF EPSCoR

Experimental Program to Stimulate Competitive Research

2016 Inaugural Research Symposium

Thursday, April 14, 2016
University of Rhode Island
Narragansett Bay Campus

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Symposium agenda

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Rhode Island EPSCoR is funded by the National Science Foundation under Award #EPS-1004057. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

| Agenda |

RI NSF EPSCoR Track 1 Annual Meeting
Coastal Institute Building
URI Narragansett Bay Campus
April 14, 2016 | 11:30 am-5 pm

11:30 am	**Check-in opens** Poster setup available
11:45 am-12:45 pm	**Networking lunch** Attendees will participate in a lunchtime discussion to answer questions and share thoughts on collaboration by table, with seating at each table based on a color code on the back of individual name badges
1-1:10 pm	**Welcoming remarks** Carol Thornber, RI EPSCoR principal investigator Robert Coyne, NSF program director
1:10-2:10 pm	**Panel discussion: EPSCoR @ RISD** | Reflections on studio-based research and its role in art+design+science collaboration Participants: *Neal Overstrom, Melita Morales, Shawn Greenlee, Brian House, Rafael Attias, Chris Rose* • Introduction: *Neal Overstrom* • Insights about studio as a tool for organizing multiple modes of inquiry: *Melita Morales, Chris Rose* • Reflections on the EPSCoR studio experience: *Shawn Greenlee, Brian House* • What did EPSCoR studios produce: *Neal Overstrom, Rafael Attias* • Q+A
2:10-3:10 pm	**Panel discussion: Mechanics of Collaboration** | How do you create successful interdisciplinary collaborations? The panel will explore some of the techniques of building collaborative research relationships used by teams of social and natural scientists, and teams of artists, designers and scientists. Participants: *Tracey Dalton, Austin Humphries, Cynthia Beth Rubin, Marta Gomez-Chiarri, Charlie Cannon* • Introduction: The nature of multidisciplinary, interdisciplinary and transdisciplinary research —*Tracey Dalton, Charlie Cannon*

- Current Research Collaborations
  - Social and Natural Science: *Tracey Dalton, Austin Humphries*
  - Art+Design+Science: *Cynthia Beth Rubin, Marta Gomez-Chiarri*
- Discussion, Q&A: *Tracey Dalton, Austin Humphries, Cynthia Beth Rubin, Marta Gomez-Chiarri*

3:10-3:15 pm **Panel summative remarks**
(Moderator: C. Cannon)

3:15-3:30 pm **Break**

3:30-5 pm **Poster session**
(Includes posters by EPSCoR researchers on EPSCoR/STAC funded research during the current grant, and EPSCoR core facilities. The URI Research Office will be present to assist in identifying funding mechanisms).

Narragansett Bay Campus

University of Rhode Island
Graduate School of Oceanography
215 South Ferry Road
Narragansett RI 02882-1197

Dean's Office
401-874-6222

Bay Campus Security
401-874-6262

URI Security
Non-emergency 401-874-4910
Emergency 401-874-2121

Buildings

19 Aquarium Annex
20 Ann Gall Durbin Aquarium / Aquarium Ark
21 Blount Aquaculture Laboratory
18 Bunker Cram
5 Center for Atmospheric Chemistry Studies
26 Coastal Institute Building
25 Coastal Resources Center
27 EPA Atlantic Ecology Division
3 Fish Laboratory
8 Furtado Building
4 Horn Laboratory
13 Maintenance Building
22 Marine Ecosystem Research Laboratory
7 Marine Geological Laboratory
17 Marine Laboratory
14 Marine Logistics Building
15 Marine Operations Building
11 Middleton Building / South Laboratory
24 Mosby Center
28 NOAA/NMFS/Northeast Fisheries Center
1 Ocean Science & Exploration Center
12 Ocean Technology Center /
Equipment Development Laboratory
16 Perkins Small Boat Facility
23 R/V *Endeavor* Pier
6 Rhode Island Nuclear Science Center
10 Sheets Building
9 Small Boat Maintenance Building
29 South Ferry Church
2 Watkins Laboratory

1 Ocean Science & Exploration Center
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3 Fish Laboratory
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29 South Ferry Church

Key Offices and Facilities

26 Coastal Institute
25 Coastal Resources Center
1 Dean's Office
1 Inner Space Center
26 Metcalf Institute
10 Ocean Engineering Department
26 Office of Marine Programs
1 Pell Marine Science Library
26 Rhode Island Sea Grant
8 Shipping & Receiving

Meeting Spaces

26 Coastal Institute Building (CI)
Coastal Institute Auditorium
Hazard Room
Large Conference Room
Small Conference Room
24 Mosby Center
1 Ocean Science & Exploration Center (OSEC)
Challenger Room
Nautilus Galley Café
2 Watkins Laboratory
Corless Auditorium

Parking

A Coastal Institute Parking Lot
B Lower Parking Lot
C Upper Parking Lot
D Horn Lab Parking Lot
E Ocean Engineering Parking Lot

Research Symposium panel members

Rafael Attias, MFA
Senior critic
Rhode Island School of Design

Rafael Attias is a multi-disciplinary fine artist, professional designer, curator, and educator. He works in diverse fields, navigating the spaces between fine art practice and design, often searching for where the two worlds intersect. He left his native home of Venezuela in 1988 to study at Rhode Island School of Design, where he received a BFA in Graphic Design. In 2015, he received an MFA in film from the Vermont College of Fine Arts. Attias has worked as a graphic designer and art director with several prominent New England firms. Today, he finds equal amounts of enjoyment as a "maker" and "investigator." His early personal work in abstract painting has transitioned into both narrative and experimental film, installations, the designing and building of musical instruments, soundtrack scores, and live performances. He has served as the program director for Pixilerations, a yearly, new media showcase that investigates the state of new media arts through installations, concert performances, and film/video screenings. Attias' work has been shown in New York City, Miami, Providence, Cambridge, Montpelier, as well as Caracas, Venezuela, and Dublin, Ireland. He balances a professional life of art and design with an academic career, finding the combination mutually beneficial and dynamic. He has been teaching at RISD since 1998, sharing his time between three different departments – Illustration, Graphic Design, and The Graduate Department of Digital Media, where he has been part of the faculty since its inception in 2005. Most recently, Attias completed a feature length, experimental documentary film titled "My Emo Life," which will premiere in 2016.

Charlie Cannon, MARC
Associate professor, Industrial Design
Head, Industrial Design Department
Rhode Island School of Design

Charlie Cannon helped found the Innovation Studio to explore solutions to complex problems through interdisciplinary collaboration and design thinking. The Innovation Studio serves as an incubator, and projects emerging from the studio have been supported by grants from the National Science Foundation, the National Endowment for the Arts, the Rhode Island Renewable Energy Fund, and the RISD Research Foundation. An exemplary teacher, Cannon is profiled in the Ken Bain's award-winning *What the Best College Teachers Do* (Harvard University Press, 2005) and in a documentary on Korean public television. He has been nominated for RISD's Frazier Teaching Award three times, and has taught at Harvard, Columbia and Yale Universities. Cannon is a co-principal investigator for Rhode Island's NSF Experimental Program to Stimulate Competitive Research (EPSCoR), a $20 million investigation of the impact of climate change on marine life and ecosystems. Working closely with Neal Overstrom, RISD's RI EPSCoR partner liaison, Cannon leads RISD's efforts to develop new ways for artists, designers and scientists to collabo-rate.

Tracey Dalton, Ph.D.
Professor, Marine Affairs
University of Rhode Island

Tracey Dalton holds a B.S. in Chemistry from Boston College and a Ph.D. in Environmental Science with a policy specialization from the University of Massachusetts Boston. Her research covers a variety of topics, all involving human interactions with marine and coastal environments. She has conducted studies on how people think about and use coastal and marine environments, the social and economic impacts of using space in different ways, and participatory processes for planning and managing human interactions with marine environments.
Dalton frequently collaborates with researchers in other disciplines, like marine ecologists and econo-

mists, to carry out interdisciplinary projects. Her work has been funded by the National Science Foundation, RI Sea Grant, Northeast Regional Sea Grant, and other funding agencies and findings have been published in the Proceedings of the National Academy of Sciences, Ocean & Coastal Management, Coastal Management, Marine Policy, Environmental Management, Conservation Biology, Marine Pollution Bulletin and other peer-reviewed journals. At URI, Dalton teaches undergraduate and graduate courses on human use and management of the marine environment, management of marine protected areas, and coastal zone management, and advises undergraduate and graduate students on research projects. She serves as a Research Member on the Stellwagen Bank National Marine Sanctuary Advisory Council.

Shawn Greenlee, Ph.D.
Programs head, Division of Experimental and Foundation Studies
Associate professor, Experimental and Foundation studies
Rhode Island School of Design

Shawn Greenlee is a composer and sound artist. He has performed extensively across the United States and Europe, appearing on several conferences, festivals, and tours. These include: All the Instruments Agree (Los Angeles 2015), NIME (Baton Rouge 2015, London 2014, Daejeon 2013), Re-new (Copenhagen 2013), ICMC (Huddersfield 2011, Barcelona 2005), IN TRANSIT (Berlin 2008), and Elevate (Graz 2007), among others. In 2008, he completed his Ph.D. in Computer Music and New Media at Brown University. In 2014, he was awarded the MacColl Johnson Fellowship for music composition by the Rhode Island Foundation.

Marta Gómez-Chiarri, Ph.D.
Professor and department chairman
Department of Fisheries, Animal and Veterinary Sciences
University of Rhode Island

At URI since 1997, Gómez-Chiarri earned her Ph.D. in Biochemistry and Molecular Biology from the Universidad Complutense de Madrid (Spain) in 1992. Before joining URI, she was a postdoctoral fellow at Hopkins Marine Station, Stanford University, where she worked in the development of DNA vaccines for fish and studied gene regulation in several aquatic species, including abalone.

Her research interests include the use of multidisciplinary approaches to the prevention and management of diseases in marine organisms. Her collaborative research spans many fields, from genomics to ecology. During a sabbatical in 2011 – 2012, Gomez-Chiarri was the Scientist-in-Residence at the Rhode Island School of Design, working with artists and designers on the development of visualization tools to mine the oyster genome. She also is working with landscape architects and sculptors on developing sculptural forms for coastal restoration.

Brian House, MSc, MA
Ph.D. candidate
Brown University

Brian House is an artist whose work traverses alternative geographies, experimental music, and a critical consideration of data-driven practices. By constructing embodied, participatory systems, he explores how computational temporalities negotiate with the rhythms of everyday life. His work has been shown by MoMA in New York, MOCA in Los Angeles, Ars Electronica, Cincinnati Contemporary Arts Center, Eyebeam,

Rhizome, Los Angeles Contemporary Exhibitions, Conflux Festival, ISEA, NIME, and Issue Project Room, among others, and has been featured in publications including WIRED, TIME, The New York Times, SPIN, Metropolis, and on Univision Sports.
Currently, House is a doctoral candidate at Brown University and a fellow at the Tow Center for Digital Journalism at Columbia University. Previously, he was a member of the R&D Lab at the New York Times and has participated in a National Geographic-funded transect of the Okavango river system in Africa as a technologist and sound recordist.

Austin Humphries, Ph.D.
Assistant professor, Ecosystem-based Fisheries Science
Department of Fisheries, Animal and Veterinary Sciences
University of Rhode Island

Austin Humphries earned his Ph.D. from Rhodes University in South Africa, where he lived and did his research in Kenya with the Wildlife Conservation Society. He received his M.S. at Louisiana State University and B.S. at the University of Vermont. Humphries conducts research on the ecological and social outcomes that arise from fisheries and coastal management interventions. He works in the United States and internationally, often studying oysters in estuaries and tropical coral reef fishes as well as the people who depend on these resources. Humphries describes his research as inherently interdisciplinary, and conducts field and lab experiments as well as socioeconomic interviews, performs synthetic statistical analyses, and designs models to understand the interactions and outcomes that arise from fisheries management interventions.

Melita Morales, MA
Program director and design educator
DownCity Design
With an emphasis on the creation of educational models that give equal value to the types of inquiry that take place in a lab, studio and workshop setting, Melita Morales uses opportunities in classrooms and informal and after-school settings to experiment with curricula that encourages students to move between divergent and convergent thinking, and to formulate a systems-level understanding of how things work.
The focus of her research is quality transdiciplinary collaborations and lesson facilitation through questions. Morales is a credentialed Secondary Level Art and Design educator with more than 15 years experience in teaching and curriculum design. Prior to coming to Rhode Island (RISD MA Art + Design Education '14), Morales created and directed a design + science summer public/private partnership called WonderLab in the San Francisco Bay Area, where she also was an art educator in schools.

Neal Overstrom, MA, MLA
Director of The Nature Lab
Rhode Island School of Design
Neal Overstrom is a biologist, designer, educator and the director of The Nature Lab at Rhode Island School of Design. He also serves as RISD's partner liaison to the RI NSF EPSCoR grant. Overstrom's work has focused on promoting environmental literacy through informal learning experiences. Prior to coming to RISD, he held senior posts for exhibit development, research and zoological management at the Mystic Aquarium in Mystic, Conn.,

and was a design associate with Kent+Frost Landscape Architecture.
He earned a Bachelor of Science degree in Biology from the University of Connecticut, a Master of Arts in Zoology from Connecticut College, and a Master of Landscape Architecture from the University of Massachusetts, Amherst. In 2009, he was named the University of Massachusetts Olmsted Scholar, exploring the intersection of living systems, technology, and aesthetics in designing for sustainability. His current interests involve investigating the biological influences on design, particularly the ways in which pattern, form and living elements in the built environment can reinforce the human-nature connection.

Christopher Rose, MDesRCA
Graduate program director
Rhode Island School of Design

Chris Rose is a designer, researcher and educator specializing in cross-discipline work, creativity and knowledge building in the field of design. Rose serves as Graduate Program director in the Department of Furniture Design, and research consultant for the National Science Foundation program at RISD. He is a fellow of the Arts Letters and Numbers project in New York founded by architect David Gersten. Formerly, Rose was Academic Programme Leader of Three Dimensional Design at the University of Brighton, England; actively involved with the Centre for Excellence in Teaching and Learning in Design (CETLD) and in the Centre for Research and Development (CRD), where he supervised a number of design-related Ph.D. programs. He has conducted specialized seminars in research for design, creative process and composite materials in Finland, India, Italy, France, Holland, Australia, UK and USA. His current research is in association with the Sustainable Design Masters Program at the University of South Australia.

Cynthia Beth Rubin, MFA
New media artist, Experimental and Foundation Studies
Rhode Island School of Design

Rubin is a graduate of Antioch College, Ohio, (BA), and the Maryland Institute, College of Art (MFA), with a studio practice extending from New York City to Narragansett, RI. With more than 17 years of teaching part-time at RISD, Rubin has developed the course "Digital Nature." She also developed the EPSCoR studio, "Digital Plankton," which was offered during the 2015 winter semester.

Rubin's selected exhibitions include a solo at the Kraft Center for Jewish Life, Columbia/Barnard, New York, NY (February, 2013), and numerous showings of Layered Histories (collaboration with Bob Gluck) such as the Jewish Museum, Prague, Czech Republic (2005), Legion Arts Center, Ceder Rapids, Iowa (2009), and Seduced by the Sacred, Jewish Art Salon Charter Oak Cultural Center, Hartford CT (2010). Her video les affinités recouvrées (Recovered Affinities) was featured opening night of multiple Jewish Film Festivals in 1995 (San Francisco, Boston). Recent group exhibitions include Waltz with the Earth: Art Kibbutz, Governor's Island New York, NY (2014), Under the Viaduct: West Harlem Art Fund New York, NY (2014), Art Gallery at SIGGRAPH2013 (peer reviewed group exhibition) Anaheim, CA (2013), and annual group exhibitions at the Oxford Gallery, Rochester, NY.
A three-time recipient of grants from the Connecticut Commission on the Arts, Rubin also has been awarded international artist residencies and grants from sources as diverse as the Videochroniques (Marseilles) and the Memorial Foundation for Jewish Culture.

RI NSF EPSCoR Steering Committee

Carol Thornber, Ph.D.
RI NSF EPSCoR Principal Investigator
Associate professor, biological sciences
University of Rhode Island
Carol Thornber is a marine community ecologist with a research focus on marine macroalgae, their importance in nearshore/coastal foodwebs, and the impacts of climate change on these systems. She works in a variety of marine systems, including salt marshes, estuaries, mudflats, and rocky shores, including intertidal and subtidal habitats. Her research is interdisciplinary, experimental, and quantitative, and she collaborates with a variety of basic and applied biologists.

Edward Harwot, Ph.D.
EPSCoR Co-Principal Investigator
Alva O. Way University Professor of Medical Science
Professor of Medical Science
Associate Dean of Biology
Brown University
As a past Established Investigator of the American Heart Association and Upjohn Professor of Pharmacology, Edward Hawrot's research interests include the understanding of the structure and function of nicotinic acetylcholine receptors and of the neurotoxins that target these important receptors.

Charlie Cannon, M.Arch
EPSCoR Co-Principal Investigator
Associate professor
Rhode Island School of Design
Research interests include: sustainability, urbanism and social innovation, education and social change. In the Industrial Design Department, he teaches core studios in the graduate program and seminars and courses focused on sustainable design and design for social innovation in the undergraduate program – including the advanced elective Innovation Studio.

Sheila Adamus Liotta, Ph.D.
EPSCoR Co-Principal Investigator
Associate professor
Dean, School of Arts & Sciences
Providence College
Sheila Adamus Liotta was appointed the first dean of the School of Arts & Sciences in 2009. She most recently served as special assistant to the vice president for academic affairs. She served as chair of the Department of Chemistry and Biochemistry for eight years and has been a faculty member at Providence College since 1993. During this time, she has served on various committees, including the Chairs/Directors Task Force and the Committee on Academic Rank and Tenure. She served as co-chair of the self-study committee that helped the College gain reaccreditation from the New England Association of Schools and Colleges, Inc. (NEASC) in 2008.

Christine M.B. Smith
Director, Innovative Programs, RI Economic Development Corporation
Executive director, RI Science & Technology Advisory Council (STAC)
At the RI Economic Development Corporation, Christine Smith is responsible for launching statewide economic development initiatives designed to maximize the economic impact of science, technology and innovation. She serves as executive director of RI STAC, a coalition of business, academic, medical and government leaders tasked with recommending strategic investments that drive economic development and job growth. STAC is the state governing committee for Rhode Island NSF EPSCoR and develops and implements a State Science Technology Plan that is consistent with Rhode Island's overall economic development strategy.

RI NSF EPSCoR Partner Liaisons

Elisabeth Arévalo, Ph.D.
Associate professor, molecular evolutionary biologist
Providence College
Elisabeth Arévalo is interested in many aspects of evolutionary biology, including phylogenetics, speciation, and social evolution. She has combined field observations and molecular techniques to address questions in a phylogenetic framework. She used lizards and wasps as model organisms and has worked on the phylogenetics and molecular evolution of these model organisms, and more recently on the reproduction of social wasps, contrasting the biology and social structure of tropical vs. temperate species.

Nancy E. Breen, Ph.D.
Associate professor, chemistry
Roger Williams University
Nancy Breen teaches analytical chemistry and instrumental analysis, and classes in the general chemistry sequence. Her doctoral and post-doctoral work was in the field of raman spectroscopy. Currently, her research uses gas chromatography to determine the fatty acid profile of various marine samples including aquacultured eggs, brood-stock diets, muscle tissue and algae. The information garnered from the profile can lead to improvements in aquaculture techniques to optimize production and can also be used to expound the health benefits of human consumption of fish.

Jameson Chace, Ph.D.
Associate professor, biology and biomedical sciences, environmental studies
Salve Regina University
Jameson Chace's area of research is primarily avian ecology, primarily how landscapes affect bird populations and communities. His current work involves exploring broader aspects of avian responses to the environment. Studying sea duck wintering populations off Newport Neck has opened questions about abundance and distribution of prey base through habitat modeling in the near shore environment. Food chain dynamics, and potential trophic cascades, are affected by changes to near shore and intertidal zone, and by nutrient pollution. He and his students have investigated nutrient flux in small coastal watershed over the past three years, results of which tie back to near shore productivity, local small fish and marine invertebrate community composition, and, ultimately, foraging behavior by sea ducks in winter.

Breea Govenar, Ph.D.
Associate professor, biology
Rhode Island College
Breea Govenar's research interests lie in community ecology and ecosystem function in marine and deep-sea habitats, including hydrothermal vents; causes and consequences of species diversity; trophic ecology and food web dynamics; and the evolution and diversity of invertebrates. She teaches Fundamental Concepts of Biology, Invertebrate Zoology, Biology Senior Seminar, and a First Year Seminar in Symbiosis. She is a guest investigator at the Woods Hole Oceanographic Institution since 2010 and director of the RIC Center for Research and Creative Activity, which aims to broaden participation of students and faculty in the practice of mentored undergraduate research and creative activity.

Lucie Maranda, Ph.D.
Associate marine research scientist, professor-in-residence
Supervisor, Marine Science Research Facility
URI Graduate School of Oceanography
Lucie Maranda studies algal blooms, anti-fouling treatments, biofouling, biology, ecosystem dynamics, fouling dynamics, microbial ecology, phytoplankton ecology, and suboxic ecology. In the marine environment, biofouling is the natural settlement of live organisms on solid structures in seawater. Although the process contributes to the productivity of coastal waters, it also leads to the unwanted accumulation of organic material on submerged surfaces that perform better or last longer when kept clean.

Dan McNally, Ph.D.
Associate professor, Department of Science and Technology
Bryant University
Dan McNally's academic interests focus on environmental toxicology and risk assessment, green technologies for sustainability, and investigation and remediation of contaminated sites. His research interests include factors affecting bioremediation of contaminated sediments: biodegradability and bioavailability, trace metal uptake by vegetation grown on coal-generated fly ash and migration of PAH contaminates from exposed petroleum products in the environment.

Neal Overstrom
Director, Edna Lawrence Nature Lab
Rhode Island School of Design
A biologist, designer, and educator, Neal Overstrom has focused his work on promoting environmental education and literacy through informal learning experiences. Prior to coming to RISD, he held senior posts for exhibit development, zoological management, and aquatic animal research at the Mystic Aquarium. His interests involve investigating biological influences on design, particularly the ways in which pattern, form and living elements in the built environment can reinforce the human-nature connection.

David Rand, Ph.D.
Professor, biology
Brown University
David Rand is interested in how natural selection acts on genes and genomes. One major focus of his research is how the mitochondrial genome and its interactions with the nuclear genome influence animal performance, evolutionary fitness, and aging. A second major interest is how thermal selection influences the genetic composition of populations. The goals of this work are to identify the genetic interactions that allow organisms to adapt to environmental heterogeneity.

John-David Swanson, Ph.D,
Associate professor, biology and biomedical sciences
Salve Regina University
J.D. Swanson teaches a variety of classes, including Human A&P for non-majors and developmental biology. His research lab works primarily on cell-cell communication, using raspberry and blackberry prickles, human stomach cancer cells and algal blooms as models. The goal of his research is to address the big picture question of relationship vs. form/function, by way of comparing across organisms to assess if the relevant molecular pathways are conserved.

Peter Woodberry, Ph.D.
Dean, Business, Science and Technology
Community College of Rhode Island
Peter Woodberry is responsible for seven academic departments, including the natural sciences, business, computer studies, engineering and technology. In the natural sciences, he oversees CCRI's Associate in Science (AS) in Science, the AS in Chemical Technology and a Certificate in Biotechnology. Dr. Woodberry also chairs several college-wide committees, including the Curriculum Committee, Academic Advisory Council and the Faculty Evaluation Committee.

Rhode Island STAC

Launched in 2005, the Rhode Island Science and Technology Advisory Council (STAC) is the official oversight body of Rhode Island NSF EPSCoR.
STAC Council members represent the academic, business and policy leadership of Rhode Island. Christine Smith is director of Innovation Programs at the RI Commerce Corporation and serves as STAC executive director. Council members are:

David A. Savitz
Vice President for Research, Brown University (Co-Chair)

Gerald Sonnenfeld
Vice President for Research and Economic Development, University of Rhode Island (Co-Chair)

Janet Coit
Director, Rhode Island Department of Environmental Management

Pierre Corriveau
Chief Technology Officer, Naval Undersea War Center

David Hibbitt
Founder and Former Chairman, ABAQUS, Inc.

Molly Donohue Magee
Executive Director, SENEDIA

Jay Marshall
Executive Director of Quality,
Amgen Rhode Island

Patricia C. Phillips
Dean of Graduate Studies, Rhode Island School of Design

Thomas Rockett
Former Vice Provost for Research and Graduate Studies, University of Rhode Island

Peter Snyder
Vice President of Research, Lifespan

Donald Stanford
Chief Technology Officer,
GTECH Holdings Corporation

Marcel A. Valois
Executive Director, RI Commerce Corporation

Rhode Island NSF EPSCoR

Dean John Kirby
URI College of the Environment and Life Sciences
Project Director

Carol Thornber
Principal Investigator

Sally J. Beauman
Project Administrator

Amy Dunkle
Communications coordinator

Shelley Hazard
Scientific Research Grant Assistant

Jim Lemire
Undergraduate Coordinator

Thank you

GSO

for assisting with set-up and use of the Bay Campus facilities for the 2016 Rhode Island NSF EPSCoR Research Symposium.

THE
UNIVERSITY
OF RHODE ISLAND
GRADUATE SCHOOL
OF OCEANOGRAPHY

Rhode Island

Poster abstracts

NSF EPSCoR

EXPLORING THE RI NSF EPSCOR RESEARCH QUESTIONS

RQ-1

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

To Eat or Not to Eat? Response of Dinoflagellates to a Patchy Food Supply

Sean Anderson and Susanne Menden-Deuer

Graduate School of Oceanography, University of Rhode Island, Narragansett, RI

We measured growth and grazing rates of three heterotrophic dinoflagellate species *Oxyrrhis marina*, *Gyrodinium dominans* and *G. spirale* exposed to starved versus continuously-fed prey conditions and assessed their starvation survival ability. All three dinoflagellate species survived long periods (>10 days) without prey, up to 103 days in the case of *O. marina*. After 1-3 weeks, starvation led to a 19-58% decrease in grazer cell volume and cells became more deformed and transparent over time. Starved grazers rapidly ingested new prey within 3 hours as evidenced by increased cell volumes of 2-15%. Grazer cultures that were starved had much lower maximum growth rates (-0.16-0.25 d-1) than continuously-fed cultures (0.18-0.55 d-1) at an equivalent prey concentration. This suggested a time lag >3 days for all heterotrophic dinoflagellate species to reach their maximum growth rates. Long survival ability coupled with immediate post-starvation ingestion may offer heterotrophic dinoflagellates an advantage over other grazers (e.g. ciliates) in the ability to exploit patchy prey. Delayed grazer population growth and ingestion after starvation has important implications on how we view predator dynamics in a prey-patchy ocean and especially at the onset of seasonal phytoplankton blooms.

RQ-2

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Biomimetic CFCs Degradation: an Insight into Biotic Halogen Cycling

Mitchell Crick and Stephen O'Shea

Chemistry, Roger Williams University, Bristol, RI

Understanding the marine microbial metabolic degradation pathways of natural halo-carbons is important not only from a climate perspective but also for what it reveals about the overall balance of biotic halo-carbons cycling and their release into the ecosystem, of which there is currently only limited knowledge. This research aims to discern the scope and mechanism for the oxidation and reduction of iron porphyrins by volatile halo-carbons as biomimetic models of marine heme systems. Furthermore, understanding the roles of marine iron porphyrin reductive dehalogenation in the transformation of halo-carbons gives insight into potential routes of anthropogenic chlorofluorocarbons marine decomposition and their metabolites potential impact on the halo-carbons global budget. Understanding the mechanism of reaction of reductive dehalogenation of these halo-carbons is important because eventually this chemistry could be used to rid the environment of these potentially harmful and robust compounds by converting them into simpler, less harmful ones. By understanding the redox potential of these porphyrins, it may be possible to use other similar pentadentate ligand complexes the achieve the same results. Rates of reaction were determined by monitoring the change in the UV-Vis absorption spectra. Products were determined in situ and from head-space analysis of the reaction mixtures by GC-MS compared to authentic standards. It was determined that the redox of the carbon-halo bond regulates the rate of reaction, where the iodo reactions were found to have higher kinetic rates in comparison to those of the fluoro-organics.

RQ-3

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Array-Based Detection of Polycyclic Aromatic Hydrocarbons in Plasma for Environmental Detection Applications

Lauren Gareau, Dana DiScenza and Mindy Levine

Chemistry, University of Rhode Island, Kingston, RI

When oil and chemical spills occur, they are detrimental to the environment and it can take more than a decade for an area affected by a spill to return to normal. These anthropogenic events release many toxicants, including carcinogenic polycyclic aromatic hydrocarbons (PAHs) into the environment. Theses carcinogens constitute the major food source for marine organisms such as green algae, brown algae, and cyanobacteria. These organisms are the basis for a complex marine food web, and changes in the availability and distribution of these hydrocarbons has rippling effects throughout the marine food web, from bacteria all the way to top feeding organisms. Climate change has severely impacted the distribution and availability of these hydrocarbons, and these changes have already been shown to affect the bacteria population (both in terms of population size and in terms of population density). Since humans consume a wide variety of marine organisms at a variety of points along the food chain, their exposure to these highly carcinogenic PAHs is going to be dramatically and irrevocably affected by climate change and its concomitant effects on the complex marine food web. Research in our group has focused on the development of a highly sensitive and selective sensor for a wide variety of carcinogens, including PAHs which are inextricably intertwined with marine food webs and food sources. The research details how this sensor can be used in complex environments for PAH detection, focused in particular on detection of PAHs in human plasma. Utilizing cyclodextrin, a non-toxic, renewable cyclic oligosaccharide, to promote proximity-induced energy transfer from a carcinogenic PAH to a high quantum yield fluorophore yields analyte-specific response patterns. By using statistical analyses of the resulting response patterns and pattern matching methods, we can determine exactly what chemicals are present in human plasma. The development and validation of such a sensor provides an invaluable tool in understanding climate change and the marine science derived from such broad-reaching, irrevocable change.

RQ-4

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

XRF Analysis of the Otolith: a Potential Environmental Bioindicator of Salinity and Toxic Metal Exposure

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Otoliths result from the accretion of aragonite ($CaCO_3$) and grow by the deposition of daily and annual increments throughout the life of the fish by elements such as Sr, Mg, Mn and Ba, which occur at a relatively high abundance in calcified structures. These are accompanied by trace elements derived from the surrounding water, thus fish otoliths are ideal biological proxy tracers of physico-chemical conditions in elucidating fish habitats histories (Sr:Ca ratios). They can be used to draw inferences about past heavy metal exposure with X-ray fluorescence (XRF) methods allowing for nondestructive otolith surface maps of the elemental distributions feasible for approximate elemental concentrations. These values were compared to whole fined ground otolith samples by XRF elemental analysis and ICPMS analysis. Fish were harvested from waters of Narragansett Bay, RI and the estuarine environment reflected in their otolith Sr:Ca mmol:mol ratios values.

RQ-5

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Rapid Detection of Environmentally Persistent Pesticides via Fluorescence Enhancement of Conjugated Polymer Nanoparticles and Thin Films

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The use of pesticides throughout the world has been a boon for agriculture by increasing the yields of a wide variety of crops world-wide, but has raised significant concerns regarding the potential environmental damage caused by such widespread pesticide application. Many of these pesticides, including organochlorine pesticides such as DDT, are environmentally persistent, which means they persist in the environment for a long time and can have significant long-term effects. The sensitive and selective detection of these molecules generally requires a significant time and resource investment, which limits the ability to conduct high-throughput screening in complex environments. Our group has developed a rapid detection method for environmentally persistent pesticides which uses highly fluorescent conjugated organic polymers. When these polymers are aggregated in nanoparticles or thin films, they exhibit sensitive fluorescence changes in the presence of the pesticides as a result of their significant intermolecular contacts. Using this method has enabled us to detect micromolar amounts of these pesticides in a rapid, straightforward, and highly selective manner.

RQ-6

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

A Cyclonic Current around the Periphery of Rhode Island Sound

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Observations by Kincaid et al. (2003) reveal a cyclonic, near surface circulation offshore of the mouth of Narragansett Bay in summer. This is captured quite well by numerical simulations in the study of Luo et al. (2013) with a circulation around the periphery of Rhode Island Sound (RIS) that occurs in summer stratified conditions but disappears in winter when solar insolation and wind stirring result in strong vertical mixing. We find that the physics of tidal residual circulation is a significant contributor to this cyclonic circulation. We also examine other mechanisms and find that a thermohaline circulation generated above sharp horizontal thermal fronts near the bottom of the water column is also important.

RQ-7

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Doing More with Less: Increasing the Resolution of Protistan Gazing-rate Measurements

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The dilution method is the standard protocol to quantify phytoplankton grazing-mortality rates and has been key in developing an understanding of protistan grazing impact, the most significant loss process for ocean primary production. Nevertheless the method is cumbersome to execute, and efforts have been made to promote an abbreviated version that uses only 2 dilutions (the 2-point method), in an attempt to increase the sampling resolution needed to overcome knowledge gaps. Here we present a cost-benefit analysis of sampling effort vs. data quality by comparing estimates of phytoplankton growth and grazing mortality obtained from each method. We analyzed results from 77 dilution experiments performed using 4-5 dilutions in diverse geographical regions under a wide range of initial chlorophyll concentrations,temperatures, and phytoplankton community composition. We quantified trade-offs associated with sampling design by investigating deviations of 2-point rate estimates as a function of fraction of seawater in the diluted treatment, in order to recommend best practices of the 2-point method. Estimates of phytoplankton growth rates were equivalent using either method. Grazing rate estimates from 2-point were either equivalent or conservative in comparison to those obtained from full dilution series. The range of differences between estimates from each method (~±0.1) was well within the bounds of inherent errors associated with rates based on dilution series, yet increased with increased plankton biomass in the diluted treatment used. Overall, we found that the 2-point method provides reliable estimates of μ and g using a range of dilutions. The experimenter needs to weigh the trade-off between obtaining the best constrained estimates and securing higher plankton biomass for analyzing samples. Rates are best interpreted based on a group of experiments rather than individually. The application of the 2-point abbreviated sampling design can facilitate acquisition of high-resolution data on predation rates across seasons, latitudes, and in response to environmental conditions in the ocean - all critical factors necessary to parameterize protistan herbivory in global biogeochemical models.

RQ-8

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Determination of Nutrient Temporal and Spatial Contributions to Narragansett Bay, RI from the Blackstone River Watershed

Colleen Mulcahey, Julia Crowley-Parmentier, Christopher Reid and Dan McNally

Science and Technology, Bryant University, Smithfield, RI

Dead zones, or hypoxic/anoxic regions in bodies of water causing fish kills, are caused by the eutrophication process. Excess nutrients, nitrogen and phosphorus in the form of nitrate and phosphate anions, initiate the eutrophication process. The sources of these nutrients are reported to be from point sources (e.g. waste water treatment plants) and non-point sources (e.g. run-off from septic systems, fertilized lawn and crop fields, and impervious surfaces). We believe the Blackstone River watershed contributes these nutrients to Narragansett Bay in increasing amounts throughout the summer and causes hypoxic/anoxic conditions in the water column. A history of fish kills in Greenwich Bay and coves near Wickford, RI demonstrate the ultimate consequence of eutrophication. We hypothesize that nutrient run-off from Blackstone River Watershed point and non-point sources contribute to nutrient loading in Narragansett Bay and these contributions vary temporally and spatially. Water samples were collected during the summer and winter at eight sites along the Blackstone River and Providence River leading to Narragansett Bay. We recorded the temperature, dissolved oxygen (DO), pH and conductivity. Each water sample was analyzed for fluoride (F^-), chloride (Cl^-), nitrite (NO_2^-), bromide (Br^-), nitrate (NO_3^-), phosphate (PO_4^{3-}), and sulfate (SO_4^{2-}) anions using a Thermo Scientific (Dionex) Ion Chromatography System (ICS) 2100 with NO_3^- and PO_4^{3-} our anions of interest. Our results indicate a slight increase in NO_3^- over the summer and down river with a high of 8.1ppm at our Providence River site. Phosphate levels also appeared to increase down river with a high of 0.08ppm at a site before the Providence River, but there was no discernable detection of phosphate in the Providence River. Samples taken during the winter show much higher levels of NO_3^- (20ppm) and PO_4^{3-} (314ppm) at the Providence River site. The Blackstone River sites ranged from 1.0ppm-5.63ppm for NO_3^- and 35ppm-54ppm for PO_4^{3-} in no particular pattern. The data suggests that run-off from the Blackstone River Watershed does not contribute nutrients during the summer. Therefore nutrient loading to Narragansett Bay may primarily come from run-off from local sources. However, there appears to be a large influx of nutrients to Narragansett Bay during the winter months.

RQ-9

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Investigation of PAH Leaching Potential from Coal-tar Based Pavement Sealant

Liana Ogata, Jared Hebert, Julia Crowley-Parmentier, Christopher Reid and Dan McNally

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There have been a number of studies on coal-tar based pavement sealant. The concern is coal-tar can be a potent source for polycyclic aromatic hydrocarbons (PAHs). Coal-tar base pavement sealant is used to repair and protect old asphalt so it can have a longer life-span before it has to be resurfaced. PAHs are known human carcinogens that can adversely affect the food web. Previous research has focused on the risk to homes and businesses from PAH-contaminated dust as the dried sealant wears. PAHs are generally hydrophobic compounds, but have a slight water solubility. Very little research has examined the potential for PAHs to be leached by water run-off. We hypothesize that PAHs can be leached during a precipitation event and enter waterways that lead into lakes and bays. Our tests include simulating water run-off of sealant at various times of its drying cycle and varying the water contact time. We will also attempt to determine the effects on the leaching potential and subsequent transport and fate of PAHs from a changing climate. Studies have shown that coal-tar based pavement sealant typically contains 35-200 parts per thousand (ppt) PAHs, or about 100 times more PAHs than found in motor oil and 1,000 times more PAHs than in asphalt-based pavement sealant. The potential for a freshly coal-tar sealed, large parking lot to contaminate surrounding surface waters, groundwater, and soils exists.

RQ-10

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Cation Exchange Capacity of Heavy Metals from Estuarine Sediment and its Correlation with Outer Shell Content of Benthic Organism *Mercenaria mercenaria*

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Industrialization and urbanization of Rhode Island and its surrounding communities has resulted in a dramatic increase in heavy metal sediment loading for Narragansett Bay (NB). To continuously monitor the extent of these pollution events over a vast area would be cost prohibitive. To circumvent this problem, this research investigated the ability of the native bivalve *Mercenaria mercenaria* (quahog) as a natural bio-indicator. In conjunction with quahog harvesting, employing X-ray fluorescence (XRF) as a part for real time field analyze will allow for more timely interventions and response to pollution events and legacy sites. In an eastern southerly transect of the NB West Passage, eight sites were XRF analyzed for their benthic sediment heavy metal content as well as the outer shells of harvested bivalves. Dried dissected soft tissue was assessed for heavy metal exposure and the internal side of the shell for long-term depositions. The cation exchange capacity (@ pH 5 and 2) of whole sediment samples, sieve sized particles and the outer surface shell of benthic bivalves were determined to access potential heavy metal re-release into pore water. Reflective Fourier transform infrared spectroscopy and XRF was used to assess the composition of sieved sedimentary material and HACH® ion tests were used in the determination of common anions found in the sediment pore water. This research has further aided in the understanding of the possible bio-accumulation of heavy metals and the health of benthic bivalves in sediments and there potential as insitu indicators of heavy metal pollution.

RQ-11

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Life on the Edge: Microbial Communities in an Urban-industrial Estuary

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Science and Technology, Bryant University, Smithfield, RI

The Providence River has been subjected to centuries of industrialization exposing the river to high levels of heavy metal and organic contamination impacting the ecosystem immensely. Bold Point Park (BPP) began as a shipyard from the 1780's to the 1840's where it served as both a terminal for the Providence and Boston Railroad which further increased industrial pollution. During the American Revolution and War of 1812, BPP also served as part of Fort Hill, a military defense base. Now, the public's increased use has added to the estimated 27,000 cubic yards of shoreline debris to have polluted the river by 1980. This legacy pollution has had a significant impact on the estuarian microbial ecosystem. Heavy metal contamination was observed in clams found at BPP. High levels of Arsenic (14.5mg/kg), Copper (90.8mg/kg), Lead (52.5mg/kg) and Zinc (163.4mg/kg) were present. Sediment samples were analyzed for Total Organic/ Inorganic Carbon (TOC/TIC) by FT-IR analysis and were found to 1.67% +/-0.68 and 9.06% +/- 5.50, respectively. Identification of the microbial community was carried out using 16SrDNA sequencing which revealed strains such as *Desulfotomaculum thermocisternum* and *Stanieria cyanosphaera*. A large presence of sulfate-reducing and halophillic microorganisms were also recorded. Despite decades of urban redevelopment, BPP remains a significantly polluted estuary which has an increasingly higher impact on the public life as the heavy metal and organic pollutants travel up to high orders of life.

RQ-12

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Large Eddy Simulation of Fine-scale Nonhydrostatic Flows in Providence River

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Narragansett and Mt. Hope Bays along with smaller connected bodies of water and riverine estuaries are a crucial part of the economy, recreation, and culture in Rhode Island. These costal waters regularly suffer from hypoxia and other pollution. Especially, Providence river is one of the regions most prone to hypoxia. The circulation in Providence river is expected to be heavily influenced by its complex geometry such as the deep shipping channel and the wide and shallow shoal. The shallow region regularly suffers from hypoxia, and the level of hypoxia is likely to be controlled by the rate of water exchange between the channel and shallow regions as well as the stratification in the shallow region. These physical properties are affected by turbulent flows whose spatial scales are 1 to 100 m and whose motions are governed by non-hydrostatic physics. With the goal of resolving the important small-scale and non-hydrostatic processes in this localized region, the Prototype Rhode Island Coastal Large Eddy Simulation (PRICLES) is developed. The PRICLES is coupled with a coarser, hydrostatic Ocean State Ocean Model (OSOM) that can provide necessary boundary conditions to the PRICLES.

RQ-13

Exploring the RI NSF EPSCoR Research Questions

- *How are the structure and function of coastal marine food webs and biogeochemical cycling being directed in response to climate change?*

Physical Controls on Phytoplankton Blooms in Rhode Island (RI) Coastal Waters

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[2]*Graduate School of Oceanography, University of Rhode Island, Narragansett, RI*

This study focuses on the mechanisms controlling the seasonal variation and spatial distribution of phytoplankton biomass in RI coastal waters. We first apply an EOF analysis to a nine-year monthly chl-a dataset, which shows that the temporal variations are dominated by a strong seasonal cycle with a broad peak during fall-winter, and the spatial distribution indicates that the phytoplankton biomass decreases with distance offshore as the water depth increases. To understand the mechanisms controlling the abovementioned spatial/temporal features, we first set idealized 1-dimensional numerical experiments using a physical-biological model (ROMS-NPZD). Results show that the fall-winter bloom is initiated by enhanced vertical turbulent mixing, which results from the combined effects of the increased surface momentum forcing and surface cooling, bringing nutrients up into the euphotic zone. The extensive mixing also has a counteractive effect on the fall/winter bloom as phytoplankton are carried below the euphotic layer. A 3-dimensional experiment is then conducted to validate the key conclusions drawn from 1-dimensional simulations from which we find that results from the 3-dimensional experiment are qualitatively in agreement with those from the 1-dimensional experiments.

RQ-14

Exploring the RI NSF EPSCoR Research Questions

- *How will global climate change affect the ecology of marine pathogens and parasites?*

Impact of Treatment with Probiotic Bacillus Pumilus Ri06-95 on The Bacterial Communities in an Oyster Hatchery

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[4]*Cell & Molecular Biology, University of Rhode Island, Kingston, RI*

Previous research showed that probiotic treatment decreases *Vibrio* abundance in tank surfaces and water in an oyster hatchery. This study investigates the potential role of interactions between probiotics and resident bacterial communities on probiotic activity. The microbial community in rearing water, tank surface, and oyster larvae at the oyster hatchery was analyzed using 16S rRNA-based MiSeq sequencing in order to understand the composition or diversity of microbial community after probiotic treatment. In total, 56 phyla were identified and the Proteobacteria was the most abundant phylum in all samples, comprising 53 – 85 % of operational taxonomic units (OUT's). The Bacteroidetes, Cyanobacteria, Actinobacteria, Planctomycetes, and/or Firmicutes were major phylum in all samples at the hatchery, which demonstrated that a few taxa constituted the majority of the bacterial community. There were significant differences on the composition of bacterial community between the sample sources. While Proteobacteria and Bacteroidetes constituted 84 % of OTU's in water, Proteobacteria and Cyanobacteria constituted 83 % of OTU's in tank surfaces. Lastly, oyster larvae has 85 % of the Proteobacteria OTU's were assigned and next major phylum are Bacteroidetes and Firmicutes with 4 % of OTU's abundance. No significant changes or shifts in microbial community were observed either between treatments and/or time points when probiotic *Bacillus pumilus* RI06-95 was applied daily at the oyster hatchery, suggesting that the effect of probiotics targets a few species within certain genera. This study would be helpful for understanding microbial community and leading to more sustainable aquaculture practices by managing bacterial communities.

RQ-15

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Marine Diatoms Host Strain Specific Bacterial Assemblages

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Interspecies microscale interactions between eukaryotic marine diatoms and heterotrophic bacteria play a role in global oceanic biogeochemical cycling by influencing nutrient and carbon cycling, rates of primary production, and phytoplankton community structure. Studies have shown that marine diatoms host a specific bacterial assemblage, but little research has been done to identify these bacterial species and to characterize their ecological relationships despite their strong potential to regulate diatom growth and production. In order to further explore ecological interactions between bacteria and diatoms, we are characterizing the taxonomic composition of diatom-associated bacterial assemblages from individual isolates of the cosmopolitan marine diatom Thalassiosira rotula collected from around the globe to examine the bacterial assemblage and how it varies among individuals. For our initial analyses, we amplified and sequenced the 16S rDNA spanning the V3 and V4 regions of the associated bacterial assemblage of > 70 *T. rotula* isolates from eleven locations around the globe and obtained > 950,000 paired-end sequences. We identified > 400 different bacterial operational taxonomic units (OTUs). Many OTUs were shared across individuals and were members of Alphaproteobacteria and Gammaproteobacteria and we identified distinct bacterial assemblages associated with individual T. rotula strains. The presence of distinct bacterial assemblages may regulate diatom growth which potentially affects rates of primary production, nutrient bioavailablity, and, ultimately, energy transfer to higher trophic levels.

RQ-16

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Structural Determinants of an Atypical Receptor Protein, the Spiny Dogfish Shark Aryl Hydrocarbon Receptor 1 (AHR1)

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The aryl hydrocarbon receptor (AHR) is a ligand-activated transcription factor that mediates a response to many environmental chemicals, including many planar halogenated aromatic hydrocarbons (HAH) and polycyclic aromatic hydrocarbons. Most AHRs bind with high affinity to the HAH 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). This chemical is extremely toxic in multiple organ systems, a teratogen, and is a probable human carcinogen. Upon binding, the AHR dimerizes with the aryl hydrocarbon receptor nuclear translocator and translocates to the nucleus where it regulates expression of genes downstream of a dioxin responsive element (DRE). The spiny dogfish shark expresses multiple AHR genes (AHR1, AHR2, AHR3), which vary in their binding affinity to dioxin-like chemicals. Shark AHR1 does not bind to TCDD, whereas AHR2 and AHR3 do. Using computational homology modeling, certain amino acid residues in the ligand-binding domain (LBD) of AHR1 were targeted for site-directed mutagenesis in an attempt to restore ligand binding to this atypical AHR protein. Mammalian cells transfected with expression plasmids containing the various AHR1 mutants were exposed with 3,3',4,4',5-pentachlorobiphenyl (PCB 126). Activation of AHR was determined via DRE-driven luciferase reporter gene assay. Preliminary results from 5 mutant AHRs showed no activation of the reporter gene, suggesting that no binding had occurred. Upon further analysis of the AHR1 amino acid sequence, a novel diproline segment was discovered just outside of the C-terminal end of the LBD. Proline, being cyclic in nature, is a rigid amino acid with very few available conformations. I hypothesize that reversion of the diproline to a proline-leucine segment, as is present in other AHRs, along with the original mutations may restore binding to PCB 126. If mutant AHR1s with the proline-leucine reversion bind to PCB 126 and subsequently activate the reporter gene construct, we will be able to make determinations of the effect of the diproline segment as well as individual amino acid contributions to the binding cavity created by the tertiary structure of the AHR1 LBD in spiny dogfish shark. Understanding the interactions of environmental pollutants with biological molecules will allow us to make predictions about the susceptibility of vertebrates to the toxic effects of AHR ligands.

RQ-17

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Hole-Y *Ulva*! Examining the Role of Perforations in Species of Bloom-forming Macroalgae

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Blade-forming species of the genus *Ulva* are key contributors to macroalgal blooms and generally propagate asexually via fragmentation. The dominant blade-forming species of Ulva in Narragansett Bay are *Ulva rigida* (blade contains perforations) and *Ulva compressa* (blade lacks perforations). These perforations are naturally occurring and seem counterintuitive since they decrease the photosynthetic area of the algal blade. We formed two hypotheses to test the role of perforations in *Ulva rigida*. First, we hypothesized that the holes in *Ulva rigida* aid in propagation via fragmentation. To test this hypothesis, we compared tissue toughness and tensile strength of *Ulva rigida* and *Ulva compressa*. *Ulva rigida* had higher tensile strength than *U. compressa* and observations indicated that tearing in *U. rigida* generally occurred near the perforations. There was also a slight difference between the tissue toughness of the species, although it was not statistically different. Our second hypothesis was that the perforations in *Ulva rigida* may increase turbulent flow over the blade surface, thus increasing nutrient uptake and growth in low water flow environments where *Ulva* blooms generally occur. For this hypothesis, both species were grown at three sites in Greenwich Bay that have varying flow rates. Blades were also grown in outdoor flow at URI's Graduate School of Oceanography through tanks using ambient seawater with two treatments: high and low flow. Both species exhibited an increase in the percent of surface area comprised of perforations under high flow conditions at the GSO, most likely due to their rapid growth rate. Interestingly, the surface area to mass ratio of the blades decreased from start to finish in all treatments. This indicates that the blades were getting thicker. The decrease in surface area to mass was more dramatic under high flow rates for *U. compressa* and was almost equal for *U. rigida*.

RQ-18

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Trophic-level Interactions and the Factors Affecting the Distribution and Abundance of Wintering Sea Ducks Along Newport Neck and Western Narragansett Bay

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Abundance and distribution of wintering sea ducks is sensitive to prey distribution and key abiotic factors (e.g., water depth, exposure, wave action, foraging substrate) especially on the wintering range because winter weather exerts direct and indirect effects on foraging behavior, metabolic rate and migration habits. In Rhode Island, wintering abundance and distribution of common sea duck species were counted as part of a weekly sea duck survey along a 5km coastal trail in 2006-2007, 2010-2012, and 2015-2016. Surveys included: the timing, abundance, and distribution of the all seabirds observed, and the location of foraging birds. Consistent with migratory sea duck behavior, all species abundance peaked in November, remained consistent through March and then declined. Eiders showed the greatest inter-annual population size variability. Habitat selection factors were determined by measuring primary productivity via phytoplankton abundance, secondary productivity via marine benthic surveys, substrate characterization, and water quality analysis. Distribution of phytoplankton and water quality at nine sites in Narragansett Bay spanned the estuarine gradient from the upper Bay (Conimicut Point) to Dutch Harbor. Phytoplankton abundance in the upper Bay was 4-fold greater than that in the lower Bay and there was a negative relationship between salinity and total phytoplankton abundance along the West Passage. Intertidal substrate and organism abundance where quantified by 0.25 sq m quadrat surveys along Newport Neck (n= 41) and Narragansett Bay (n = 29; Bay n= 20 , Coves n = 9). Species-specific substrate preferences were detected among Neck, Bay and Cove sites. Results suggest that prey abundance is a key factor affecting local sea bird behavior and distribution, which in turn is more closely associated with substrate characterization rather than primary productivity. Changes to the near shore environment with sea level rise may, therefore, have cascading effects through the Narragansett Bay community from benthic invertebrates to the wintering sea ducks that feed on them.

RQ-19

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Predatory Specialization in Siphonophores: Coevolution of Tentacle Morphology and Diet

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Siphonophores are an understudied clade of colonial hydrozoans, ubiquitous in the global ocean. They are abundant gelatinous planktonic predators, voracious consumers of crustaceans and fish larvae, with prominent predatory impact on the food webs. The unique and and fragile nematocyst batteries (tentilla) in the tentacles are of outstanding value to study the evolution of predatory functional morphology, as they function exclusively for prey capture. Prior studies suggest that the morphological and cnidomic diversity of tentilla is closely related to prey type. In this study we propose a multidimensional phylogenetic regression of tentilla and nematocyst morphometrics together with dietary composition. Specimens from across the phylogeny will be collected using Blue Water Diving techniques and ROVs. Tentilla and nematocyst morphology will be assessed with 3D confocal microscopy combined with immunofluorescent probes targeting different nematocyst exclusive minicollagens. Diet will be determined using qPCR amplification and pyrosequencing of the metazoan 18S present in the gastrozooids. Phylogenetic regressions will be calculated upon the molecular 16S and 18S consensus tree from Bayesian Inference, assuming an Ornstein- Uhlenbeck trait evolution model. Preliminary results using data from published sources presented in this communication. Prospected results will shed light on the correlated evolution of nematocyst batteries and predatory interactions in the plankton. Understanding the evolutionary history of predatory specialization in siphonophores will allow us to better predict the response of their populations to global shifts in the planktonic prey field, and their high alpha diversity in the epipelagic ocean.

RQ-20

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Hidden Diversity: Resolving Annual and Seasonal Community Composition of a Diatom Genus in Narragansett Bay through Long-term Data and Molecular Analysis

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Diatoms generate 40-50% of oceanic primary production. Understanding the ecology of individual diatom species is essential for generating predictions of phytoplankton community composition, production, export and phenology. Here, we examine the diatom genus *Thalassiosira*, using data from the Narragansett Bay Long Term Phytoplankton Time Series. This data set is comprised of weekly microscope counts of phytoplankton, physical water column data and nutrient and Chlorophyll a concentrations. We analyzed these data in conjunction with newly generated high-throughput sequencing data obtained from archived DNA samples. Due to limitations of taxonomic identification using light microscopy, an average of 47% of the *Thalassiosira* species counted over the past 15 years (1999-2014) could not be identified to the species level. Just three species of *Thalassiosira* could be identified to the species level in this data set through visual counts. In contrast, taxonomic studies have identified 11 different species from Narragansett Bay. Preliminary results utilizing molecular barcoding at the highly-variable V4 region of the 18S ribosomal gene successfully identified multiple *Thalassiosira* species from the long term time series over a 6 year time period (2009-2014). The incorporation of new technologies into long-term time series requires extensive validation. A set of experiments designed to examine the extent of 18S copy number variation in the genus *Thalassiosira* may allow for the integration of microscopy counts and high-throughput sequencing data in a quantitative fashion. Inclusion of methods that provide high-resolution species identification into long term time series has the potential to reveal annual and seasonal variations in species composition that were previously "hidden," allowing for new insights into the factors that drive both short- and long-term variation in phytoplankton communities.

RQ-21

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Competition in Macroalgal Blooms: Two Species of Blade-forming *Ulva* Inhibit the Growth of Co-occurring Macroalgae through Allelopathy

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Macroalgal blooms have increased in frequency worldwide due to anthropogenic activities and will likely continue to increase due to climate change. Algal blooms can disrupt recreational activities, interfere with fisheries, and deplete oxygen during decomposition. Narragansett Bay has experienced blooms dominated by blade-forming *Ulva* for over a decade. Evidence from other systems has suggested that *Ulva* can negatively impact other organisms through allelopathy (i.e. chemical inhibition). The objective of this study was to determine whether the dominant bloom-forming species of *Ulva* inhibited the growth of co-occurring macroalgae (*Gracilaria* spp., *Cystoclonium purpureum*, and *Chondrus crispus*), through allelopathy via laboratory-based growth assays. We found that *U. compressa* and *U. rigida* significantly inhibited the growth of *Gracilaria* spp. and *Cystoclonium purpureum*. In addition, *U. compressa* and *U. rigida* negatively impacted the growth of adult thalli of *Chondrus crispus*, while the growth of *C. crispus* carposporelings was not affected by the presence of *Ulva*. Our results indicate that bloom-forming *Ulva* competes with co-occurring macroalgae through allelopathy, and that chemically-mediated competition between macroalgae may be an important feature of bloom dominated ecosystems. With macroalgal blooms predicted to increase with climate change, allelopathic interactions will likely become an important factor in shaping coastal communities.

RQ-22

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Ocean Acidification Impacts Otolith Morphology and Mineralogy in Larval Fish

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Background: Ocean acidification is expected to influence calcification of otoliths in teleost fishes, which may have profound consequences for hearing and gravisense. Much research has investigated effects on otolith morphology in fish larvae, but little has considered effects on mineralogy. We selected the smallmouth grunt (*Haemulon chrysargyreum*) for its long larval cycle, and analysed otolith morphology and mineralogy after rearing in pCO_2 treatments that simulate future ocean scenarios.

Methods: Multiple thousand *H. chrysargyreum* larvae were reared in 4 pCO_2 treatments (pH 8.1, 7.8, 7.6, 7.3) until settlement. Treatment setpoints were achieved by dosing CO_2 into continuously-monitored experimental aquaria with our dynamic pH-stat CO_2 dosing system. Aquaria were replicated 5x for 20 independently-controlled experimental units. All 6 otoliths were extracted. Stereomicrographs were analysed for area, perimeter, and circularity. Scanning electron micrographs were scored for crystal habit, mineralogy (proportion of vaterite vs. aragonite), % visible minerals, and core development.

Findings: Fish standard length peaked in moderate pCO_2 before levelling and finally plummeting in highest pCO_2. Right lapilli circularity decreased and right asterisci circularity increased with increasing pCO_2. No differences in sagittae circularity or otolith area and perimeter were observed between treatments. Changes to otolith mineralogy, including enhanced core development and shifting crystal habit, were observed between treatments. Sagittae in which crystal habit shifted from orthorhombic aragonite to 100% amorphous $CaCO_3$ were observed in acidified treatments.

Conclusions: Our study boasted 3x longer exposure relative to earlier studies involving clownfishes, facilitating observation of longer-term ocean acidification effects on teleost reef fishes. It is the first of its kind to observe any effect of ocean acidification on asterisci in fishes. Furthermore, it represents an unprecedented analysis of otolith mineralogy in the context of ocean acidification. We anticipate that the observed effects on otolith mineralogy, manifested as topographical abnormalities, will impair otoconial function in teleosts.

RQ-23

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

The Application of Microsatellite Analysis to Determine Bloom Identity of *Ulva compressa* and *Ulva rigida* in Narragansett Bay, RI

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Narragansett Bay, RI is largely characterized by two closely related green macroalgae: *Ulva compressa* and *Ulva rigida*. These species have been found to form harmful algal blooms (HAB) that have the ability to cause widespread ecological and economical damage in the area of occurrence. We seek to determine if these HABs are due to the proliferation of one or multiple individuals. In order to determine this causation, microsatellite analysis was performed to better understand the changes in bloom population identity. Specific microsatellite primers were designed by searching for di, tri, tetra, penta and hexa- nucleotide repeats using Microsatellite Commander V2. These primers were then used with genomic DNA from *U. compressa* and *U. rigida* samples in a PCR. With this amplified DNA, we then ran a 2% agarose gel electrophoresis to visualize polymorphism. With the analysis of the banding patterns, we can determine bloom identity due to the gel revealing if the algal samples are from the same or multiple individuals. By working with the previously stated techniques, as well as observing the relativity of individuals in each population in PCoA, it has been supported that the proliferation taking place in our three collection sites have relation. More specifically, the populations of Oakland Beach and Sandy Point are significantly similar.

RQ-24

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Ocean Warming Effects on the Reproductive Proteome of *Ciona intestinalis*

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Climate change models predict a 4-degree increase in global ocean temperature, and even small increases in temperature have been shown to have negative effects on animal physiology. A preliminary fertilization study to assess the reproductive physiology of *Ciona intestinalis* (a common marine invertebrate), found that *Ciona* raised in the higher temperature had lower embryo viability when compared to the normal temperature. For this experiment the *Ciona* were reared at 18C (maximum temperature for normal development) and 22C (stress condition with anticipated climate change). Once sexually mature they were harvested, and the ovarian and testicular tissue was dissected and frozen. Protein was then extracted from the tissue and sequenced on a tandem mass-spectrometer, at Rhode Island Hospital. There were about 206 up-regulated proteins and 68 down-regulated proteins in common among the 5 replicates from both the experimental and control groups (out of 1616 total proteins identified at 1% FDR). Analysis is ongoing, but it is focused on signaling and transcription factor proteins, as well as those associated with the reproductive process. So far a set of GO terms has been assembled for the up and down regulated proteins using Blast2GO. Gene ontology will be used to identify the function of selected proteins and pathways to infer which overall processes are being disrupted in *Ciona* reproduction due to the increase in temperature.

RQ-25

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

The Metal Response in Amphioxus: Evolution and Expression

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Lancelets inhabit shallow coastal regions, vulnerable to pollution from runoff, ocean warming and episodes of hypoxia. We wish to identify the metal-binding proteins that maintain that mediate the response to subtoxic levels of cadmium and other industrial trace metals, and to test the idea that responses to metal exposure may overlap the responses to hypoxia. Based on the recently published genome of the Asian lancelet, *Branchiostoma belcheri*, we have identified orthologs of vertebrate genes encoding metallothionein (Mth), metal-sensitive transcription factor (MTF-1), hypoxia-inducible factor (HIF) and the zinc transporters Znt7 and ZIP14. Here we report our progress using three approaches: (i) phylogenetic analysis of MTF-1 (metal-sensitive transcription factor-1); (ii) analysis of the effect of cadmium (Cd) on the expression of these genes by RT-PCR; (iii) purification of metal-binding proteins from whole animal lysates using immobilized metal affinity chromatography (IMAC).

(i) the genomes of the Asian, Mediterranean and Florida lancelets encode a vertebrate-like MTF-1 ortholog with six conserved C2H2 zinc-binding domains. Bayesian phylogeny indicates that the gene in *B. belcheri* evolved earlier from a common lancelet ancestor than did the genes in *B. lanceolatum* (Mediterranean) or *B. floridae*.

(ii) exposure to Cd (72 h, 100 ppb) resulted in significant increases in the expression the genes encoding Mth (35-fold), MTF-1 (75-fold), HIF (5-fold) and ZIP14 (8-fold)(p Ni >> Cr, is consistent with competition for a zinc binding site.

(iii) lysates of whole (untreated) animals were subject to cobalt resin-based IMAC, and 10 high-affinity proteins were resolved by 1-dimensional SDS-PAGE. Studies are in progress to determine the amino acid composition of these metal-binding proteins and to compare the impact of trace metals and hypoxia on the lancelet metallome.

RQ-26

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Exposure to 3,3',4,4',5-Pentachlorobiphenyl (PCB 126) Impacts Multiple Organ Systems in Developing Little Skate (*Leucoraja erinacea*)

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Effects of exposure to coplanar polychlorinated biphenyls (PCBs) and other dioxin-like chemicals on developing vertebrates involve many organ systems, including the skeletal and cardiovascular systems. Apex predators, including those from the class Chondrichthyes (sharks, skates, and rays), accumulate high body burdens of PCBs through biomagnification of chemicals moving through food webs. There are no published reports of the effects of dioxin-like chemicals on the development of sharks, skates, or rays. A study was undertaken to assess developmental effects of 3, 3', 4, 4', 5 pentachlorobiphenyl (PCB 126) exposure in little skate, *Leucoraja erinacea*, a model for oviparous elasmobranchs. Skate embryos cultured outside of their egg cases were exposed to 0.02 - 20 ng/ml PCB 126 for 6 days and then grown in clean seawater for up to 29 days. Gas chromatography was used to measure PCB 126 in the exposures water and quantify its accumulation in the embryo. Digital still and video imaging was performed to assess growth, identify developmental abnormalities, and cardiovascular function. Embryos accumulated approximately 50% of PCB 126 exposure mass in the embryonic tissues and yolk sac. All embryos in the control and 0.02 ng/ml treatment survived; mortality rates were 14, 52, and 40% of embryos exposed to 0.2, 2.0, and 20.0 ng/ml, respectively. PCB 126 exposure induced yolk sac edema, deformities of the jaw, cranium, and fins, and cardiovascular system failure in skate embryos at all concentrations. This study demonstrates that little skate embryogenesis is sensitive to the toxic effects of PCB 126. Many of the developmental effects of PCB 126 in skate embryos are similar to that observed in other vertebrates, however, the alteration in pectoral fin architecture is novel and may represent disruption of developmental pathways that differ between cartilaginous and bony fish appendages. The research continues to ascertain the no observable effects concentration for PCB 126 and identify sensitive developmental pathways using the little skate model.

RQ-27

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Populations of *Fundulus heteroclitus* Adapted to Pollution Show High Levels of Genetic Diversity

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We conducted mitochondrial (mtDNA) population genetics analyses on seven populations of *Fundulus heteroclitus*: five along a pollution cline and two 'clean' populations. We also conducted microsatellite analyses on a clean and a polluted population at two different points in time (1999/2000 and 2007/2008). MtDNA analyses showed similar levels of haplotype diversity (Hd ≈ 0.97) and nucleotide diversity ($\pi \approx 0.060\%$) in all populations. No single nucleotide polymorphisms (SNPs) were fixed within any population. However, 16 segregating SNPs caused non-synonymous amino acid changes. These changes occurred in 5 subunits of the mtDNA NADH genes, and 1 subunit of mtDNA ATP synthase genes. Additionally, 15 SNPs occurred in mtDNA translation genes (rRNAs and tRNAs). Microsatellite analyses showed no genetic differentiation between time points and no reductions in genetic diversity. Both markers suggest that migration rates are high between clean and polluted habitats, and that genetic structure has been stable over time. Overall, this is suggestive of rapid adaptation to pollutants.

RQ-28

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Differential Gene Expression in *Ulva compressa* Under Summer and Winter Photoperiods

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Ulva compressa is one of the most abundant species in harmful macroalgal blooms in Narragansett Bay, RI. These aggregations of algal biomass can have significant impact on coastal communities and have increased in 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. This was done by collecting *U. compressa* at Oakland Beach in Warwick, RI and growing the samples in culture. Cultures were grown under typical summer and winter photoperiods, and then tested for differential expression of light response genes using qPCR. Gene candidates were identified through computational screens that showed differential gene expression in NGS data from *U. compressa* samples collected at relevant stages in the bloom cycle. Candidates include the genes for stress related light harvesting complex (lhcSR), malate dehydrogenase, Rieske iron-sulfur protein gene, carotene biosynthesis related gene, and heat shock protein 90c. The qPCR data displays differential gene expression of these light response genes in response to exposure to different photoperiods; sixteen hours of light simulating the summer and eight hours of light simulating the winter. The gene most up-regulated is lhcSR with a fold difference of 118.42. CBR had a fold difference of 23.98 and MDH, RIE, and HSP had lesser fold differences of 1.57, 1.65, and 2.42 respectively. These data support previous findings of differential gene expression of the 5 genes in samples collected from Narragansett Bay throughout the *U. compressa* bloom cycle.

RQ-29

Exploring the RI NSF EPSCoR Research Questions

- *What are the stress responses and evolutionary potentials of marine organisms in response to climate change?*

Heat Shock Proteins as a Potential Gauge of Climate Change in Narragansett Bay

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Functional proteins must have 1) a specific primary sequence and 2) be able to assume a particular higher order structure. Hsp70 is a chaperone protein. Chaperone proteins aid in the correct re-folding of damaged proteins so they may re-acquire the necessary overall structure to retain their function. Hsp70 is found in all cells. However, cells that have undergone stress have a far greater expression of Hsp70. Stress factors include hypoxia, hyper and hypothermia, and deviations in pH. This project involves measuring Hsp70 levels induced by heat stress on live organisms. The overall hypothesis is that Hsp70 levels in marine organisms will correlate with climate change. The organism being studied is *Geukensia demissa*, a species of mussel native to Narragansett Bay. Samples were collected from Watchemocket, Passeonkquis, and Fox Hill, located in East Providence, Warwick, and Jamestown, respectively. The organisms were dissected upon collection, after being acclimated in a 20 C bath, or after exposure to 40°C for 20-30 minutes. Hsp70 was extracted from dissected gill tissue, isolated by gel electrophoresis, imaged by a western blot and antibody protocol and analyzed using "Image J" software. Isolation of Hsp 70 was substantial in nearly all trials of the experiment. We have seen correlation with the temperature exposure of the organisms and the collection location.

LEVERAGING RI NSF EPSCOR INFRASTRUCTURE TO ADVANCE COMPETITIVE RESEARCH IN THE OCEAN STATE

Ecological Assessment of Coastal Urban Watersheds on Aquidneck Island

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The water quality of our local watersheds is of high importance due to their role as primary sources of drinking water for the residents of Newport and Middletown, Rhode Island. In 2014-2015, we made an integrated, ecological assessment of water quality through physical, chemical and biological properties. For our study the EPT (Ephemeroptera, Plecoptera, Trichoptera), Order richness, and EPT/Diptera scores where determined to give each stream a Macroinvetebrate-based bioquality index. We found that EPT scores were highest at Cork Brook in Scituate Resevoir, the most pristine and forested site, and lowest at Maidford River which is mostly an agricultural landscape. EPT/Diptera scores were used to determine the ratio between pollution intolerant and pollution tolerant macroinvetebrates. Chemical coorelates of the bioassessment showed a negative correlation between high nutrient readings in the Maidford River (nitrates 1.94ppm, phosphates 0.25ppm) and low EPT and EPT/Diptera ratios. Lowest ratios, indicating lower water quality were found along Maidford River, while higher ratios were found along Bailey's Brook and Cork Brook. Physical assessments were made at two spatial scales: a macrohabitat 10-point habitat assessment and 5-km scale land-use association using analytic tools in Geographic Information System (GIS). Narrow or absent stream vegetative buffers and high levels of impervious surface (Bailey Brook) and agricultural land use (Maidford River) were most strongly correlated with low levels of water quality from both chemical and biological assessments. Water quality "hot spots" were mapped and identified for future riparian restoration and should aid in watershed management. Compared to the reference site, Cork Brook, Aquidneck Island's Bailey Brook and Maidford River watersheds are ecologically impoverished

Morphologically Cryptic Species and Phylogeographic Patterns in the Diatom Genus *Thalassiosira*

Gang Chen

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Morphologically cryptic diatom species are being increasingly identified in field samples reflecting the high level of species diversity present within the diatoms. The species crypsis could deeply affect our understanding of evolutionary potential and ecological response of marine diatoms to climate change. We collected cell isolate DNA samples from a global distribution range for two ecologically important but morphologically indistinguishable species *Thalassiosira gravida*/*rotula*. By using three molecular genetic markers (nuclear 18S, ITS, and mtCOII), we identified the two target species along with a number of co-occurring *Thalassiosira* species, including *T. aestivalis*, *T. nordenskioldii*, *T. anguste-lineata*, *T. miniscula*. The newly developed mitochondrial gene marker, cytochrome c oxidase subunit II (mtCOII) showed a general genealogical concordance with 18S and ITS, but higher inter- and intraspecific diversity. The sequence divergence of mtCOII was ~10% among those commonly occurring *Thalassiosira* species, while ~4% between two young sibling species of *T. gravida* and *T. rotula*. Intraspecific variation at mtCOII was remarkable in *T. gravida*, with 10 recorded haplotypes forming two well-diverged geographic clades (~2%) between North Atlantic and Northeast Pacific, suggesting geographic isolation and/or local adaptation may contribute to its genetic structure at the global scale. In North Atlantic, geographic populations (Gulf of Maine, Disko Bay, Icelandic basin) were dominated by one haplotype with derived private ones, suggesting a shared phylogeographic origin, strong gene flow, and some level of differentiation among local populations.

Dye Sensitized Solar Cells Utilizing Polyethylenedioxythiophene (PEDOT) Cathodes and a New Light-absorbing Dye Complex

Kate Digan, Connor Sweet, and Cliff Timpson

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Dye-sensitized solar cells (DSSCs) have yet to emerge as a major alternative to fossil fuels due, in part, to the overall cost associated with manufacturing DSSCs and the overall efficiencies at which they operate. This implies there are at least two ways to make DSSCs more economically attractive: reduce their cost and/or improve their efficiencies. We wish to investigate lowering the overall cost of traditional DSSCs by exchanging platinum, a critical component of the cell, with a less expensive, conductive polymer based on ethylenedioxythiophene (EDOT). In a parallel effort, we are also investigating a new ruthenium dye species that may help to minimize an unwanted redox pathway that is known to decrease the overall photo-conversion efficiency of liquid-based DSSCs. Our efforts to explore the utility of polymerized EDOT cathodes, along with our efforts to modify the ruthenium-based, chromphoric dyes to try and improve the overall efficiencies of DSSCs will be presented.

Distribution of the Small Hive Beetle in Rhode Island

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The Small Hive Beetle, *Aethina tumida* (SHB), is an invasive species from Africa which represents a threat to European Honeybee populations. SHBs invade hives and destroy brood resulting in reductions in hive size and fitness. SHB infestations also contaminate honey eliminating the possibility of harvest. Thus the SHB poses an additional threat to European Honeybees, a species already facing significant stressors. SHB populations were first observed in the United States in the late 1990's. While populations are well-documented in southeastern states, migration to northern regions of the US was thought unlikely due to cold winters. Beginning in 2012, beekeepers in Rhode Island observed SHBs within hives on a sporadic basis. Such anecdotal evidence was also observed in other neighboring states and may indicate significant migratory ability. Recently, SHBs were also observed in early Spring (2014) and may indicate the capacity for SHBs to overwinter within hives. To better understand the distribution and incidence of SHBs in Rhode Island, we monitored populations during the 2015 growing season within 35 apiaries throughout the state. Using specialized bottom board traps, we collected and enumerated beetles, and plotted the resulting data using ArcGIS for each of 5 time points throughout the summer. These data show that the largest SHB populations exist in the Providence area, the most density populated region of Rhode Island. While only sporadically observed outside of the Providence area in June, SHB distribution increased throughout the summer and along with concomitant increases in beetle numbers per hive. These data provide a one-year snap-shot of SHB distribution and population size in Rhode Island and provide a base line to examine changes in successive years. Ultimately such data can be combined with climatic data to better understand population dynamics of the SHB in the face of climate change.

Biochemistry but not Biophysics Drives Cefotaxime Resistance Evolution in TEM-1 ß-lactamase

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One of the leading intellectual challenges in evolutionary genetics is to identify the specific phenotypes on which natural selection acts. Enzymes offer a particularly promising opportunity to pursue this question, because an enzyme's contribution to organismal fitness can often be expected to depend on a comparatively small number of experimentally accessible biochemical and biophysical traits. Here we examine four mutations in the TEM-1 ß-lactamase previously shown to increase bacterial resistance to the antibiotic cefotaxime by more than three log-orders. In this, we hoped to understand the mechanistic basis of the dramatic selective constraints on cefotaxime resistance evolution previously described. While catalytic efficiency among alleles explains much of the variance in cefotaxime resistance, interestingly and contrary to widely held expectations, we find that mutational effects on native form folding stability are irrelevant in this system. We speculate that the classical structure-function tradeoff in proteins may not apply as broadly to cases of adaptive evolution as it does to deleterious mutations. Finally, we show that sign epistasis – necessary and sufficient for the selective constraint previously observed – emerges in a system that nevertheless exhibits near additivity in mutational effects. Similarly, antagonistic pleiotropy – necessary and sufficient for discrepancies between sign epistatic patterns between traits – emerges in a system that exhibits nevertheless exhibits very high correlation between traits. Both findings pose broad challenges for some efforts to reconcile evolutionary constraints on adaptation in terms of mechanistically more proximal traits.

Application of Chromophoric Dyes with Applied Bias to Increase Photoconversion Efficiency of Dye Sensitized Solar Cells

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Dye-sensitized solar cells (DSSC) have garnered attention for renewable energy applications, due to their promising photo-conversion efficiencies, and potential for cheap production. In previous work we have applied microwave heating to the deposition of N719 dye to silanated and unsilanated TiO_2 layers on FTO, resulting in more rapid dye deposition. Additionally, microwave heating appears to increase the efficiency of our DSSCs in comparison with conventionally heated slides. We hypothesize that this may be due to the surface carrying charge due to microwave excitation which may influence coupling of the polar dye molecule. Here we present dye deposition by applying a low voltage bias in an electrolytic solution, using chronoamperometry. Biased silanated and unsilanated substrates were compared with non—biased substrates with heating. Preliminary data suggests that dye application with bias increases photoconductive efficiencies, with a positive correlation with increasing voltage (silanated: 0.072%-0.3V, 0.070%-0.2V, 0.014%-0.1V, 0.032%-conventional; non-silanated: 0.033%-0.3V, 0.022%—0.2V, 0.031%-0.1V, 0.008%-conventional).

Fatty Acid Profiles of Marine Fishes from Rhode Island Coastal Waters

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Marine fish are an excellent source of omega-3 fatty acids, including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which provide numerous health benefits to human consumers. Further, the majority of consumed fish are of marine origin, thus underscoring the importance of research focused on this topic. In this study, fatty acids were analyzed in Rhode Island coastal fishes, including summer flounder, *Paralichthys dentatus* (n = 10); black sea bass, *Centropristis striata* (n = 10); striped bass, *Morone saxatilis* (n = 6); scup, *Stenotomus chrysops* (n = 11); winter flounder, *Pseudopleuronectes americanus* (n = 10); and bluefish, *Pomatomus saltatrix* (n = 11). Fatty acid profiles of fish muscle tissue were determined by esterification and gas chromatography. Data were categorized as mono-saturated, saturated, omega-3, and omega-6 fatty acids, and results were expressed as concentrations (mg/100 g wet weight; [FA]) and percent of total fatty acid content (%FA). Irrespective of fish species, mono-saturated fatty acids had the highest [FA] and %FA (mean [FA] = 183.5 mg/100 g; %FA = 46.2%), followed by saturated ([FA] = 146.6 mg/100 g; %FA = 32.7%), omega-3 ([FA] = 44.3 mg/100 g; %FA = 18.6%), and omega-6 fatty acids ([FA] = 7.5 mg/100 g; %FA = 2.5%). Fatty acid profiles also demonstrated significant inter-species differences. With respect to %FA, mono-saturated fatty acids were significantly higher in scup and bluefish relative to summer flounder and striped bass (SCP = 54.6%, BF = 48.8%, SF = 40.1%, SB = 39.3%). Conversely, omega-3 fatty acids were significantly higher in both flounder in comparison to black sea bass and scup (SF = 31.1%, WF = 26.3%, BSB = 12.1%, SCP = 8.3%). With respect to [FA], bluefish had significantly higher concentrations of mono-saturated and saturated fatty acids relative to summer flounder (BF = 245.4-307.4 mg/100 g, SF = 52.5-81.3 mg/100 g). Ratios of omega-6-to-omega-3 (n6:n3) fatty acids were reduced in flounder and striped bass (n6:n3 = 0.14-0.23) relative to scup, bluefish, and black sea bass (n6:n3 = 0.30-0.36); hence suggesting the former species provide greater health benefits for human consumers. Future research will examine total mercury and selenium concentrations of each fish species to further evaluate their respective health risks and benefits to human health.

Low-cost Sensors for Environmental Sensing

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Detecting low concentrations of analytes with low cost and high enough sensitivity is rapidly becoming a norm by which sensors are being developed. We have chosen to use a new class of sensors based on nanopores--device elements comprised of molecular-scale channels through insulating membranes--in which passage of molecules (and even organisms, for analogous micropore sensors) through suitably engineered nanopores allows them to be easily detected. In real world applications, a major challenge is to devise methods to avoid analyte molecules sticking onto the inner pore walls which would ultimately render the pore unusable for further applications. Modifying the inner pore walls by depositing gold or decorating it with molecules with specific functional moieties are two methods to overcome the sticking problem. We fine-tuned a gold deposition method on planar silicon nitride thin films for this purpose. Attaching organic molecular species that would suppress deposition of gold on silicon allowed us to create conductive patterns on silicon nitride. These patterns, when scaled down, can be used as molecular level electrodes in nanopores which would enhance the sensitivity of nanopores. We found that our gold layers for nanopores were useful for SERS (Surface Enhanced Raman Spectroscopy), and that the very methods we could use to control the gold deposition in our nanopore single molecule sensors could also be used to control the SERS sensing quality in our other efforts.

Next-generation Environmental Sensing: From Molecules to Microbes

Buddini Karawdeniya, Nuwan Bandara, Julie Whelan, and Jason Dwyer

Chemistry, University of Rhode Island, Kingston, RI

Our work is focused on developing next generation environmental sensors based on Raman spectroscopy. The native Raman signal is quite low, but surface-enhanced Raman spectroscopy (SERS) dramatically overcomes this limitation and permits the rapid acquisition of "molecular fingerprint" spectra characteristic of the molecules and microbes that are brought proximal to the sensing surface. The design of SERS substrates frequently requires costly materials and processes, but we have developed a low-cost approach that can deliver surface enhancement on traditional materials such as silicon, as well as on materials, like paper, that allow for lower cost and more exotic SERS substrate designs. Our paper-based substrates offer a variety of favorable chemical analysis capabilities, including SERS sensing integrated naturally with their ability to chromatographically separate and physically filter samples. We present results that demonstrate the promise of this platform for delivering sensors that meet the demands of fast, easy and reliable sensing for the next generation environmental analyst.

Development of a Photo and Electrochemical Detector of Thiocyanate in Marine Environments

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Due to the million-dollar aquarium trade, cyanide fishing poses a threat to coral-reef systems around the world. Fish caught by cyanide fishing will produce thiocyanate ions as a metabolic product that could serve as a marker for this activity. There needs to be a chemosensor device that is both sensitive and selective to thiocyanate ions to aid in the identification of fish obtained by cyanide fishing. Porphyrins with metal centers present good candidates for chemosensors due to their ability to bind thiocyanate ions and be analyzed photo- and electrochemically. Here we present synthetic strategies to synthesize functionalized porphyrins to incorporate into a solid-state chemosensor device. UV-Visible absorption spectra and cyclic-voltammetry characterize the response of copper (II), manganese (III), cobalt (II), and iron (III) porphyrins to thiocyanate exposure in seawater. These devices were created through Sonogashira coupling functionalized porphyrins to silanated TiO_2 on FTO glass.

ADVANCING RESEARCH INFRASTRUCTURE, CYBER INFRASTRUCTURE, CAPACITY IN COMPUTATIONAL BIOLOGY, AND PUBLIC COMMUNICATION OF SCIENCE

The Potential of Data Narratives to Facilitate Effective Science Communication and Public Engagement

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Data narratives look to bridge objective, scientific data and compelling, visual storytelling with the goal of fostering broader engagement and understanding around scientific discovery, potentially informing critical environmental policy discussions such as those associated with climate change. Over the past two years, Rhode Island School of Design and Brown University students, faculty and staff collaborated with scientists from the University of Rhode Island to create novel visual narratives from established biological, chemical, and physical data sets representing decades of environmental monitoring of Narragansett Bay. These studio-based outcomes, which ranged from video animations to a storybook for children, were shared in a data narratives workshop organized by URI's Metcalf Institute in which natural and social scientists, non-profit and state agency staff, journalists and other communication professionals, educators, and undergraduate and graduate students explored how scientific findings and their consequences could be recast into messages that a wider audience can understand and relate to their own lives and value systems. Visual literacy, especially in the promotion of ecological awareness, is increasingly recognized as a key element in the overall effort to establish social policy on these issues. Workshop outcomes reinforce that visual data narratives can be an effective tool to advance public knowledge and conversation about scientific discovery and serve as a catalyst for cross-sector, multidisciplinary discussion among the many parties working to expand public engagement on climate change.

The Molecular Characterization Facility

Al Bach

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The Molecular Characterization Facility (MCF) is an EPSCoR core laboratory located in the College of Pharmacy building on the URI Kingston campus. The mission of the MCF is to provide access to NMR and mass spectrometry instrumentation for EPSCoR, University, and Rhode Island researchers.
The MCF consists of an Agilent 500 MHz NMR spectrometer, a Bruker 300 MHz NMR spectrometer, and a Sciex 4500 QTrap mass spectrometer. The NMR spectrometers are used to determine the molecular structure of natural products isolated from plants and bacteria. They are also used to confirm the molecular structure of chemically synthesized molecules. The mass spectrometer can be used in two ways. It can determine the molecular weight of natural products and synthesized molecules or measure the quantity of a known molecule in a complex biological matrix.

You can learn more at our web page: http://web.uri.edu/pharmacy/mcf/

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Advancing research infrastructure, cyber infrastructure, capacity in computational biology, and public communication of science

RI-NSF EPSCoR Proteomics Services: A Strategic Collaboration between Brown University's NSF EPSCoR Proteomics Core Facility and Lifespan's Proteomics Laboratory

Michael Clarkson

Molecular Pharmacology, Physiology & Biotechnology, Brown University, Providence, RI

The mission of the RI-NSF Proteomics Facility at Brown University is to provide well-maintained, state-of-the-art instrumentation and fundamental proteomics expertise to the Brown University and Rhode Island-EPSCoR scientific communities. We aim to be a focal point of intellectual activity in proteomics by enabling nationally recognized proteomics research within Rhode Island. We welcome inquiries from scientists and teachers seeking information regarding how we may assist them in furthering their research and educational goals. The facility's function is catalyzed by its Directors, a responsible Facility Manager and a knowledgeable advisory committee. Together their research interests are based on the pursuit and implementation of proteomics approaches to biological inquiry.

As an NSF EPSCoR funded laboratory, the Proteomics Facility has a broadly-inclusive philosophy to ensure rapid and equal access to the facility's services for the entire Rhode Island research community. In addition to the acquisition of instrumentation, the Proteomics Core Facility undertakes the training of research in emerging proteomic techniques, a component that is essential to maintaining a productive and professional level of service. The Proteomics Facility has a strong commitment to be at the leading edge of current and developing technologies and provides consultation on their application.

Further information regarding use of the RI-EPSCoR Proteomics Facility can be obtained by contacting the Facility Manager Michael Clarkson at Michael_Clarkson@brown.edu

Library Support Services for Data Management, Public Access Compliance, and Reproducibility

Andrew Creamer

University Library, Brown University, Providence, RI

In 2016 certain federal research funding agencies, including the National Science Foundation (NSF), began implementing public access policies that in some cases will require that researchers deposit publications resulting from funded-research into publicly accessible repositories. This poster explains the NSF's new Public Access Policy and its new publications repository, "NSF-PAR", and summarizes the comments, questions, and outcomes that emerged from a meeting held for Rhode Island NSF EPSCoR community members and investigators about the NSF Public Access Policy and the NSF-PAR repository. Lastly, the poster will highlight the additional ways that the library can support Rhode Island NSF EPSCoR members' archiving and dissemination of research products by helping faculty and student researchers with the writing and carrying out of data management plans (DMPs), creating metadata and depositing research products into data-sharing repositories, and providing tools for making research products discoverable and accessible into the future.

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Advancing research infrastructure, cyber infrastructure, capacity in computational biology, and public communication of science

Building a Centralized Database for RI NSF EPSCoR: Triumphs and Challenges of Implementing ER-Core

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Introduction: The National Science Foundation (NSF) evaluates the progress of funded programs by requiring the awardee to submit Research Performance Progress Reports (RPPR) on a specified basis. RI NSF EPSCoR is required to submit an RPPR annually for each of their 2 awards (Track I and Track II). Both awards involve multi-institutional collaborations. Track I involves researchers from 9 RI institutions and Track II involves researchers at multiple institutions in 3 states. Preparation for the RPPR submission involves collecting data from each participant.

Problem: Reporting during the early years (2010-2013) of the Track I award proved challenging due to reliance on decentralized and individual file management systems that resulted in program data spread throughout the state. Files were inconsistent, frequently inaccessible to management, and data integrity declined with transitions in key personnel. A remedy was clearly needed, but the only viable solution was untested, incomplete, open source software. Would the solution improve or further jeopardize the reporting of deliverables?

Approach: In the fall of 2013 a web-based database, EPSCoR Reporting Core (ER-Core) was evaluated and implemented by a collaborative interdisciplinary team (N=4, total FTE <1.0). ER-Core runs within the open source Drupal content management system. The software is designed to support EPSCoR reporting but it is still under development by 10 EPSCoR jurisdictions that formed a consortium to advance it. In the first year of use the RI team found the software to be lacking important functionalities with many bugs to be fixed.

Conclusion: After initial evaluation, we found ER-core to be an adequate system to replace "manual data gathering" across multiple institutions. Using a web-based system yielded the necessary improvements in data management to fundamentally support RPPR. To date, NSF has approved 4 RPPR demonstrating the accomplishments of 394 participants. Advancing software code through consortium efforts also proved to be beneficial to IT professional development and strengthening collaborations. However, developing software to high standards during active data collection and with sole reliance on a consortium was found to be less than ideal. A survey and comparison of other web databases is underway.

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Rhode Island Genomics and Sequencing Center

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The Rhode Island Genomics and Sequencing Center (RIGSC) was established to provide technical and analytical support for molecular biology and genomics research at the University of Rhode Island and all RI-EPSCoR institutions. The mission of the RIGSC is to facilitate interdisciplinary genomics research and undergraduate and graduate student training opportunities by providing researchers access to cutting-edge technologies in the field of genomics. The RIGSC offers services in robotic sample preparation, DNA sequencing (Sanger and Next Generation), fragment analysis and quantitative-PCR. We also provide imaging services using transmitted light, epifluorescence, and laser scanning confocal microscopy, as well as cryostat sectioning of frozen specimens. The RIGSC is available to students, staff, and faculty at URI, as well as RI-EPSCoR researchers.

Detailed information on sample preparation, submission instructions, equipment use and any fees is available on our website at http://web.uri.edu/gsc/

The URI Marine Science Research Facility: Cutting-edge Equipment, Unparalleled Location

Rodrigue Spinette

Marine Science Research Facility, University of Rhode Island, Narragansett, RI

The Marine Science Research Facility (MSRF) is located at the University of Rhode Island's Narragansett Bay Campus and serves as a platform for experiential learning, undergraduate and graduate student training, research, and outreach.

The MSRF boasts state-of-the-art laboratories with instruments that cover a wide range of analyses: particle count analysis (BD Influx flow cytometer, Beckman Coulter Counter, Flow Cam), microscopy (Nikon epifluorescence microscope, Olympus dissecting microscope), water chemistry (Lachat nutrient analyzer, YSI meter, pH meter), molecular biology (PCR cycler, Stratagene quantitative PCR cycler, gel imager, nanodrop, Qubit, SpectraMax plate reader), light measurements (Turner fluorometer, PAR sensor), and gas analysis (Membrane Inlet Mass Spectrometer) among others. The MSRF is also well equipped to help researchers and scientists with many aspects of sample preparation for molecular, ecological and physiological research with shakers, filtration pumps, centrifuges, and cell/tissue homogenizers.

Located on the shores of Narragansett Bay, the MSRF also provides direct access to flowing water from the Bay. Seawater of varying quality (raw, filtered, heated, or chilled) can be pumped in tanks of many sizes. A range of environmental conditions can be reproduced in our environmental chambers (polar and temperate) and incubators of various sizes. In combination with off shore activities (Endeavor and other vessels) and docking at our doorstep, the MSRF provides researchers with opportunities for vertical integration of their research efforts. Scientists are able to collect samples and organisms at sea and return them to the laboratory where experiments can be conducted in the wet labs, and/or samples efficiently processed in the analytical laboratories.

Our facilities have been used for rearing and maintaining a variety of marine organisms. Investigators can conveniently study marine life under conditions ranging from polar to tropical environments or conditions resulting from global climate change.

The MSRF is available to students, staff, and faculty at URI, as well as researchers from RI NSF EPSCoR institutions. Researchers and teachers from around the region also are invited to use the MSRF's resources. Experienced staff can provide technical and analytical support covering a broad spectrum of research topics.

CoresRI.org

Pamela Swiatek

Biology & Medicine, Brown University, Providence, RI

CoresRI (www.CoresRI.org) is a directory of core facilities, services and instrumentation in Rhode Island. Development of CoresRI grew out of a need to maximize awareness and optimize utilization of these important core facility resources within the state. Operational since September 2014 and updated at least annually, CoresRI has grown to include 610 listings in 30 categories at 51 facilities at 14 institutions and 17 centers within Rhode Island. The web portal catalogs instruments (specific makes, models, and uses), services, locations, and contact personnel pertaining to each core or facility. Investigators at Lifespan and all participating institutions have full access to the listed facilities, equipment, and expertise via CoresRI.org. Most of the equipment resides in Core Facilities that are either free-standing or operated within the NIH Centers of Biomedical Research Excellence (COBREs), NIH IDeA Network of Biomedical Research Excellence (INBRE) or NSF Experimental Program to Stimulate Competitive Research (EPSCoR). Besides encouraging equipment sharing and reducing duplication of services, CoresRI.org fosters collaborations and enables investigators to better assess future shared equipment needs. The institutions participating include Brown University, Bryant University, Butler Hospital, Community College of Rhode Island, Providence College, Rhode Island College, Rhode Island Hospital, State of Rhode Island, Roger Williams University, Salve Regina University, and the University of Rhode Island.

Bioinformatics Resource Facility, Brown University

Raghavee Venkatramanan

Biology & Medicine, Brown University, Providence, RI

The Bioinformatics Resource Facility in the Division of Biology and Medicine provides analysis of high throughput sequencing data for basic, clinical, and translational research. Our aim is to provide bioinformatics resources and education to faculty, research associates, staff and students to advance collaborative research and discovery.

Our primary goal is to provide a Bioinformatics support system to assist researchers in analyzing data for different applications including, but not limited to, DNA variation, methylation studies, RNA-Seq gene expression, pathway analysis, metagenomics, metabolomics and other biological research. Custom data analysis pipelines can be created. Consultation for experimental design, followed by frequent interaction during data collection and analysis, is available to facilitate effective data interpretation. Each project is appraised prior to initiation and then a suitable pipeline will be used for data analysis. We welcome inquiries from scientists and teachers seeking information regarding how we may assist them in furthering their research and educational goals.

Since 2011, members of the Rhode Island NSF EPSCoR community have had access to the resources provided by the Center for Computation and Visualization (CCV) and the Bioinformatics Resource Facility at Brown University. CCV fosters and manages high performance computing, highly reliable research data storage, visualization resources, physical and virtual server hosting, high-performance backup and archival services, and outstanding scientific support to empower computational research and scholarship. EPSCoR users can apply for high priority access to the scientific compute cluster and the Bioinformatics Resource Facility services. Seminars on bioinformatics and computational biology at Brown are open to the RI NSF EPSCoR community.

Further information about the facility can be obtained by contacting the Facility Manager Raghavee Venkatramanan at Raghavee_venkatramanan@brown.edu.

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Advancing research infrastructure, cyber infrastructure, capacity in computational biology, and public communication of science

Marine Science Research Facility: Unlimited Research Potential

Alishia Zyer and Edward Baker

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The Marine Science Research Facility (MSRF) at the URI Bay Campus has been serving researchers and students since the early 70's. It has provided a platform for hundreds of research projects, scientific papers, and produced many, many PhD and Masters graduates. Undergraduates have also used the MSRF for internships, work study programs and special projects. Lastly, the ongoing outreach program has exposed thousands of Rhode Island middle school and high school children to marine science and marine creatures. These visits excite their imaginations and we hope to inspire academic achievement and interest in science throughout Rhode Island.