Mini-Grant Recipient Descriptions for Website

Nicole Fahrenfeld, PhD (Dept. Civil & Environmental Engineering, RU-ENG) and Kristi MacDonald, PhD (Raritan Headwaters), "Controls on the Fate and Ecotoxicity of Microplastics in the Raritan River"

Microplastics (plastic <5mm diameter) are emerging contaminants of concern in the freshwater environment because of their potential negative impacts on aquatic ecosystems. Major sources of microplastics include personal care products (e.g., microbeads), synthetic microfibers in textiles, tires, cigarette butts, and the degradation of macroplastics. These plastics enter surface water by bypassing wastewater systems or through storm water. In our previous studies, we found wastewater treatment plants (WWTPs) to be a significant source of microplastics in the Raritan River and Bay. While we observed a moderate correlation between microplastic concentration and distance downstream, the pattern of residuals on this correlation provides evidence that other processes (e.g., skimming, settling, biological uptake) may be controlling microplastic fate. The relative importance of these phenomena in microplastics transport is poorly understood.

Plastic particles <300µm are less likely to be removed during wastewater treatment and upon release to our rivers these particles have increased bioavailability due to their small size. There is growing concern about microplastic ecotoxicity, which could be impacted by contaminants including biofilm growth on microplastic surfaces. Microplastic surfaces can develop biofilm rapidly with varying composition and concentration as influenced by the water source. Given that WWTPs are a source of microplastics and that untreated wastewater contains pathogens, the potential for the colonization of indicator organisms and pathogenic bacteria in microplastic biofilm is of interest.

The objectives of this research are to (1) provide insight into the role of microplastics as a unique environment for microbial growth in freshwater environments and (2) determine the role of settling as a control on microplastic fate downstream of sources (e.g., WWTP). To achieve these goals, a combination of field and laboratory studies will be performed by undergraduate researchers at Rutgers in collaboration with community partners, including a student intern, at Raritan Headwaters (RHA), a 501(c)(3) non-profit environmental group. This project will broaden the water quality data available on an emerging contaminant in the Raritan, foster a new partnership between RU and RHA, provide opportunities for undergraduate student research experiences, and facilitate a new training for citizen scientists.

Dr. Nicole Fahrenfeld is an Assistant Professor in Civil & Environmental Engineering. Her research interests include pathogen fate and transport, microbial source tracking, bioremediation, sand emerging contaminants. Dr. Kristi MacDonald is Director of Science at Raritan Headwaters. Her current research is focused on understanding how aquatic

ecosystems are affected by land use, pollution, invasive species and climate change in order to guide better decision-making to protect and restore water resources.

For more information, contact Dr. Nicole Fahrenfeld, nfahrenf@rutgers.edu.

Olaf Jensen, PhD (Dept. Marine and Coastal Sciences, RU-SEBS), with NJDEP, NJ Water Supply Authority, and New Jersey American Water Company, "Monitoring Fish Migration on the Raritan River: A Live Stream of Fish Ladder Passage"

Dams and weirs present obstacles for fish migrating upriver during spawning runs. With populations of American shad (*Alosa sapidissima*) and river herring (*A. pseudoharengus* and *A. aestivalis*) in decline in the Mid Atlantic region, it is important to understand the impacts of these obstacles to spawning migrations. Fish ladders are commonly installed near dams and weirs to allow migrating fish to continue their journey upstream to spawning habitat. However, the effectiveness of these facilities is species- and context-specific, and passage rates for species other than anadromous salmon are often extremely low.

This project would supplement an ongoing effort to monitor the passage of shad and river herring through the Island Farm Weir in Bound Brook, NJ, which, since the removal of the Calco dam, is now the first obstacle these species face in their annual migration up the Raritan River. Since 2011, in partnership with the New Jersey American Water Company and the New Jersey Department of Environmental Protection, the project has involved Rutgers faculty and research staff, the New Jersey Water Supply Authority, dozens of Rutgers students every year, and many local fishermen. The project currently monitors fish passage using a combination of Passive Integrated Transponder (PIT) tagging and a closed circuit video system. Each spring the project recruits undergraduate students and local volunteers to assist in the capture and tagging of American shad and river herring using a number of methods. The project is well known among local anglers, and has a strong following on social media.

Support from the Rutgers Raritan River Consortium would allow for the installation of a state of the art video system that would stream a live video feed from the fish ladder over the Internet. This presents an excellent opportunity for rapid data collection and to raise public awareness of the many fish species that live in the river and pass through the fish ladder each day.

Dr. Olaf Jensen is an Associate Professor in the Department of Marine & Coastal Sciences. His research focuses on fisheries and aquatic ecosystems, ranging from the Raritan River to global marine fisheries.

For more information, contact Dr. Olaf Jensen, ojensen@marine.rutgers.edu.

Josh Kohut, PhD (Dept. Marine & Coastal Sciences, RU-SEBS), and Robert Schuster (NJDEP Marine Water Monitoring Bureau), "2017 Raritan River Water Quality Sampling: Introducing Rutgers Students to NJDEP Sampling and Quality Control Standards"

One of New Jersey's greatest natural resources is its fresh and marine waters. These waters are a significant asset to the state for recreation, tourism, and as a food supply. Preserving this resource in its most naturally occurring condition is of great importance. The New Jersey Department of Environmental protection is charged with monitoring and assessing water quality standards throughout all state waters from inland freshwater ponds and streams to the coastal ocean. This is done through various monitoring programs. Parameters monitored include dissolved oxygen, pH, temperature, salinity, and turbidity.

The tidal Raritan River from the Rutgers campus in New Brunswick downstream to the river mouth, links freshwater monitoring programs upstream with the marine water monitoring programs downstream. This reach of the Raritan River remains a gap between these two water monitoring programs. The proximity of the Rutgers New Brunswick Campus to this stretch of the River and the recent introduction of the new R/V *Rutgers* sets up a great opportunity to fill this gap. The capability of the boat to accommodate up to 20 students enables us to incorporate student training into a program that could stand up a student led workforce to fill this water quality monitoring gap. Through a partnership with NJDEP, Rutgers undergraduate students will be trained on the proper way to monitor the tidal Raritan to ensure quality data can be ingested into the NJDEP data archive. It will be an important training opportunity for our students while simultaneously contributing to NJDEP and their important water quality monitoring activities.

The overall goal of this project is to fill a gap in water quality monitoring along the tidal Raritan River between the Rutgers New Brunswick Campus and the Raritan Bay. This will be done through a student lead sampling program aboard the newly acquired R/V *Rutgers*. Specifically, we will: (1) Train students on a series of four river surveys aboard the R/V *Rutgers* with NJDEP staff to sample four stations along the tidal Raritan River (Rutgers Campus, upstream of South River, downstream of South River, and the Raritan River mouth), and (2) Provide hourly student support for a student volunteer following each survey to prepare a survey data report suitable for submission to NJDEP as part of their monitoring.

Dr. Josh T. Kohut is an Associate Professor of Oceanography at Rutgers University. His interests include circulation processes that define the physical ocean that structures marine ecosystems and the application of ocean observing technologies including satellites, high-frequency radar, and underwater gliding robots as part of a research program that applies ocean observations to research and decision making. Robert Schuster is Interim Chief of the NJDEP's Marine Water Monitoring Bureau. He has responsibility for oversight of all NJDEP Marine Water Quality Monitoring, including sample collection, laboratory analysis, and data assessment.

For more information, contact Dr. Josh T. Kohut, kohut@marine.rutgers.edu.

Max Häggblom, PhD (Dept. Biochemistry & Microbiology, RU-SEBS), and wastewater treatment plants discharging to the Raritan, "Anaerobic Biodegradability of Pharmaceuticals and Personal Care Products in Raritan River Sediments"

Pharmaceuticals and personal care products (PPCPs) include a diverse array of thousands of chemical substances, including prescription and over-the-counter therapeutic drugs, veterinary drugs, fragrances, and cosmetics. These compounds are released directly or indirectly to the environment, but their long-term fate is poorly understood. Over the past decades PPCPs have emerged as a major group of environmental contaminants in numerous watersheds around the world. The continued introduction of new chemicals into the environment, such as the discharge of a plethora of PPCPs, requires new understanding of their behavior and environmental impact. PPCPs enter the environment through a variety of routes, but the primary pathway is through incomplete removal during the wastewater treatment process. They are biologically active and can thus pose adverse effects to aquatic biota. The goal of this research is to investigate the role of potential for biodegradation of PPCPs in the Raritan River watershed.

While there is an increasing body of work examining the fate of PPCPs in wastewater treatment plants (WWTPs) there has been less attention to factors affecting their biodegradability in the environment. PPCPs exit WWTPs largely untreated, but little is known about their fate in aquatic systems, in particular under anoxic conditions of the water column and sediment. This is a fundamental gap in our knowledge. An understanding of the factors affecting the fate and effects of PPCPs and their transformation products is needed to inform policies aimed at protecting aquatic ecosystems.

Our overall research goal is to determine the biodegradability and environmental fate of PPCPs and their metabolites. We postulate that the redox environment, and the availability of alternate electron acceptors, such as sulfate in estuarine sediments, will control the activity of microorganisms active in PPCP degradation. Our specific objectives for the Raritan River Consortium Mini-Grant is to determine how the redox environment impacts the biodegradability of a suite of PPCP compounds in anoxic sediments of the Raritan River comparing and contrasting, freshwater (and less impacted) sites with estuarine (and more polluted) sites at the mouth of the river.

This work will lay the foundation for determining how the redox environment impacts biodegradability of PPCPs. The longer-term goal is to identify novel anaerobic bacteria and their functional genes encoding for the enzymes responsible for the degradation of specific PPCPs in order to develop tools for monitoring the natural attenuation of these chemicals in aquatic sediments. Monitoring tools are key in gaining an understanding of how microbial processes, and thus remediation, are affected by different engineering approaches. Identification of the microorganisms mediating anaerobic degradation of different PPCP compounds will provide new bioindicators that allow for a more detailed assessment and monitoring of important microbial processes for use in combination with chemical monitoring.

We will assess the potential for microbial degradation and biotransformation of select PCPPs by establishing sediment microcosms from Raritan River locations representing a range of PCPP exposures (low to high) from rural to the urbanized areas, and freshwater to estuarine habitats.

Dr. Max M. Häggblom is a Distinguished Professor and Chair of the Department of Biochemistry and Microbiology. He has research interests in microbial ecology, environmental biotechnology and in the bioexploration, cultivation and characterization of novel microbes with an aim to apply understanding of microbial metabolic processes for development of bioremediation technologies for treatment of contaminated soils, sediments and groundwater.

Collaborators for this proposal include the Raritan Township Municipal Utilities Authority, Somerset Rartian Valley Sewage Authority, Middlesex County Utilities Authority, and Rahway Valley Sewerage Authority.

For more information, contact Dr. Max M. Häggblom, haggblom@rutgers.edu.

Beth Ravit, PhD (Dept. Environmental Sciences, RU-SEBS), and Keith Cooper, PhD (Dept. Biochemistry & Microbiology, RU-SEBS), with NY/NJ Baykeeper, "Microplastic Pollution in the Raritan River"

Plastic “microbeads” (pieces of plastic smaller than 5 mm - approximately the size of a grain of sand) came into widespread use beginning in the 1990s, particularly in personal care and cosmetics products. Napper et al. (2015) estimate that thousands of microbeads are released by an individual using as little as 5 ml of facial scrub exfoliant once a day; total daily microbead release into aquatic environments is estimated to be as high as 8 trillion microbeads a day. Recent research documents the presence of microbeads in freshwaters, including drinking water sources; however, the full extent or impacts associated with microplastic pollution are not well understood. Microplastics have been documented in fin fish and shellfish tissues, suggesting plastic pollution has the potential to move into human food chains. Microbead pollution in Raritan Bay was confirmed by a collaboration between NY/NJ Baykeeper and Rutgers Center for Urban Environmental Studies (CUES) based on samples collected in 2015. During summer 2016 we sampled five additional locations in the Raritan River, ranging from a freshwater reach in Berkeley Heights to an estuarine tidal reach in Sayreville, and found densities as high as 1,000,000 to 1,900,000 microplastics/km2. However, these data reflect only one sampling event per location under dry conditions, and so additional data is needed to accurately reflect Raritan River microplastic densities and as an aide in source tracking. We are in the process of exposing fish embryos to the Raritan microplastics, and there appear to be observable effects after exposure to the plastic particles. In collaboration with the Rutgers Environmental & Occupational Health Sciences Institute (EOHSI) and NOAA (Sandy Hook), we will also be analyzing plastic samples from the Raritan River to determine potential plasticizers susceptible to leaching, as well as the composition of sorbed organic contaminants.

We will utilize the Rutgers Raritan River Consortium funding to expand our sample collections to an additional five locations in the freshwater portion of the Raritan River and to conduct

multiple sampling events at both the new and the original (2016) sampling locations under wet and dry conditions during the spring-summer of 2017 (N = 10 locations x 3 dry sampling events and at least 2 wet weather sampling events > 50). Samples will be processed in the Rutgers environmental science teaching lab to separate plastic particles of various sizes from biotic organic materials in order to calculate the mean density and type of microplastic(s) collected at each sampling location.

Dr. Beth Ravit is an Assistant Research Professor in the Department of Environmental Sciences. Her research focus is rehabilitation of the Hudson-Raritan Estuary, with emphasis on the region's wetlands and coastal resiliency. Dr. Keith Cooper is a Professor in the Department of Biochemistry & Microbiology. Dr. Cooper's research includes human risk assessment from contaminants that impact both humans and aquatic animals. This training as a comparative toxicologist allows the examination of a chemical's effect on different levels of ecological organization, going from molecular to population effects.

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For more information about the **Rutgers Raritan River Consortium** or this mini-grant program, contact Sara J. Malone, sjmalone@ejb.rutgers.edu.