Rutgers Raritan River Consortium

Description of FY18 Mini-grant and Internship Award Recipient Proposals

Research Mini-Grants

Kaixuan Bu (Dept. Marine & Coastal Science, School of Enviromental & Biological Science ("SEBS")) and Jeffra Schaefer, PhD (Dept. Environmental Science, SEBS), "Temporal Heavy Metal Distribution and Bioaccumulation in the Lower Raritan River"

With the surge of urban growth and industrialization, the Raritan River, and in particular its 15-mile long lower portion, has experienced profound contamination over the last 100 years. Exceptionally high concentrations of toxic heavy metals such as cadmium, copper, lead, and mercury have been observed in Raritan Bay sediments. These heavy metals are known to accumulate and in the case of mercury, bio-magnify within the aquatic food chain. Few studies examining Raritan River as a source of metal contamination to aquatic biota and the bay have been published dating back >25 years. This is despite that many of the 15+ EPA designated Superfund Sites within the Raritan watershed, such as Kin-Buc and Horseshoe Road site, are known for heavy metal contamination (e.g. As, Cd and Pb). Thus, updated information on the current impact of this legacy contamination is strongly needed. These metal contaminants pose significant environmental threats to the local ecosystem, the water supply and the community living along the Lower Raritan River. Understanding the heavy metal distribution along the Lower Raritan River and their extent of accumulation in the river biota, will not only assist with on-going contaminant monitoring efforts, but will also provide necessary information to evaluate cleanup and remediation strategies.

The objective of this project is to better understand the temporal variability as well as spatial distribution of toxic heavy metals (As, Cr, Cd, Pb and Hg) in water, sediment and biota dwelling in the regional ecosystem along the Lower Raritan River. A broader suite of elements will also be measured during the study. To our knowledge, this has never been achieved in a prior study. Undergraduate student participation will be a key component of the project; they will learn contamination-free sampling techniques for collecting river water, sediments and biota samples from Lower Raritan River. They will also learn analytical principles and techniques for metal analyses of different sample types.

Matthew Campo (Environ. Analysis & Communications Group, Edward J. Bloustein School of Planning and Public Policy ("EJB")), "Understanding the Benefits and Risks of Coastal Flood Hazard Adaptation Strategies for Water-Dependent Uses in the Raritan Bay"

Mal-adaptive planning strategies to enhance resilience sometimes fail to recognize the interrelated systems of benefits and risks that face water-dependent uses. As a result of their reliance on suitable access to water, water-dependent uses are inherently vulnerable to coastal flood hazards. However, flood risks are not the only risks that water-dependent uses face. Some water-dependent uses, like commercial fishing establishments, are targets for redevelopment proposals and at risk to fisheries moving in response to climate change. In addition, the spatial constraints of water dependence limit the application of adaptation strategies (e.g. managed retreat). This research will investigate how water-dependent uses currently plan for resilience to coastal flood hazards, and seeks to clarify how users might comprehensively consider the benefits and risks within climate resilience planning processes.

The proposed research will identify current techniques for integrating water-dependent uses and resilience into planning processes in Raritan Bay communities. In Monmouth County, NJ and Middlesex County, NJ the project team will investigate how different water-dependent users and planning officials consider flood hazard resilience in existing planning processes. Researchers expect that the project will result in shared alternative approaches for resilience and adaptation among coastal managers, planners, and water-dependent use stakeholders. Municipal staff and officials, county staff and officials, non-governmental organizations, the New Jersey Department of Environmental Protection, and other professionals will benefit from this research.

Donna E. Fennell, PhD (Dept. Environmental Sciences, SEBS), "Tracking Genes and Bacteria Responsible for Organohalide Reduction in the Raritan River Basin"

The Raritan River receives wastewater treatment plant (WWTP) effluent, stormwater runoff, combined sewer overflow (CSO), and groundwater infiltration from a variety of sites contaminated with organohalide pollutants. Organohalides are known or suspected carcinogens and some bioaccumulate and enter the food chain, leading to human exposure. In NJ, organohalides are present as groundwater and sediment pollutants and drive site remediation across the state. Along the Raritan River there are many organohalide contaminated sites (e.g., American Cyanamid and Kin-Buc Landfill). Naturally occurring bacteria — the organohalide respiring bacteria (OHRB) — have reductive dehalogenase enzymes (rdhs) that dechlorinate and detoxify these compounds. Often, ORHB contain many rdhs and can dechlorinate many different organohalides. The OHRB are important agents in bioremediation of contaminated sites or in natural attenuation of pollutants.

The specific objective for this research is to map the extent of organohalide transformation activity and prevalence of associated marker genes in soils from the Rutgers - New Brunswick campus, and in sediments along the river that encompass freshwater sites, estuarine sites, and sites in close proximity to potential sources of organohalide contaminants. We hypothesize that higher microorganism activity will occur in closer proximity to contaminant release from CSOs, WWTPs or contaminated sites. This work will lay the foundation for understanding the potential of the river to undergo intrinsic bioremediation and will also determine if the presence of activity and genes are correlated to potential inputs of pollutants.

Jie Gong, PhD (Dept. Civil and Environmental Engineering, School of Engineering) and Jennifer Whytlaw, GISP (Environ. Analysis & Communications Group, EJB), "Digital Raritan River – A Pilot Study on Creating a Rich Digital Environment to Support Resilience Centered Investigations in the Raritan River Region "

The Raritan River region is home to many businesses, residential communities, critical facilities, and diverse wildlife species. Flooding is a persistent problem in the Raritan River region when excessive rain from storms affects the river basin. During hurricane events, flooding can be even more severe due to combined storm surge and heavy rainfall effects. For example, record flooding in the aftermath of Hurricane Floyd has wreaked havoc in the Raritan River region, paralyzing major transportation links along the waterfront. Elevation products, such as those created from airborne lidar data, play a critical role in assessment and communication for flooding events. Nevertheless, airborne lidar data are collected less frequently for riverine communities than for coastal communities. Dense vegetation along the riverbanks also pose particular challenges for airborne lidar data collection. Lastly, due to the limitation in resolution, it is challenging to conduct high-resolution flood simulations and create high-fidelity visualizations for risk communication with airborne lidar data.

This project is directed at collecting high resolution lidar data in selected areas in the Raritan River region to pilot a digital Raritan River initiative for supporting virtual exploration of the Raritan River environment. These areas include, but are not limited to, New Brunswick downtown area (urban setting) and Perth Amboy area (residential communities). The end goal of the project is to turn the high-resolution lidar data collected along the waterway of Raritan River and the roads in the proximity of the Raritan River into a rich digital environment to support resilience centered investigations such as identifying properties potentially impacted under future flooding risks. The digital environment can also be used by students to examine other resilience related issues such as biodiversity, river deposits, and channel erosion.

Jill Lipoti, PhD and Mary Nucci, PhD (Dept. Human Ecology, SEBS), Beth Ravit, PhD (Center for Urban Environmental Sustainability, SEBS), Kristi MacDonald, PhD (Raritan Headwaters Association), "Plastics in the Raritan River"

Plastics in the aquatic environment are of increasing concern because of their persistence in the environment. Plastics pose both physical and chemical threats to wildlife and the marine ecosystem. Wildlife can become entangled in plastic fishing line, gastrointestinal blockage can occur in seabirds that ingest plastic pieces believing them to be food, and underwater plants can be destroyed by plastic coverage. Plastics can bioaccumulate and toxic chemicals can be sorbed to plastics, further endangering wildlife. Plastics can be in the entire water column, not necessarily just floating on top of the water. Some of the sources for plastics could be the outfalls from sewage treatment plants, as microbeads and microfibers pass through the plants untreated.

The goals of the project would be twofold: 1) to add additional sample results to the water quality data on plastics, and 2) to provide data for justification of various strategies to decrease the plastic burden in NJ watersheds. Students would research legislative/ regulatory options such as BYO bags for grocery shopping. They would also research technological tools to remove microfibers in washing machines, and other ways to stop the plastics from reaching the Raritan.

Another component of the project is to construct a simplified apparatus for collecting samples for visual analysis for microplastics. The idea would be to make microplastic sample collection so easy that a citizen science project could be initiated to add to the data collection.

Karl Nordstrom, PhD (Dept. Geography, School of Arts and Sciences ("SAS") and Jonathan Miller (Dept. Marine & Coastal Sciences, SEBS), "Assessment of Protection Strategies for Estuarine Beaches: A Case Study of Cliffwood Beach"

Estuarine beaches often erode at higher rates than ocean beaches, but estuarine beaches get less attention from scientists and local managers. Interest in estuarine beaches is increasing because of damages by Hurricane Sandy and subsequent coastal storms, coupled with increased rates of sea level rise. The shoreline of Raritan Bay is developed with homes and recreational sites that are now vulnerable to these threats. The US Army Corps of Engineers has implemented coastal storm-risk management projects or studies for isolated portions of several communities on Raritan Bay, including Union Beach, Highlands, Keyport, Leonardo and Port Monmouth and Keansburg, but many portions of Raritan Bay are not included in these large-scale plans. Municipalities have some freedom in managing beaches and dunes using earth-moving equipment, sand fences and vegetation, but scientific expertise is usually missing at local levels.

The purposes of this proposed work are to (1) establish a working relationship between faculty and students at Rutgers University and decision-makers in a threatened Raritan

Bay municipality; (2) gather data on beach processes and shoreline change; and (3) use the data and insight to make informed decisions about managing threatened coastal habitats and infrastructure at the municipal level.

John Reinfelder, PhD, Jeffra Schaefer, PhD, Philip Sontag (Dept. Environmental Sciences, SEBS) and Grace Saba, PhD (Dept. Marine & Coastal Sciences, SEBS), "Influence of Raritan River Spring Discharge on Mercury Bioaccumulation in Raritan Bay"

The Raritan River and Bay ecosystem is an important nursery and feeding ground for marine fish, but is also surrounded by urban and industrial development, including historic and ongoing sources of mercury. Mercury (Hg) is a non-essential contaminant trace metal, which in the environment, is transformed into methylmercury (MeHg) a neurotoxin and the chemical form that increases in concentration at higher levels of aquatic food webs. The bioaccumulation and microbial and photochemical degradation of MeHg in aquatic environments is controlled in part by the quantity and source of dissolved organic carbon (DOC), which in the Raritan Bay, may be attributed to discharges from the Raritan River and associated salt marshes. During the spring season, the Raritan River produces higher freshwater discharges contributing terrestrial material and possibly inorganic contaminants, such as Hg to the ecosystem. Inputs of terrestrial organic matter from riverine discharge may lengthen coastal marine food webs through the stimulation of bacterial production and the growth of microzooplankton, thereby adding links in the food chain, and increasing the biomagnification of MeHg. Currently little is known about the effects of variable inputs of terrestrial organic material and DOC on the accumulation and degradation of MeHg at the base of Raritan Bay's pelagic food web.

This project seeks to understand the control of terrestrial dissolved organic carbon (DOC) on the accumulation of MeHg at the base of the pelagic food web and microbial transformations of MeHg during a time of higher freshwater discharge into Raritan Bay. We hypothesize that spring-time, high discharge events in the Raritan River will induce DOC metabolisms by the planktonic microbial community fueling biogeochemical cycling of Hg and organic matter, but may lead to higher accumulation of MeHg in mesozooplankton through elongation of the food chain, increasing trophic transfer of MeHg.

David A. Robinson, PhD (Dept. of Geography, SAS), "Raritan Basin Weather and Climate Monitoring and Information Access"

Virtually every focus area for the Rutgers Raritan River Consortium (R3C) mini-grant program is associated with or potentially impacted by the wide variety of weather episodes that occur within central New Jersey. Be it drought, flood, excessive heat or cold, climate variability and change, or simply the more "normal" day-to-day conditions in the basin, it is exceedingly beneficial to have adequate and accurate environmental

data at hand to assist the research community, decision/policy makers within diverse stakeholder communities and the general public. Our proposed project will facilitate the observation and availability of a multitude of observed weather variables at numerous locations within the basin. This includes establishing a research-quality New Jersey Weather Network (NJWxNet) station in the heart of the basin, the recruitment of citizen scientist precipitation observers throughout the basin, and the development of a webpage that includes summary information and links to real-time and archived basin-wide weather/climate data. The outcome of this activity will better facilitate research within the basin requiring weather information. Such need spans a multitude of dimensions sitting at the core of the R3C program.

Project goals include: 1) generating a comprehensive list of weather stations within the Raritan Basin, including manual National Weather Service (NWS) Cooperative (COOP) and NJ Community Collaborative Rain, Hail and Snow (CoCoRaHS) network and automated NWS and NJWxNet, 2) developing a website (linked to the R3C website) with summary information and links to real-time and archived weather/climate data, 3) recruiting citizen scientists within the basin to participate in the CoCoRaHS daily precipitation observation program, and 4) install a research-quality weather station at Duke Farms in Hillsborough, a location adjacent to the Raritan River within the central basin.

Douglas Zemeckis, PhD (Dept. Agriculture & Natural Resources, SEBS), "Providing Data on Discards and Fishery Dynamics to Inform Management Policy of the Recreational Summer Flounder Fishery in Raritan Bay"

Summer flounder (*Paralichthys dentatus*) is one of the species most commonly targeted by anglers in Raritan Bay during the spring and summer, including by anglers aboard private boats and for-hire party and charter boats. Management of the summer flounder recreational fishery in Raritan Bay is negatively impacted by limited data on discards, mortality rates, and total catch. Fishery scientists and managers quantify the total catch by accounting for all fish that are either harvested or discarded. Therefore, to accurately quantify total fishery removals, reliable estimates are needed for the proportion of fish that are caught and discarded (i.e., "discard rate"), and then robust discard mortality rate estimates for determining how many discarded fish survive catch-and-release. Presently, there are no Raritan Bay-specific data collection programs to address these needs.

Recent fishery management measures have imposed increasingly strict regulations for summer flounder to rebuild the population and simultaneously maintain some fishing opportunities. These regulations have shortened the open season, reduced the number of fish anglers can harvest, and increased the minimum landing size. These regulations have reduced anglers' fishing opportunities and satisfaction, resulting in significant negative socioeconomic impacts for businesses and communities along Raritan Bay. As a

result, additional data are needed to inform fishery management policy which meets both conservation and societal objectives.

The goal of this project is to provide data on discards and fishery dynamics of the recreational summer flounder fishery in Raritan Bay. Working with fishing industry stakeholders to fill these data gaps will provide valuable data for informing the management of Raritan Bay's recreational fisheries.

Internship Grants

Jean Marie Hartman, PhD (Dept. Ecology & Evolution, SEBS), "Status of Forests in the Lower Raritan Watershed"

Forest cover in the Lower Raritan Watershed Management Area accounts for less than 16% of total area, and is decreasing annually. Less than 25% of the existing forest is protected by easements, fee simple ownership or local regulations. The general health and ecological status of these forests are unknown, although we do know that high deer populations and invasive plant species threaten their long-term viability. Simultaneously, investment in expensive green infrastructure programs is rising. Protecting and managing current forest cover may be some of the most cost-effective green infrastructure. In order to generate better forest protection and management, we need a better understanding of the current status.
This project will supplement an ongoing research project addressing forest vulnerability to development. Through the use of site visits and remote sensing analysis, we will evaluate long-term viability of approximately 50 forest stands and develop recommendations for further forest protection measures for the Lower Raritan watershed. Forests associated with headwater areas and riparian zones will be given particular attention. The urban forestry technique to be employed is an appropriate tool for citizen science projects and could be used for further inventory and continuing monitoring by local volunteers.

Olaf P. Jensen, PhD (Dept. Marine & Coastal Sciences, SEBS), "Quantifying Fish Movement and Phenology on the Raritan River"

Since 2012, we have conducted field sampling and recorded fish passage on the Raritan River as part of a study on passage of American shad and river herring at the Island Farm Weir in Bridgewater, NJ. This study has produced a robust, 6-year dataset that includes catch data using a variety of gear types and 24/7 video recordings of fish passage. This video data has been analyzed for shad and river herring, which are the species included in the grant from NJDEP that funded this work. However, more than 25 other species of fish can be found in the Raritan. Understanding these fish populations is essential to assessing the state of the river ecosystem. The Raritan is a popular angling location, and the analysis of this dataset may reveal much about the fish these anglers typically

target. Engaging with the local angling community presents a unique way to educate citizens about the riverine ecosystem and foster future stewardship of the Raritan.

Mini-grant funds would support an undergraduate student intern whose research would *focus on those fish species not included in the NJDEP grant* – i.e., all species other than shad and river herring. The student will also have the opportunity to participate in field sampling. This student will learn a variety of data analysis methods, and participate in public outreach opportunities.

The above research proposals were funded through the Rutgers' Raritan River Consortium (R3C) mini-grant and internship program in the Fall of 2017.

The R3C is a collaborative effort of Rutgers New Brunswick-Piscataway schools, programs, and departments that have joined together to advance Rutgers' mission to be a better steward of the Raritan River and its environs. The R3C has two primary goals: to utilize the Raritan River and its environs to inform university-based education, research and scholarship; and to apply Rutgers' efforts, research and programs to collaborate with other Raritan partners to advance improvements in regional planning, policy and decision-making that positively affect the Raritan region and resources. By facilitating collaboration among Rutgers faculty, staff and students and engaging the greater Raritan community of businesses, municipalities, NGOs and other Raritan stakeholders, the R3C will bring the university's resources to bear to address concerns for the Raritan.

To learn more about the R3C, the mini-grants and internship pool, or the other Rutgers Raritan River initiatives, visit www.raritan.rutgers.edu or contact Sara Malone at sjmalone@ejb.rutgers.edu.