Sea Grant
NJ Sea Grant Consortium

PROJECTS & PROGRESS

Research Projects 2014-2016

The Research Program at the New Jersey Sea Grant Consortium

Founded in 1969, the New Jersey Sea Grant Consortium (NJSGC) is an affiliation of colleges and universities and other entities dedicated to advancing knowledge and sustainable use of New Jersey's marine and coastal resources. To achieve its goals, the NJSGC works with its members to coordinate efforts that ensure a healthy environment for New Jersey and its coastally-dependent economy.

Since 1976 the NJSGC has managed the Sea Grant program in New Jersey. The Sea Grant program at the NJSGC supports stakeholder-driven research, extension, communications and education in direct service to New Jersey's coastal environment and its citizens. Every two years, the NJSGC awards approximately four research grants using a rigorous and competitive, peer-reviewed process. NJSGC research is guided by relevancy criteria determined through a collaborative strategic planning process that receives input from stakeholders, NJSGC's advisory boards and partners, and the public. The research reflects local concerns and provides solutions to New Jersey's most pressing marine and coastal issues including water quality, shoreline restoration, dune protection and other erosion concerns, recreational and commercial fisheries management, and coastal hazard mitigation.

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This publication is the result of work sponsored by New Jersey Sea Grant with funds from the National Oceanic and Atmospheric Administration (NOAA) Office of Sea Grant, U.S. Department of Commerce, under NOAA grant #NA100AR4170075 and the New Jersey Sea Grant Consortium. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the views of New Jersey Sea Grant or the U. S. Department of Commerce. NJSG-14-862

Facilitating Natural Dune Building R/6410-0013

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Bulldozed dune at Brick Township following Superstorm Sandy 2013

Assessments of damage along the New Jersey shore after Superstorm Sandy indicate that the condition of the dunes had a pronounced effect on susceptibility to flood and wave damage. Not all dunes were alike; some dunes evolved by natural processes; some were created by direct deposit of fill; some were created using sand-trapping fences; some were bulldozed using local beach sand or storm-wave deposits. Some dunes had surfaces stabilized by planted vegetation; some had vegetation growing throughout; and some were unvegetated. The size, shape, and resistance to erosion of dunes are related to the method of construction, but when and how the different methods can be optimized to provide a better protective dune is poorly understood.

Naturally evolving dune at Avalon 2009

This project focuses on the quantification of the resistance of different dune types to wave erosion and of sand supplied to the dune by winds, accounting for the constraints to wind-blown sand transport across narrow beaches of developed shorelines. Field investigations will provide data on the ability of human-modified dunes to withstand wave impact, the rates of delivery of sediment to dunes from nourished and unnourished beaches, and the ability of dunes to resist erosion and maintain their effectiveness as a barrier against flooding, especially during the critical period when they are rebuilding after storms. Maintaining healthy dunes on developed coasts like New Jersey is challenging because dunes require space to accommodate growth and time to evolve, which are frequently unavailable.

The results of this project will provide better criteria for creating protective dunes where human development has introduced spatial and temporal constraints. Local managers can use results of this project to design management activities that enhance dune resilience based on site-specific constraints.

Advancing Eastern Oyster Aquaculture through Marker-Assisted Selection R/6410-0010

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Dr. Ximing Guo (right) and colleague Paola López-Duarte challenge oysters with *Perkinsus marinus* (a pathogen that causes Dermo disease) in the lab.

The eastern oyster (*Crassostrea virginica* Gmelin) is one of the most important marine resources in the U.S. Over the past 60+ years, however, over-fishing, habitat destruction and diseases have decimated eastern oyster populations and fisheries in much of the mid-Atlantic region including Delaware Bay. The prolonged decline in oyster fishery has brought social and economic hardship to coastal areas. Oyster farming or aquaculture has the potential to ease the economic pain of coastal communities by providing stable jobs and high quality oysters without adding additional fishing pressure to wild stocks.

Oyster aquaculture in New Jersey and much of the Atlantic U.S. faces many challenges. The lack of a domesticated stock with desirable traits for aquaculture is a major impediment. The eastern oyster faces two major diseases: MSX (caused by the parasite *Haplosporidium nelsoni*) and Dermo (caused by the parasite *Perkinsus marinus*). These diseases present a major threat to oyster aquaculture, as each of them can cause up to 90% mortality in susceptible stocks.

Rutgers University has been breeding oysters since the early 1960s. Strains resulting from the Rutgers breeding program have shown strong resistance to MSX. However, the Rutgers strain has only moderate resistance to Dermo. Further improvement in Dermo-resistance has been slow. Currently, selection is based on field-exposure, which becomes ineffective in years when disease exposure is low or absent. The inability to maintain constant selection pressure presents a major challenge for breeding disease resistance in oysters. The problem can be solved by identifying genetic markers for disease resistance and practicing marker-assisted selection. With disease-resistance markers, we can target them in years when diseases are absent. Even when diseases are present, disease-resistance markers can be used to increase selection pressure and efficiency by selecting the best genotypes among survivors.

Dr. Guo's team at Rutgers University has been actively working on the identification of disease-resistance genes in oysters. Through several years of research on the oyster genome, they have identified a few disease-resistant markers that are ready to be tested for marker-assisted selection in the field. In this new project Dr. Guo's team will test the efficacy of marker-assisted selection for disease resistance. They will select the most disease-resistant oysters based on their field survival as well as their genetic makeup. The addition of marker-assisted selection is expected to improve selection efficiency and speed up the development of disease-resistant oysters. These improved disease-resistant oysters should give oyster farmers a much better return. They may also speed up the recovery of wild oyster populations in Delaware Bay and beyond.

Oyster spawn.

Development of Historically-Calibrated Sea Level Rise Projections for Risk Management Along the New Jersey Shore R/6410-0014

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Photo - Benjamin Horton

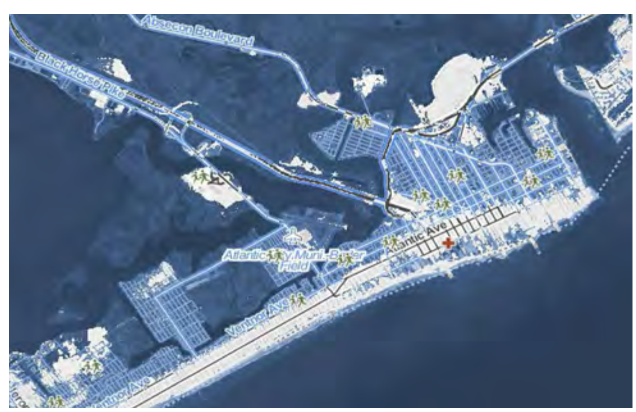
Chris Vane, a collaborator of Benjamin Horton, works with high school students in the coastal marshes of New Jersey to collect sediment cores that will be used to reconstruct past sea-level changes.

The devastation caused by Superstorm Sandy highlighted the vulnerability of communities, economies and ecosystems in our region to sea-level rise and the associated increase in the intensity of coastal flooding. A mere 1.1 ft. of sea-level rise would be sufficient to cause the 1-in-10 year storm at Atlantic City to exceed the worst known from the historical record, including both Superstorm Sandy and the December 1992 nor'easter. Both tide gauge and satellite records show that the rate of sea-level rise is increasing globally and in New Jersey. In fact, geological records show that the twentieth century rate of sea-level rise in New Jersey was faster than during any other century in at least 4,300 years.

Decisions on how to adapt to rising seas and protect vulnerable ecosystems require probabilistic sea-level rise projections to inform risk analysis. Accordingly, this project, led by Dr. Robert Kopp, Assistant Professor of Earth & Planetary Sciences at Rutgers University and Associate Director of the Rutgers Energy Institute, in collaboration with other researchers at Rutgers and Climate Central, will produce state-of-the-art sea-level rise projections for the region, grounded in the best available science on historical and pre-historical sea-level change, sea-level physics, and uncertainty analysis.

The project will develop a database of geological and observational sea-level and ice sheet volume constraints and use it to disentangle the different factors that have driven sea-level rise in New Jersey over past millennia, among them: the ongoing effects of adjustment to the end of the last ice age, compaction of coastal sediments, uptake and loss of heat from the oceans, changes in ice sheet and glacier volume, and changes in ocean dynamics. The past responses to changes in climate will be used to calibrate a model of future sea level change, the projections from which will be integrated with statistical analysis of extreme flooding to provide predictions of changing flood risks over the next century on the Jersey Shore.

The results will be used to identify vulnerable developed and undeveloped land areas, infrastructure, assets, ecosystems and populations exposed to flooding during the 21st century. The research team will communicate the results to federal, state, and local policymakers and the broader public through direct outreach and through tools such as Surging Seas (sealevel.climatecentral.org) and NJ Flood Mapper (www.NJFloodMapper.org).



Flooding in Atlantic City due to an increase in water level of 5' above mean highest high water, indicated by blue shading. This level exceeds the highest known from the observational record (4.4 ft.), and is expected to be comparable to a 1-in-10 year storm after 1.7 ft. of sea-level rise. Children icons indicate schools, red cross indicates a hospital.

Source: Surging Seas, sealevel.climatecentral.org

Determining Sustainable Catch Limits for Data-Poor Fisheries in New Jersey: Validation and Refinement of a Data-Poor Harvest Control Rule R/6510-0012

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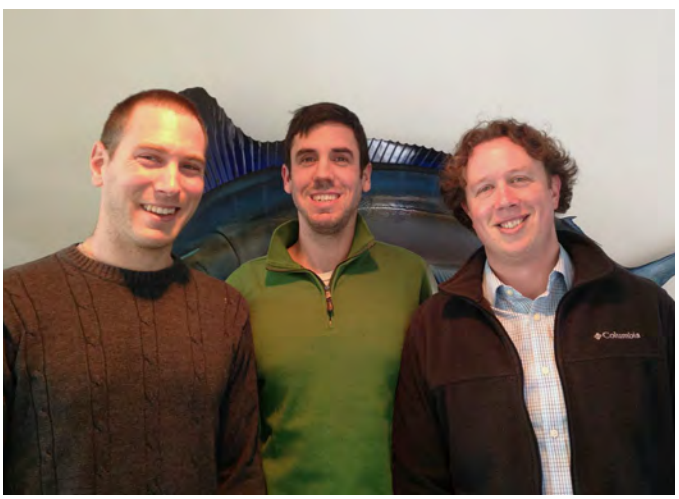

Research team (left to right): Chris Free, John Wiedenmann and Olaf Jensen.

Many fish populations support thriving commercial and recreational fisheries in New Jersey, and the health of these fisheries has broad implications for the economies of many coastal communities. Sustainable fisheries management typically requires large amounts of data to estimate population size and sustainable catch levels using a stock assessment model. However, many species in New Jersey are considered data-poor, where data are limited or of poor quality, preventing the use of traditional stock assessment methods. As a result, sustainable fisheries management is particularly difficult.

Recently, an approach for classifying abundance and setting catch limits for data-poor fish populations has been developed. The Only Reliable Catch Series (ORCS) approach utilizes readily available information on the population and fishery characteristics of a population to predict abundance and set catch levels. The ORCS approach is being considered for the management of many data-poor fish populations (including black sea bass), despite the fact that it has not been validated. Led by Dr. John Wiedenmann, Assistant Research Professor in the Institute of Marine and Coastal Sciences at Rutgers University, along with Dr. Olaf Jensen and graduate student Chris Free, this research project will evaluate the ability of the ORCS data-poor approach to reliably estimate the abundance and sustainable catch levels for a fish population. To test the ORCS method, a database will be utilized that contains stock assessment estimates for over 300 global fish populations. The reliability of the ORCS method will be determined by applying it to populations in the database, and comparing the predicted estimates of abundance and sustainable catch levels to the stock assessment-estimated values in the database.

The main benefit of this project will be to improve the ability to manage data-poor stocks in the region. If effective, the ORCS approach represents a potentially powerful tool to help sustainably manage many of the data-poor fish populations found in New Jersey and the greater Mid-Atlantic.

Black sea bass support large commercial and recreational fisheries in New Jersey.

Understanding the Impacts of Climate Change on the Distribution, Population Connectivity, and Fisheries for Summer Flounder *(Paralichthys dentatus)* in the Mid-Atlantic R/6410-0011

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Summer flounder is a critically important species to commercial and recreational fishermen throughout the Middle Atlantic region, but the species has been found further and further north at the same time that temperatures have warmed in recent decades. These shifts in summer flounder have greatly complicated fisheries management, and climate change will likely further impact the distribution and productivity of summer flounder. This project aims to uncover why summer flounder have shifted north and what the implications for management will be. The ultimate goal is to provide information that supports management of the summer flounder fishery for both high yields and long-term sustainability.

The project brings together a diverse, multi-state and multi-university team with expertise in fisheries ecology, climate science, and economics. Dr. Malin Pinsky (Rutgers University) leads the team. Co-investigators on the project include Olaf Jensen and Ken Able (Rutgers University), Janet Nye and Hyemi Kim (Stony Brook University), Joel Fodrie (University of North Carolina), and Chris Kennedy (George Mason University).

The project will integrate a range of scientific approaches, from genetics to microchemistry, analysis of historical data, and bioeconomic modeling of fishery outcomes. Key questions to be answered include the degree to which summer flounder move up and down the coast, and to what extent they move in response to changing temperatures. In addition, the combined impacts of climate and regulations on the fishery will be examined. In total, the project aims to provide much of the scientific understanding needed to begin including climate change and range shifts in assessment and management of summer flounder.

Photos - Rutgers University Marine Field Station

Genetic Monitoring to Improve Fish Stock Assessments

R/6410-0018

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The Rutgers University Marine Field Station has been collecting larval fish, or ichthyoplankton, on a weekly basis since 1989. These 26 years of data provide a valuable means of examining how fish populations and communities off the central New Jersey coast are changing with time. This study will focus on using the long-term larval fish data in a novel way: performing genetic monitoring of summer flounder (*Paralichthys dentatus*) to determine population abundance.

Summer flounder is an economically important and popular species for commercial and recreational fishermen in New Jersey and the Mid-Atlantic region. In 2009, for New Jersey alone, the commercial summer flounder fishery was worth over $3 million, while the recreational industry generated over $1.4 billion in sales (NMFS 2011). Given the high economic value of summer flounder, it is important that managers be able to accurately estimate population abundance, or stock size, in order to set sustainable fishery catch limits. Setting a sustainable catch limit not only reduces overfishing, it also benefits fishermen and consumers in the long run by reducing uncertainty. Historically, summer flounder management has been a contentious topic between managers and fishermen. The steep population decline in the 1980s resulted in marked fishing restrictions and conservation measures to improve stock abundance. Today, the summer flounder stock has been successfully rebuilt, but there is still debate about how to properly manage the species.

Stock assessments for summer flounder and many other commercially important fish are often based off of a small number of bottom-trawl and other surveys. By using genetic monitoring to assess the size of the summer flounder stock, this project aims to provide an independent estimate of summer flounder population size. Comparisons between estimates of stock size from genetic monitoring and traditional survey methods may help to reduce uncertainty in stock abundance and ultimately improve management strategies. If shown to be useful in stock assessment for summer flounder, genetic monitoring can then be expanded to other important or data-poor fisheries.

Taking a tissue sample from a 9mm long summer flounder larvae for genetic analysis.

National Marine Fisheries Service. (2011) Fisheries economics of the United States, 2009, U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-118.
Available from
http://www.st.nmfs.noaa.gov/st5/publication/index.html.

A Green Technology for Nutrient and Metals Reduction in New Jersey Coastal Waters   R/6410-0015

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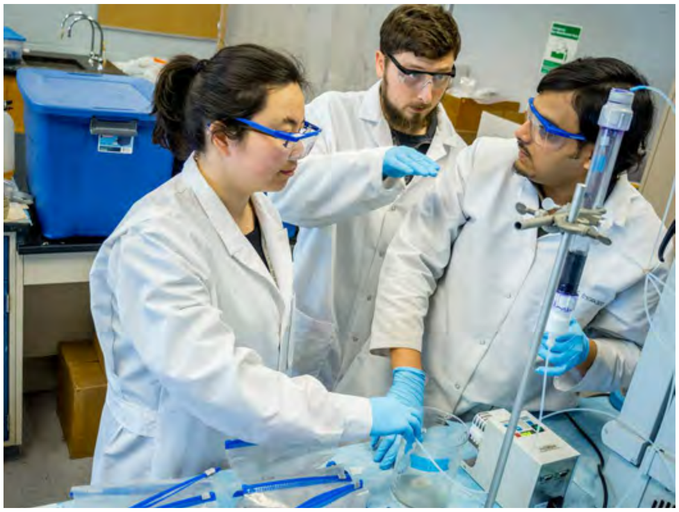
The goal of this project is to develop a "green" and inexpensive technology to reduce nutrient and metal input from stormwater into New Jersey's coastal waters. The project will test phosphorus and metal fixation potential of a waste material – the drinking water treatment residuals that are generated in the order of 2 megatons daily in the United States alone, and in conjunction with different plant species with varying degrees of metal and nutrient uptake capacities, via greenhouse and pilot-scale field experiments.

The first phase of the project will consist of laboratory-based experiments and greenhouse tests to study the mechanisms of metals and nutrient removal for both the residuals and vegetation, and to optimize their pollutant removal capabilities. In the second phase, the technology will be field tested in a pilot scale in two coastal locations in the Barnegat Bay watershed. The aluminum-based drinking water treatment residuals, which are



Laboratory column studies using aluminum-based drinking water treatment residuals. *Photo - Mike Peters, MSU*

Vetiver grass growing in the climate controlled greenhouse of Montclair State University. *Photo - Mike Peters, MSU*

considered non-hazardous and safe for land application, will be mixed with sand and/or granular carbon, and placed in filter bags and inserted into catch-basins in a parking lot to capture runoff. Also, buffer strips will be installed to intercept runoff from a golf course. The soil in the strips will be amended with the residuals and sections will be planted with the different vegetation. Water will be sampled entering and leaving both the catch-basin insert and the buffer strips to determine the pollutant removal performance of each type of installation. Reduction in erosion potential will be monitored as well.

Excess nutrients and the resultant eutrophication is a serious problem in coastal waters in New Jersey. Waters are also affected by metal pollution. This problem is exacerbated during storm events when huge amounts of nutrients, metals and sediments enter the water bodies. This project will couple scientific and engineering efforts to develop and test a new "green" technology that could be widely deployed to reduce such pollution in New Jersey's coastal waters.

Development of Climate Change Adaptation Elements for Municipal Land Use Plans: Building Resiliency in Ventnor City, New Jersey R/6410-0016

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Now more than ever, towns all over the country are focused on how to make their land and infrastructure more resilient to extreme whether events and climate change. The destruction from Superstorm Sandy put this issue at center stage in most municipal planning activities in the State of New Jersey.

One way municipalities can plan for climate change is to incorporate climate change adaptation elements in already existing land use documents such as master plans, zoning ordinances, open space and recreation plans and stormwater management plans, to create a more grounded, science-informed and holistic approach to climate change preparedness.

The project team will work with Ventnor City in Atlantic County as a replicable model for other coastal communities. Atlantic County is one of the nine "most impacted" counties from Superstorm Sandy. The storm reduced Ventnor's ratable base by almost $5 million and hundreds of homes were damaged, leaving the city with significant rebuilding costs. Specifically of relevance to this project, the community is considering the development of an eco-park on a parcel of tidal land, and is looking for an opportunity to develop the park in a resilient way.

The investigators will inventory and assess Ventnor's current planning documents, and use existing leading practices in resilience planning to recommend ways in which the town can strengthen local land use regulation and mechanisms, both at the implementation and the policy levels. This project will benefit from Rutgers' work over the past year, including the assembly and compilation of key sets of data that are needed for community-based recovery planning.

Ventnor beach, 9/3/14
Photo - Stacy Perrine

Dudley Avenue, Ventnor Heights, 10/30/12.
Photo - Danny Drake, Press of Atlantic City

Public engagement and communication is an important part of the project. The team will facilitate public workshops where geospatial sea-level rise tools such as Floodmapper and NJAdapt will be used to explain future sea level rise scenarios to residents and the implications these scenarios will have on their town. The workshops also offer residents a chance to voice their concerns about climate change impacts and suggestions for building resilience.

The municipal planning review and associated changes implemented based on this project's recommendations will assist Ventnor with improving its Community Rating System (CRS) rating. Project activities will result in a more resilient town, while at the same time supporting other positive changes, such as providing support to the town's efforts to increase preserved land, expanding research into the possibility of restoring a salt marsh, and potentially offering residents more public recreation opportunities.

Minimizing Risks of *Vibrio* Bacteria in Farm-Raised Oysters Grown in Mid-Atlantic Intertidal Environments R/6410-0019

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Intertidal farm

Oyster farming is a $300 million-plus industry in the U.S. supporting thousands of small farms and sustainable green jobs in rural areas. Farm-raised oyster production has increased rapidly along the East Coast during the last decade with production in Virginia exceeding 30 million oysters in 2013 and steady increases in Maryland and New Jersey. New Jersey's oyster farms are concentrated on the extensive intertidal sand flats of the lower Delaware Bay (Cape Shore) where they are exposed twice daily during low tide. Hatchery reared oyster seed is grown in mesh bags on racks just off the bay bottom. Farmers carefully tend the oysters for 18-30 months as they grow to market size. The confluence of estuarine and ocean waters along the Cape Shore produces a high quality oyster with a flavorful blend of salt and sweetness. The farm-raised Cape Shore oysters are sold under a variety of brand names in the expanding half-shell market where they are consumed raw.

Recently, farmers and state and federal regulators have become increasingly concerned about vibriosis, a human illness that can be associated with consumption of raw and undercooked seafood. *Vibrios* are naturally occurring and among the most abundant bacteria in the marine environment. Although only a small fraction of environmental strains cause illness in humans, their widespread distribution in marine and estuarine environments raises concerns for seafood safety. Therefore, developing effective grow-out, harvesting, and handling methods that minimize levels of harmful *vibrios* in oysters is of paramount importance to the industry.

Principal investigator Dave Bushek and his post-doc Tal Ben-Horin at Rutgers University are working collaboratively with New Jersey Sea Grant Consortium Shellfish Aquaculture Program Coordinator Lisa Calvo and colleagues from the Virginia Institute of Marine Science to conduct parallel studies on the ecology of *vibrios* that specifically examine how regional aquaculture practices influence *Vibrio* density in oysters. Current regulations and guidance regarding intertidal shellfish culture are based on information from the Pacific Northwest where environmental conditions are significantly different from the mid-Atlantic.

Bushek, Ben-Horin and Calvo emphasize the need to obtain locally relevant scientific data to develop optimal growing and harvest practices that minimize *vibrio* risk in the mid-Atlantic region. By examining *vibrio* concentrations in relation to local environmental and farm practices, the team will evaluate risks "locally" and identify appropriate aquaculture practices to reduce consumer risk. The collaborative study promotes a regional approach that engages both state and federal regulators to ensure rapid transfer of results in support of science-based regulations.

Dr. Tal Ben-Horin

Collaborative Climate Adaptation Planning for Urban Coastal Flooding R/6310-0001

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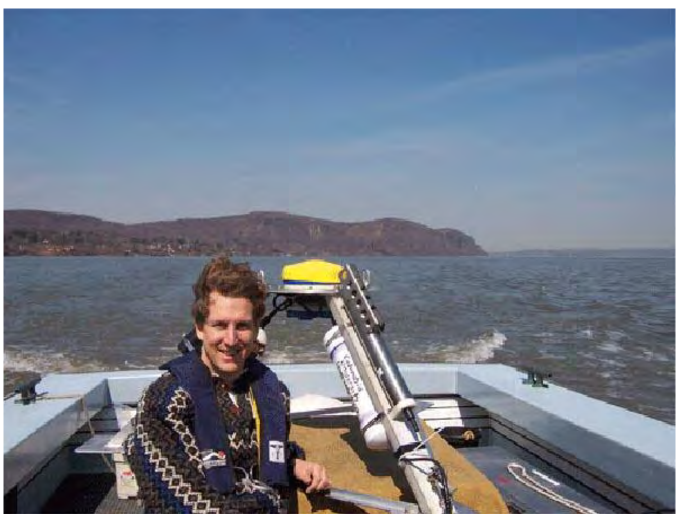
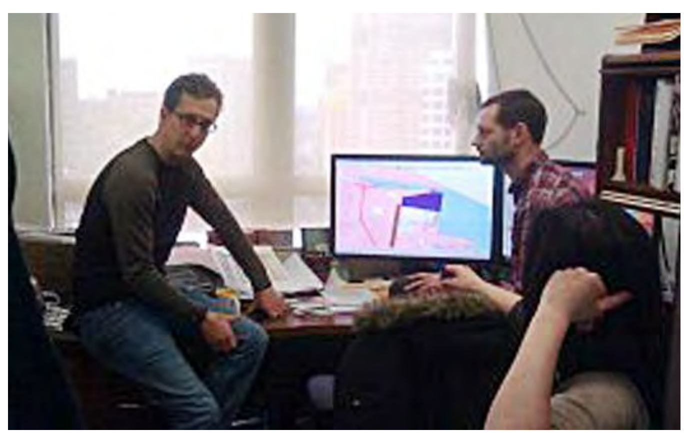


Dr. Philip Orton

Coastal cities across the country are weighing their options for adapting to rising floods, yet there is limited quantitative information available to help make these decisions. Here, we propose a collaboration between coastal flooding scientists and Jersey City planners to develop and test several options for adapting the region's urban coasts to flooding and sea level rise. Jersey City is the second-most populous city in New Jersey, yet has 43% of its land within the new FEMA 100-year flood zones. The investigators lay out a plan to leverage existing storm surge modeling to quantify the performance of a set of protective measures for Jersey City, including a variety of grey and green options such as storm surge barriers, deployable barriers, and wetlands.

Outcomes and outputs from the proposed research include: (1) flood zone maps that account for future sea level rise and storm climatology changes, (2) model-based map animations of how floodwaters enter Jersey City to help understand how the pathways can be blocked, (3) a report on the flood protective benefits of a collaboratively determined set of coastal adaptation options, and their performance with future climate change, (4) an outreach workshop where we present the project's results to additional regional stakeholders, and (5) a transferable, peer reviewed and published adaptation planning and evaluation framework. Lastly, a primary performance measure for success will be that at least Jersey City, and possibly additional area cities, will implement climate change planning policies to adapt to coastal flooding.

The framework can also be utilized for many other U.S. coastal regions – anywhere that hydrodynamic models are already being used to simulate storm surges or map flood zones. FEMA has embarked on an ambitious effort to re-evaluate the nation's coastal flood zone maps, and many of these regional efforts are utilizing these models. Many areas also have storm surge forecast models in place that can be similarly used for adaptation studies.



Jersey City planning personnel project team members Jeff Wenger and Tanya Marione-Stanton are pictured at right meeting with Dr. Philip Orton (left) to discuss GIS delineations of coastal protection features.