Rutgers Raritan River Consortium

Description of 2019 Mini-grant Award Recipient Proposals

Michele Bakacs (Dept. Agriculture and Natural Resources, School of Environmental and Biological Sciences ("SEBS")), Richard G. Lathrop (Dept. Ecology, Evolution & Natural Resources, SEBS), Heather Fenyk (Lower Raritan Watershed Partnership), Jessica Bonamusa (Interstate Environmental Commission), Robert Buchanan (New York City Water Trail Association), and Jesse Stratowski (Rutgers Dept. Recreation), $8,000 award for "Citizen Science Monitoring for Pathogen Indicators on the Lower Raritan River"

Currently, little water quality data exists that can inform the safety of recreating on the Lower Raritan River (also known as Watershed Management Area 9). The Lower Raritan is actively used for fishing, boating, and in some cases swimming at public access points, yet we have very limited information about pathogen levels at these sites that have a direct effect on human health. Having access to pathogen data at public access points along the Lower Raritan during the spring and summer is critical for people to make informed decisions about recreating on the water. Real-time, easily interpreted data is needed that can be accessed by the public during the active recreation season.

Rutgers Cooperative Extension of Middlesex County (RCE) and the Lower Raritan Watershed Partnership (LRWP) will gather data and other information on water quality for public access sites along the tidal portions of the Raritan River at locations considered non-bathing beaches. Non-bathing beach sites (active kayak/canoe launches, fishing or other primary contact activities) are not regularly monitored by the New Jersey Department of Environmental Protection (NJDEP) or the New Jersey Department of Health and Human Services and lack sufficient water quality data. The Project will also allow for development of civic science and expanded volunteer environmental monitoring programming within the Lower Raritan Watershed and Middlesex County, NJ. Working with an approved Quality Assurance Project Plan (QAPP), provided by the Interstate Environmental Commission (IEC), will allow for data generated from this project to inform water quality policy and regulatory decisions at all levels of government within the project area, and to educate the public about the safety of recreating on the River.

The final product will be a baseline of data that is published every Friday during the summer before the weekend so recreational anglers and boaters can make informed decisions about the health of the River where they have access. The data, program methodology and findings will be reported via the "RU on the Raritan" posts and SRRI newsletter, the LRWP website and the Green Knight Newsletter. The civic science

bacteria monitoring program will be published in peer reviewed Extension journals such as the Journal of Extension- https://joe.org/ and at regional and national conferences such as the New Jersey Watershed Conference, The Sustainable Raritan River Conference, and the National Association of Natural Resources Extension Professionals (ANREP) 2020 biannual conference- www.anrep.org.

Robert Chant, Travis Miles, Nicholas Beaird (all of Dept. Marine & Coastal Sciences, SEBS), and Ruo-Qian Want (Dept. Civil and Environmental Engineering, School of Engineering (SOE)), $8,000 award for "Synthesizing bathymetric and topographic data in the Raritan River basin towards development of hydrodynamic model "

Hydrodynamic and storm surge models are essential tools to investigate and understand the circulation, vulnerability to extreme precipitation and surge events, fate of pollutants, and overall water quality in the Raritan River and Bay. To develop these models requires an accurate discretization of both the bathymetry of the river and the topography of the surrounding land. While several data sets exist, such as FEMA charts, NOAA soundings, USGS topographic maps and LIDAR data of the shoreline -- significant work is required to fuse these data into a single topographic data set suitable for incorporation into a hydrodynamic/storm surge model of the region. Moreover, examination of NOAA's 30m resolution of the River's bathymetry reveals a poor representation of the main stem of the tidal river and does not extend to the Head of Tide.

The goal of this effort would be 1) Synthesize existing bathymetric and topographic data to produce a single gridded data set of the Raritan that can be used for future model development. 2) Identify data gaps to be filled with targeted side-scan sonar surveys of the river. 3) Develop software to process side-scan data to be disseminated to educational efforts. We anticipate that side-scan surveys will be conducted as part of field components of the Ocean Modeling and Data Analysis class, the newly developed Masters in Integrated Ocean Observing, and incorporated into other educational units across the university. The students in these courses will directly benefit from the processing software developed in topic 3.

The final product would be 1) A digitized bathymetric/topographic data set of the Raritan River and its surrounding water shed. 2) Identify data gaps that would target future side-scan surveys of the Bay 3) development of software to process side-scan sonar data suitable to be disseminated to students in Ocean Modeling and Data Analysis and the Integrated Ocean Observing Class.

Keith R. Cooper (Dept. Biochemistry and Microbiology, SEBS) and Gina Moreno (Dept. Environmental Sciences, SEBS), $7,950 award for "Quantifying the presence and abundance of freshwater and euryhaline bivavles in the Raritan River"

There is virtually no current information on the density and or the species of bivalve mollusks present in the watershed of the Raritan River basin. This will serve as a baseline study to identify what bivalves are present and at what densities. Bivalves serve a vital function in the ecosystem.

The first goal is to carry out bank surveys from Bound Brook to the mouth of the Raritan River by counting and identifying specific species. The second goal is to run transects where there are indications of bivalves from shoreline surveys to establish the density.

The students will be required to writeup their results and present their findings at a regional scientific meeting. This will serve as a baseline study but will form the basis for future studies examining trends in the river concerning bivalve populations.

Katherine Dawson (Dept. Environmental Sciences, SEBS) and Philip Sontag (Rutgers Center for Advanced Infrastructure and Technology), $8,000 award for "Influence of biogeochemistry on toxic metal availability in iron-replete New Jersey sediment: Development of point-of-use trace metal sensor with integrated sediment microbial community and geochemical measurements"

Toxic divalent trace metals (Copper (Cu), Nickel (Ni), lead (Pb)) dissolved in the water column of the Raritan River have been measured at comparable levels to the Upper and Lower New York Bay and particulate forms are found to be highly correlated with iron (Fe) particulates within the river estuary. Although strong relationships exist between Fe concentrations and trace metals, the biogeochemistry governing the release and transport of Fe and associated toxic, heavy metals in the Raritan is not understood.

This project seeks to understand the biogeochemical cycles of trace metal availability in the Fe rich sediment of the Raritan River. Work will focus on how the microbial diversity and metabolic activity govern the partitioning of toxic trace metals into oxidized Fe (Fe3+) and sulfide chemical fractions. Metal availability will be verified by sequential extraction, traditional laboratory analysis, and geochemical modeling software. Microbial community diversity will be assessed through amplicon sequencing of the 16S rRNA and various functional genes. Following pre-treatment of sediment organic matter with hydrolytic exoenzymes, to reduce organic material complexity, laboratory based incubations will be used to enhance understanding of organic matter (OM) cycling in Raritan River sediments and its impact on the release of toxic trace metals and Fe into the water column.

Results from this study will contribute to the understanding of trace metal sources, bioavailability, and biogeochemical cycling in the Raritan River and Bay. Data generated from this study will include trace metal concentrations, sediment microbial community composition, and metabolic data associated with OM breakdown in exoenzyme digest

enrichments. The integration of trace metal sensor development and measurements with geochemical and microbial community data will lead to one or more publications in Environmental Science and Technology, Frontiers in Environmental Sciences, or Applied and Environmental Microbiology.

Nicole Fahrenfeld (Dept. Civil & Environmental Engineering, SOE) and Christopher Vinnard (Public Health Research Institute, NJ Medical School), $7,850 award for "Opportunistic pathogens in the Raritan and the homes of people drinking the river"

The burden of non-tuberculosis mycobacterium (NTM) infections on the US healthcare systems is estimated to cost $815 million annually. NTM causes chronic lung infections most commonly in older, immunocompromised, and cystic fibrosis patients. NTM infections may be established through inhalation of aerosolized droplets containing NTM or ingestion with subsequent aspiration of NTM-contaminated water. NTM have a niche in surface water and due to cellular impermeability are 100 times more resistant to disinfectants than E. coli, upon which drinking water regulatory standards are based. Thus, NTM can by-pass drinking water treatment and have been shown to proliferate in household plumbing biofilms after chlorine-sensitive competitors have been inactivated. The burden of NTM in NJ waters is unknown. Few surveys for the opportunistic pathogen NTM have been performed in surface water and none in NJ. However, insurance data indicated that clusters of NTM disease are present in NJ including in areas where the source of drinking water includes the Raritan. A comprehensive framework to address the rising challenge of NTM disease must include community-based environmental assessments. A cluster of doctors and scientists have formed at Rutgers Medical School, Public Health Research Institute, and Rutgers School of Engineering to address the NTM cluster in NJ through engineering, epidemiological, and clinical studies. Our team currently has a small seed grant from NJ Department of Health ($12,785) to study the prevalence of NTM in private wells (the DOH funding is restricted to studying private wells) but we have noted that everyone in our patient cohort recruitment thus far has had public water supply. The R3C funding would be an ideal opportunity to expand our study to surface water and citizens drinking the Raritan, taking advantage of the fact that we already have methods and IRB approval in place (meaning an amendment is all that would be needed to recruit more participants). Thus, this support would allow us to understand better the sources of NTM in NJ toward protecting public health.

The aims of this work are to screen both the Raritan and treated water in the homes of consumers drinking treated water from the Raritan to determine the prevalence of NTM in both the source water and premise plumbing biofilm. The microbiome for select samples with and without NTM will be determined to provide insight into the conditions allowing for NTM proliferation. To achieve these aims, biofilm samples will be collected from the homes of a cohort of NTM patients (if available) and the general public volunteers that use the Raritan as their drinking water source. Data will also be collected on the factors expected to promote the growth of opportunistic pathogens

(i.e., the premise plumbing pipe material, water heater temperature). Samples will be collected from the Raritan River and D&R canal near drinking water intakes for the water treatment plants serving the community on a biweekly basis to establish the natural prevalence of Mycobacterium and NTM in the basin. A total of up to 86 samples are proposed (biofilm: 50 homes + water: 3 sites × 6 months × 2 times a month). The results will provide insight into the prevalence waterborne pathogen NTM in NJ and serve as preliminary data for a larger multi-pronged epidemiological study of NTM in NJ that represents an interdisciplinary collaboration between faculty in Rutgers Civil & Environmental Engineering and NJ Medical School.

Thomas Grothues (Dept. Marine & Coastal Sciences, SEBS) and Isabelle Stinnette (NY-NJ Harbor & Estuary Program), $8,000 award for "Aquatic Connectivity and Climate-Ready Streams Assessment"

Aquatic connectivity of fish and other organisms along and among streams has been studied in the Raritan watershed with respect to dams, however, the effectiveness of fish passage at road-stream crossings, such as culverts, has not been assessed. In many areas, the size and condition of the culvert or crossing structure has not been inventoried and thus data is lacking to adequately produce hydraulic models related to connectivity for these small tributaries.

This project will, 1) Utilize a popular protocol to assess crossing structures in one subwatershed of the Raritan River for aquatic connectivity. The scores produced by this protocol allow for an assessment of prioritization for restoration of problematic road-stream crossing structures. 2) Provide data on culvert size, material and condition for hydraulic models, and 3) Train 2 teams of 3 each Rutgers students to be Observers in the assessment protocol developed by the North Atlantic Aquatic Connectivity Consortium (NAACC).

Following the assessments, project partners will review the assessment data, hydraulic capacity modeling and other observations to make recommendations (as needed) for restoration of any road-stream crossings in the subwatershed. HEP will create a sharable fact-sheet about the subwatershed upon completion. Students will have access to all data to present.

Julie Lockwood (Dept. Evolution and Natural Resources, SEBS) and Olaf Jensen (Dept. Marine & Coastal Sciences, SEBS), $8,000 award for "Development of an environmental DNA (eDNA) assay for monitoring the recovery of river herring in the Raritan River watershed"

Mid-Atlantic populations of river herring (*Alosa pseudoharengus*, alewife, and *A. aestivalis*, blueback herring) have declined precipitously in recent years. River herring are now listed as "Species of Special Concern" by the National Marine Fisheries Service. With over 1,700 dams in New Jersey, barriers to spawning migration are one of the most

important impediments to restoration of river herring populations in this state. Over the past seven years, four major dams have been removed within the Raritan River watershed with the goal of improving fish passage and restoring freshwater spawning habitat for river herring. Three major mainstem Raritan River dams were removed in three years: the Calco dam in 2011; the Roberts Street dam in 2012; and the Nevius Street dam in 2013. An additional dam on the Millstone River, a major tributary of the Raritan, was removed in 2017. Given all of the investment in dam removal, the pressing question is: to what extent have anadromous fish utilized the newly available upstream habitat? Dam removal can be an important component of anadromous fish restoration; however, we cannot assume that because a habitat is now physically accessible to anadromous fish it is being used. Thus, there is a clear need to document the effectiveness of dam removal on the use of upstream spawning habitat by threatened anadromous fish such as alewife and blueback herring.

Previously, physical sampling using nets and electrofishing has been the sole methods used to monitor recovery and habitat use of anadromous fish in the newly opened sections of the Raritan. However, physical sampling, with the exception of destructive methods like the piscicide rotenone, is inefficient at detecting species when present at low abundance, which is characteristic of those that are colonizing new locations. Environmental DNA (eDNA) has only recently been developed as a tool for surveying rare fish species, and is already being deployed in a variety of fisheries monitoring programs. The technique is ideally suited to documenting the presence/absence of endangered species within habitats where they are very rare. For example, eDNA is being used to monitor endangered bull trout over large drainages in the Western US. We propose to develop eDNA survey assays for tracking the return of river herring into habitat newly opened via dam removal in the Raritan River watershed.

Our primary goal is to develop and test a refined eDNA assay that can distinguish between these alewife and blueback herring, while also distinguishing between DNA from these two species and other co-occuring Alosine species (e.g., shad). Our previous experience in developing eDNA assays for insects suggests that using ribosomal DNA instead of mitochondrial DNA (the typical target of eDNA assays) will accomplish this goal, but it has not been tested for use in fish. Thus, the funds provided here allow us to explore this novel approach to developing eDNA assays for fish that can significantly expand the use of such a tool within fisheries restoration and management, while also allowing us to finalize a fundamental step toward using eDNA surveys to asses the success of dam removal on recovering river herring populations.

Establishing the feasibility, specificity, and sensitivity of our assay is a key first step to deploying a full-scale field survey across the watershed. Thus, these funds support research outputs that we can use to leverage full funding support from NJ DEP and/or NOAA for watershed-wide surveys next summer.

Dario Pompili and Mehdi Rahmati (both of Dept. Electrical and Computer Engineering, SOE), $8,000 award for "Near-real-time water quality monitoring in the Raritan River using hybrid vehicular-static stations"

Fixed water quality water monitoring stations with predefined configurations are currently deployed in the Raritan river, which is not a real-time and efficient solution to collect data as the phenomenon of interest may occur sporadically and propagate spatially through the water bodies.

The goal is to deploy a network of hybrid vehicular-static stations with adaptive spatial and temporal sensing resolutions. Instead of waiting for the pollution to reach the fixed stations, a team of underwater/surface vehicles chase the phenomenon of interest to collect the data. real time.

Several experiments will be conducted in the Raritan River over Summer and Fall 2019. The results will be disseminated through conference/journal paper submissions, presentations at technical meetings (including the 11th Annual Sustainable Raritan River Conference), and demonstrations.

Laura Reynolds (Rutgers Institute of Earth, Ocean and Atmospheric Sciences), Julie Blum (Dept. Ecology, Evolution and Natural Resources, SEBS), Kristen Joyse (Dept. Earth and Planetary Sciences, School of Arts and Sciences), Richard Lathrop (Dept. Ecology, Evolution and Natural Resources, SEBS), and Margaret Christie (Dept. Marine & Coastal Sciences, SEBS) $7,700 award for "Determining accretion rates and carbon content of tidal marsh sediments along the Raritan River and Bay: implications for tidal marsh resilience to future sea level rise"

Tidal marshes provide a range of ecosystem services such as carbon sequestration, water quality control, and habitat for ecologically and commercially important species. In addition, tidal marshes are thought to protect against storm surge inundation and wave erosion; an estimated $625 million of losses from Hurricane Sandy were prevented by the presence of tidal marshes in the Mid-Atlantic. Although New Jersey's tidal marshes appear to have kept pace with historical sea level rise in the pre-industrial period, accelerating rates of sea level rise coupled with land-use changes and sediment starvation may limit their resilience to future sea level rise. Potential future marsh loss will contribute not only to the loss of the habitat and protection they provide, but also to the release of their stored carbon. To identify areas where targeted conservation or restoration efforts would be most beneficial for communities and ecosystems, it is important to predict future marsh response to sea level rise (SLR). However, realistic modeling of future tidal marsh response to SLR requires site specific data on rates of accretion, edge erosion and upland migration. Currently, data on accretion\surface elevation change is lacking for tidal marshes of the Raritan River and Bay. Estimates of current and future carbon stored in tidal marshes (i.e., blue carbon) are also absent for this region.

Here we propose to use sediment core analyses to measure decadal-centennial accretion rates and carbon sequestration in the tidal marshes along the Raritan River and Bay to improve models of future marsh response to sea level rise. We will collect sediment cores at five tidal marsh sites (see attached map for proposed locations—exact location will depend on permits and accessibility). In each core, we will analyze the grain size, water content, bulk density, organic carbon content, and inorganic carbon content to determine the carbon stocks contained in the sediments. To calculate accretion rates through time, we will date the cores using radioisotopes Pb-210 and Cs-137. The grain size and density measured in tandem will allow us to "decompact" the sediments to calculate accurate, decadal accretion rates, which we can compare to contemporaneous local tide gauge records (Sandy Hook, NYC Battery, NOAA) to determine the extent of tidal controls on sediment accumulation. Previous sediment cores have been taken from or near several of our proposed sites. These studies focus on reconstructions of past environments and do not calculate carbon content or accretion rates through time; in addition, little to no core material remains from these studies and therefore we cannot recycle old cores for the analyses proposed here. However, we will be able to leverage the results of previous studies by using their published chronologies and stratigraphic and historical information to supplement new data generated.

David Tullock (Dept. Landscape Architecture, SEBS) and Colin Marx (Dept. Environmental Science, SEBS), $7,975 award for "#lookfortheriver: finding historic streams of the Lower Raritan Watershed"

The changing climate and development patterns of the Lower Raritan Watershed occur against a backdrop of substantial impervious surface coverage (approximately 34%), high population density, and significantly modified stream networks (e.g., stream straightening and burial, culverts, underground retention). Through hundreds of years of anthropogenic influence, the historic stream channels have been altered or "disappeared," resulting in increased flooding, compromised water quality, and decreases in aquatic and other species. The added influence of climate change heightens these impacts. In addition, many Lower Raritan Watershed municipalities have no way to understand the lost natural and cultural heritage represented by the historic hydrology, the failing underground infrastructure and the collapse of buried streams. This project will be first step towards capturing that lost heritage by creating new data while making existing records more widely available and used.

This research will develop a systematic approach to define, identify, and describe the progression of the geographic pattern of "hidden" and "dynamic" streams in the Lower Raritan Watershed — that is, those areas that no longer exhibit all of their surface stream channels due to the effects of human development and population growth. It will allow for creation of an organized system for relevant stream and hydrology maps and map downloads to assist in "finding" the lost and hidden waterways in our

watershed. This research is important as a way to understand our historic ecology and also to inform efforts that seek to use stream daylighting as a form of Green Infrastructure for stormwater management, water infrastructure management, and water quality improvements in our urban communities. Sharing the resulting data and materials will represent a first step towards the creation of a comprehensive data clearinghouse for the communities of this landscape.

The above research proposals were funded through the Rutgers' Raritan River Consortium (R3C) mini-grant and internship program in the Summer of 2019. The program is made possible with the support of Chancellor Christopher Molloy, Dean Piyushimita (Vonu) Thakuriah at the Edward J. Bloustein School of Planning and Public Policy, Executive Dean Robert Goodman at the School of Environmental and Biological Sciences, and the Johnson Family Chair in Water Resources and Watershed Ecology.

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.