HUDSON RIVER
ENVIRONMENTAL SOCIETY

# 2018 Hudson River Symposium

## Contaminants in the Hudson River and Watershed:
## *A Look at the Status, Trends, and the Response of Natural Resources*

**Wednesday May 2, 2018**
**Student Union Building**
**State University at New Paltz**
**9:00 AM - 5:30 PM**

**Polychlorinated biphenyls (PCBs) have been a part of the Hudson River ecosystem for decades. Between 2009 and 2015, EPA estimates that General Electric removed 310,000 lbs. of PCBs from the upper Hudson River. This one day symposium will explore the long history of environmental contaminants, present current status of the PCB clean-up with insights to the future, and discuss the potential effects of perfluorinated chemicals recently detected in fish and water within the watershed. Additional presentations will provide information on manufactured gas plant site remediation, potential ecological effects of microplastics, and the biodegradation of persistent organic pollutants.**

**The day will conclude with a contributed poster reception presenting a vast array of research and monitoring programs and results from the Hudson River Watershed.**

## *Symposium Sponsors and Collaborators:*

# *Thank you!*

The Hudson River Environmental Society wishes to thank the following people for their invaluable help in developing today's agenda: *Yu Chen, Sean Madden, Wayne Richter, Larry Skinner, Dennis Suszkowski, and Ike Wirgin.*

We also thank today's speakers and poster presenters for their commitment to present their latest work and knowledge on the complex interactions of humans and the Hudson River environment.

HRES is very grateful for today's sponsors whose generosity allows us to keep the costs down for all of the conference participants:

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We are also very grateful to our Grady Moore Student Fund raffle contributors:

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We thank the Benjamin Center and SUNY New Paltz, in particular Gerald Benjamin and Janis Benincasa for their logistical and academic support.

We wish to thank our individual members for your continued financial support of our efforts to bring contemporary scientific and environmental issues and information to the Hudson Valley.

Finally, HRES would like to acknowledge the 2018 HRES Board of Directors:

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# 2018 Hudson River Symposium: Contaminants in the Hudson River and Watershed
## *A Look at the Status, Trends, and the Response of Natural Resources*

State University of New York at New Paltz,
Student Union Building
May 2, 2018, 8:45 AM - 5:30 PM

8:00 – 8:45: Registration and Light Breakfast

8:45 – 9:00: Welcome – HRES and the Benjamin Center, SUNY New Paltz

***Polychlorinated Biphenyls (PCBs) – History, Status on the Hudson, and What's to Follow***

9:00 – 9:25 - **The Environmental History of PCBs – Why are there PCBs in the Hudson River?** *Simon Litten, Ph.D., Division of Water, New York State Department of Environmental Conservation (Retired).*

9:30 – 9:55 **Hudson River PCB Site Remedial Program – State Perspectives on Remedy Performance**. *Kevin Farrar, Division of Environmental Remediation, New York State Department of Environmental Conservation*

10:00-10:25 **Hudson River PCB Superfund Site – EPA Project Update.** *Gary Klawinski, Director, U.S. EPA Hudson River Field Office.*

10:30 -11:00 ***Coffee Break, Registration, and Poster Set-up***

11:00-11:25 **An Independent Evaluation of the Effectiveness of the Hudson River PCB Dredging Program.** *Kevin Farley, Ph.D., Manhattan College*

11:30 - 11:55 **Are PCBs and PCDD/Fs Toxic to Hudson River Fishes?** *Isaac Wirgin, Ph.D., Department of Environmental Medicine, New York University School of Medicine*

12:00 – 12:30 **Panel Discussion** – *Chaired by Dennis Suszkowski, Ph.D., Science Director, Hudson River Foundation*

12:30– 1:30 ***Lunch (Provided)***

***Remarks by Martin Brand***
***Deputy Commissioner for the Office of Remediation & Materials Management***
***New York State Department of Environmental Conservation***

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***Contaminants of Emerging Concern, Cleaning-up the Past and Microbial Degradation***

1:30 – 1:55 **Historical Perspectives on Global Distribution, Bioaccumulation and Sources of Perfluoroalkyl Substances.** *Kurunthachalam Kannan, Ph.D., Deputy Director Division of Environmental Health Sciences, NYS Dept. of Health, Wadsworth Center*

2:00 – 2:25 **Perfluoroalkyl Substances in the Hudson River Watershed: What We Found for PFOS and PFOA –** *Wayne Richter, Bureau of Habitat, Division of Fish and Wildlife, New York State Department of Environmental Conservation*

2:30 – 2:55 **Manufactured Gas Plants - Status of DEC's Investigation and Remediation Program & Ecological Considerations.** *George Heitzman, P.E., Division of Environmental Remediation, New York State Department of Environmental Conservation*

3:00 – 3:25 **Biodegradation of Persistent Organic Pollutants.** *Max Haggblom, Ph.D., School of Environmental and Biological Sciences, Department of Biochemistry and Microbiology**, Rutgers University***

3:30 – 3:55 **Characterization of Microplastics by Using a Novel Method of Pyrolysis GC-MS.** *Ashok Deshpande, Ph.D., NOAA Fisheries, Sandy Hook Laboratory*

3:55-4:00 **Final Remarks**

4:00 – 5:30 ***Poster Session, Reception and Student Travel Fund Raffle***

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***Hudson River Environmental Society***
***Fall Eco-Tour:***
***The Upper Hudson River of***
***Washington County***
***Saturday September 22, 2018***

General Electric Manufacturing Plant
Hudson Falls, New York

The 13,000 square mile Hudson Basin contains diverse physiographic and social regions. The Hudson River Environmental Society has sponsored tours to visit some of these regions and interact with knowledgeable residents and experts. This year we will tour a part of the Upper Hudson in Washington County. The tour begins on Rogers Island at Fort Edward. Fort Edward was the site of one of General Electric's (GE) capacitor manufacturing plants. This facility, as well as another upstream in Hudson Falls, used polychlorinated biphenyls (PCBs). PCBs, which are now considered a toxic substance, entered the river. GE recently completed a remediation project in the river. GE and New York Department of Environmental Conservation experts will give their perspectives of this work. After a morning of science and engineering we will travel by bus for lunch and a talk about Washington County agriculture at the Gardenworks Farm in Salem, NY. During the half hour ride to Salem Stephen Lapham of the Washington County Historical Society will talk about the area's history. After lunch and a farm tour we will go to the Battenkill Creamery for a visit to the milk bottling plant and ice cream.

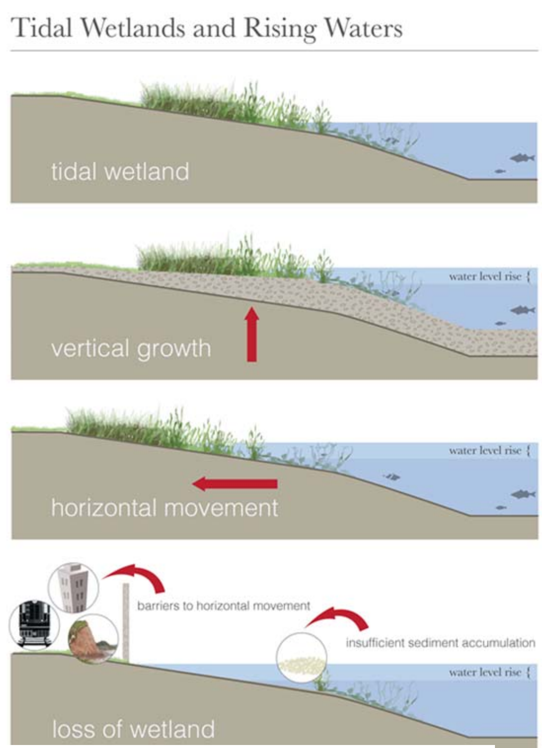
Gardenworks Farm
Salem, New York

*Spring 2019 Hudson River Symposium:*
*Wednesday May 1, 2019*
*Student Union Building*
*State University of New York at New Paltz*

# Vulnerability of Hudson River Habitats to Climate Change

Climate change is having devastating effects in the watershed of the Hudson River. Floods have threatened lives and destroyed homes forcing us to change how we manage lands and build infrastructure. Like human communities, climate change is altering the natural communities in the estuary and watershed. Changing sediment dynamics in the river have altered aquatic habitats and could lead to shifts in fish and wildlife communities. Sea level rise may alter tidal wetlands. How will decisions to protect human communities affect the natural resource of the Hudson River?

In 2019, HRES will provide a forum to present the state of the science and provide an opportunity for us to discuss how we should react in the future.




L. Tumbelty, Cary Institute of Ecosystem Studies

# SPEAKER ABSTRACTS

### Characterization of Microplastics by Using a Novel Method of Pyrolysis GC-MS

Ashok Deshpande
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NOAA Fisheries, Sandy Hook Laboratory, Highlands, NJ

Plastics are contaminants of emerging concern that are accumulating at increasing rates in the marine and freshwater ecosystems. Some scientists refer to plastics as the next predator of wildlife. Because of the sun and wave energy, the plastics tend to break down into smaller particles, called the microplastics of grain size lower than 5 mm. Microplastics also enter the aquatic environments directly from a variety of sources, including cosmetics, clothing, and industrial processes. Microplastics are a cause for concern because their size range overlaps with the preferred particle size ingested by the animals at the base of the aquatic food webs. We seek to characterize microplastics polymer types by using a novel method of pyrolysis gas chromatography-mass spectrometry (GC-MS). In this method, a small piece of microplastic sample, less than 1 milligram in weight, is placed in a narrow quartz tube which is then placed in a platinum coil and heated to 750 degrees C. The intense heat breaks down the large plastic polymer chain into smaller fragments. The pyrolytic fragmentation patterns are reproducible and unique to a given polymer type. These fragments are then transferred to and separated on a gas chromatographic column and identified using a mass spectrometer. We have created a pyrolysis GC-MS library of some of the most commonly used plastics polymers. The next step in this effort is the characterization of the weathered field samples. Understanding the nature of microplastics is critical to the identification and possibly the regulation and mitigation of sources of plastics that can impact the quality of bivalve and fish habitats as well as that of the aquaculture facilities. As different types of plastics exert different toxicities by themselves, and as in addition they adsorb different levels of chemical contaminants, the knowledge of polymer composition is important to the understanding of fisheries risk assessment.

**An Independent Evaluation of the Effectiveness of the Hudson River PCB Dredging Program**

*Kevin J. Farley*
*kevin.farley@manhattan.edu*

*Joel E. Baker*
*University of Washington*

*W. Frank Bohlen*
*University of Connecticut*

*W. Rockwell Geyer & David K. Ralston*
*Woods Hole Oceanographic Institution*

*Simon Litten*
*Albany NY*

In February 2002, the General Electric Company (GE) was ordered by the U.S. Environmental Protection Agency (EPA) to conduct targeted dredging of PCB-contaminated sediment in a 40-mile stretch of the Upper Hudson River between Fort Edward and Waterford, NY. GE performed dredging of the Upper Hudson in two phases, beginning in May 2009 and ending in October 2015. Following completion of dredging operations, the Hudson River Foundation convened an expert panel to evaluate the effectiveness of the dredging program on the Upper and Lower Hudson. Based on water column and fish monitoring data and other information that were available through December 2016, the panel concluded: (i) the dredging program met mass removal targets for PCB-contaminated sediments, (ii) the dredging program was effective in reducing PCB concentrations in fish from Thompson Island Pool, (iii) post-dredging PCB concentrations in fish downstream of Thompson Island Pool showed mixed results, (iv) the reduction in Tri+ PCB loads to the Lower Hudson during the 2016 post-dredging period were in part due to below-average flows in the river, (v) water column, sediment and fish in the Lower Hudson below Albany are showing slow responses to the Upper Hudson dredging program due to the complexities of sediment transport in the Lower Hudson, and (vi) additional years of natural attenuation will be required to reduce PCB concentrations in fish throughout the Upper and Lower Hudson to acceptable levels. Modifications to the post-dredging monitoring program and continued evaluation of the next few years of monitoring data are therefore recommended to assess if natural attenuation will be sufficient in reducing PCB concentrations in fish in a reasonable time frame or if additional remedial actions will be required.

## State Perspectives on Hudson River PCB Site Remedy Performance

*Kevin L. Farrar*
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*Division of Environmental Remediation, NYSDEC*

The approach to remediation of the PCB pollution in the upper Hudson River was described in the Record of Decision (ROD) issued by the United States Environmental Protection Agency (EPA) in 2002 for the Hudson River PCBs National Priorities List Site. In the ROD, EPA set quantitative Remedial Action Objectives to achieve human health and ecological risk reduction, and detailed the remedial approach for the site. This approach – a combination of upstream source control, targeted sediment removal, and monitored natural attenuation (now called monitored natural recovery) was selected in consultation with, and with the concurrence of, the State of New York. This presentation focuses on the State's perspective on the elements of the selected remedy in the ROD, on the progress of State-led efforts to accomplish upstream source control, and on the current state of the EPA-lead remedial program for the upper Hudson, and offers a path forward for achieving the goals of the remedy.

## Biodegradation of Persistent Organic Pollutants

*Max M. Häggblom*
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*Rutgers University*

Microbial degradation is one of the key factors that determine the ultimate fate of pollutant chemicals in the environment. Natural microbial communities can play a key role in improving water and soil quality through the process of biodegradation, which offers an approach towards eventual detoxification and complete degradation of persistent organic pollutants. Our aim is to elucidate the diverse catabolic activities of microbes mediating biodegradation of key organic pollutants, including polychlorinated dibenzo-*p*-dioxins and dibenzofurans, the fuel oxygenate methyl tert-butyl ether, and an array of pharmaceuticals and personal care products. Aquatic sediments are significant sinks for many of these compounds and we have therefore focused on investigating the activity of anaerobic bacteria in anoxic sediments. Understanding the microbial processes that control the fate of persistent organic compounds will in turn lay the foundation for harnessing the activities of bacteria in the development of novel bioremediation strategies. For example, stimulating anaerobic biological dehalogenation offers one of the most promising approaches towards eventual detoxification and complete degradation of halogenated contaminant mixtures. Identification of the microorganisms responsible for the biodegradation activity can help us better understand degradation processes in the field and determine biomarkers for these processes. New molecular tools are being developed to monitor the abundance and activity of bacteria mediating biodegradation which can be applied for monitoring natural attenuation and assessing the effectiveness of the remediation treatments.

## Manufactured Gas Plants -Status of DEC's Program & Ecological Considerations

*George Heitzman*
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*Division of Environmental Remediation, NYSDEC*

New York State DEC has one of the most aggressive MGP site investigation and remediation programs in the country. Nearly 275 former gas manufacturing and storage sites have been identified in New York, most located adjacent to waterbodies. Challenges in investigating and remediating MGP tar impacts in sediments include distinguishing MGP-related PAH contamination from urban runoff and other PAH sources, assessment of PAH toxicity to benthos, and the resulting selection of sediment PAH cleanup goals as part of MGP site remedies. The physical and chemical nature of MGP tars, methods of distinguishing PAH sources using forensic chemical techniques, and recent developments in evaluating the toxicity of PAH mixtures will be reviewed using case studies. Other ecological considerations in implementing sediment remedies for Hudson River MGP sites will be discussed, including the use of man-made versus natural backfill and the effect of schedule restrictions ("fish windows") on dredging projects.

## Historical Perspectives on Global Distribution, Bioaccumulation and Sources of Perfluoroalkyl Substances

*Kurunthachalam Kannan*
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*New York State Department of Health, and Department of Environmental Health Sciences, School of Public Health, State University of New York at Albany*

Perfluoroalkyl substances (PFASs) are a class of fluorochemicals manufactured for their unique chemical stability and surface-tension lowering properties. Following several decades of commercial use, several of the PFASs have been discovered to be globally distributed. Our research interests are in the areas of identifying sources, pathways and distribution of PFASs in the environment. PFASs and related fluorinated compounds are used in a variety of consumer products including non-stick cookware and microwave popcorn bags. We identified and measured PFASs released from non-stick coated cookware into the gas phase under normal cooking temperatures. PFASs present in several consumer products can ultimately be released into wastewaters from domestic, commercial and industrial sources and be directed to wastewater treatment plants (WWTPs). We measured concentrations and fate of several PFASs in WWTPs in New York State. Our results suggested that for every million gallons of domestic and commercial waste treated, a typical WWTP will discharge 27 mg of PFOS and 1.3 g of PFOA, and that WWTPs are major sources of PASs to the aquatic environment. Contamination of aquatic environment and aquatic animals by PFASs is mainly through wastewater discharge. Some PFASs have been found at higher concentrations in predators, than in their diet. We measured the occurrence of PFASs in natural waters, lower trophic organisms, sport fish, birds, and aquatic mammals. We also analyzed several oceanic fish, especially skipjack tuna, collected from several oceans and found that the pattern of PFASs in tuna vary depending on the location.

This showed the existence of unique sources and transport pathways of PFASs in the global environment. Our results provide evidence that some PFASs are bioaccumulative and human exposure to these chemicals are widespread on a global scale.

## Hudson River PCB Superfund Site – EPA Project Update

*Gary Klawinski*
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*U.S. EPA Region 2, Emergency & Remedial Response Division*

In February, 2002 EPA issued a Record of Decision (ROD) for the Hudson River PCBs Superfund Site that called for targeted environmental dredging of approximately 2.65 million cubic yards of PCB-contaminated sediment from a 40-mile section of the Upper Hudson River. This Superfund site extends from Hudson Falls NY south for 200 miles to New York City.

The cleanup of the Hudson River occurred in two phases. Phase 1 of the project was conducted by GE with oversight by EPA from May to November 2009. During this phase, approximately 283,000 cubic yards of PCB-contaminated sediment was removed from a six-mile stretch of the Upper Hudson River near Fort Edward, NY. After an extensive evaluation by an independent panel of scientists and input from a broad range of stakeholders, EPA developed plans for the second part of the cleanup.

Phase 2 began in June, 2011, and was conducted at full production to remove the remainder of the contaminated river sediment targeted for dredging. Phase 2 was completed in 2015 with a total volume removed of 2.7 million cubic yards of sediment.

This presentation will provide a summary of the progress to date for this historic, high profile, and very important project. The project update will include work associated with monitoring the long term recovery of the river (water, sediment and fish), EPA's recent draft five-year review of the project, the comprehensive study of the 6,000 acres of floodplain, and other related project activities.

## Industrial History of PCBs

*Simon Litten*
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PCBs originated in Swann conglomerate in Alabama that made artillery shells, ferromanganese, and phosphates. In 1920 the conglomerate's owner, Theodore Swann, met a customer wanting tank cars of biphenyl. Swann chemist Russel Jenkins devised a rough process for making biphenyl. In 1929 a roofing manufacturer wanted a substitute for polychlorinated naphthalene to be an additive in a mixture of asphalt and asbestos. In response Jenkins invented PCBs. In 1920s varnish was made with highly flammable nitrocellulose that could be made safer by adding PCBs. However, Jenkin's biphenyl process generated colored by-products rendering it unsuitable for use in clear varnish. Jenkins redesigned the process to reduce the amount of by-products some of which are dioxin-like when chlorinated. The 1920s rapidly expanding electrical industry was being retarded by the failure of existing transformer fluids at high voltages. PCBs were a solution. In WWI chlorinated rubber was used for aircraft and dirigible fabric "dope". Chlorinated rubber was brittle and had poor adherence but beginning in the late 1930s PCBs were added as plasticizers. PCB augmented chlorinated rubber was used in paints and concrete sealers. During WWII aircraft designers reduced wind resistance with hydraulic retractable landing gear. PCB hydraulic fluids in aircraft met the demanding environmental conditions and, in combat aircraft, the necessary fire resistance. In 1940 National Cash Register invented a coating of PCB microcapsules to hold chemicals that would form a pigment when broken eliminating the need for carbon paper. GE had been using xylenols as a dielectric in capacitors but as early as 1938 found PCBs to be better both as a dielectric and as a plasticizer for the cellulose acetate films in the capacitors. PCBs continue to be produced inadvertently in the manufacture of certain organic pigments and in silicone sealants.

Because of these and many other applications PCBs became deeply embedded in the built environment. However, there were always readily available substitutes when PCBs were banned.

## Perfluoro Alkyl Substances in the Hudson River Watershed: What We Found for PFOS and PFOA

*Wayne Richter*
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*Jesse Becker*
*Bureau of Habitat, Division of Fish and Wildlife,*
*New York State Department of Environmental Conservation*

Following discovery of PFOA in well and surface waters near Hoosick Falls and Petersburgh, and PFOS near Newburgh, the New York State Department of Environmental Conservation did an intensive study of these and other PFAS in fish from these areas. DEC Fisheries staff collected two to six species of fish from five potentially affected waters plus one reference site near Hoosick Falls and Petersburgh, and from six potentially affected waters plus one reference site near Newburgh. We analyzed edible-size sportfish in three portions: (1) a standard fillet to evaluate potential human health risk from consumption, (2) the viscera to evaluate tissues thought to have the highest potential concentrations, and (3) the remaining carcass so that whole fish concentrations could be calculated from the three components to evaluate potential risks to piscivorous wildlife. We also analyzed smaller forage fish as whole fish for this same goal. PFAS were detected in all 310 fish and 698 samples, including those from reference sites. PFOS was the dominant PFAS in both frequency (99%) and concentration. Concentrations were highest in viscera with a maximum of 3,360 ppb, intermediate in carcasses, and lowest in fillets. At the six non-reference sites in Newburgh and at a pond near the Hoosick Falls landfill, PFOS concentrations were high enough for the New York State Department of Health to issue advisories against eating fish until further notice. PFOA, an eight-carbon acid, was detected in low concentrations in almost half the samples. The longer 10-, 11- and 12-carbon acids were detected in 75% to 88% of the samples, typically at concentrations somewhat higher than PFOA but much less than PFOS. Findings support the hypothesis that PFAS are pervasive in fish and can be found at high concentrations near release sites.

### Are PCBs and PCDD/Fs Toxic to Hudson River Fishes?

*Isaac Wirgin*
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*Nirmal K. Roy & Allison Candelmo*
*Department of Environmental Medicine, NYU School of Medicine*

*Ehren Habeck*
*R. Christopher Chambers*
*Northeast Fisheries Science Center, NOAA Fisheries*

The Hudson River fish community has been chronically exposed to PCBs, PCDD/Fs, and a variety of other toxicants for at least 70 years, however, the actual toxic effect of exposure on populations in the tidal estuary (downstream of the Federal Dam) is largely under investigated. While young life-stages of many fishes are often especially sensitive to these toxicants, there are orders of magnitude differences among species and even populations in their responses. Several eco-epidemiological studies have suggested little or no correspondence between exposure to PCBs and toxic effects in several upriver Hudson River fishes. However, in controlled laboratory studies with Atlantic tomcod and both Hudson River sturgeons, we have observed positive relationships between levels of exposure and molecular and higher-level perturbations in young life-stages that likely have impaired recruitment to natural populations. For example, the Hudson River tomcod population, which at one time exhibited one of the highest frequencies of hepatic tumors ever observed in a natural population is now highly resistant to coplanar PCB and TCDD toxicity at the molecular and organismic levels. In fact, our genomic studies have demonstrated that the resistant phenotype is more pervasive than previously reported. Similarly, early life-stages of both sturgeon species have proven to be vulnerable to a variety of developmental toxicities at environmentally relevant levels of TCDD and coplanar PCBs suggesting that sturgeons are among the more sensitive of fishes to these xenobiotics. In recent studies, we have evaluated the interactive effects of binary combinations of stressors on toxic responses in these species including exposure to Hg and TCDD in tomcod, and a warming environment and PCBs in sturgeons. We recommend that future studies, in addition to addressing body burdens of PCBs and PCDD/Fs in fishes in the tidal estuary, should also evaluate the damage that chronic exposure to these toxicants may have caused to these downstream populations.

# POSTER ABSTRACTS

### Hale Creek Field Station

*David Bryk*
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*Tanya Jasewicz, Haleigh Dutcher, Katryn Williams, Brian Buanno, John Finn, Mark Aboumrad*
*NYS Dept. of Environmental Conservation, Bureau of Habitat, Division of Fish and Wildlife*

The Hale Creek Field Station ("HCFS"), located in Gloversville New York, is operated by the New York State Department of Environmental Conservation. HCFS is the only New York State operated laboratory that analyzes fish and wildlife tissues from animals collected all across New York for legacy contaminants (*e.g.*, PCBs, Organic Pesticides, and Hg) and contaminants of emerging concern (*e.g.,* perfluoroalkyl substances, PFAS). The resulting data are used by New York State Department of Health to develop health advice on eating sportfish and game. These data are also used to determine ecological impacts of environmental contaminants and to track the recovery of organisms following a superfund clean-up. Essentially, all of the work being conducted at Hale Creek since the 1970s is dedicated to safeguarding the fish and wildlife resources of New York. In addition to analyzing fish and wildlife for contaminants, the Hale Creek Field Station contains stocked fish ponds and raceways as well as miles of hiking trails for the public to enjoy and hosts an annual environmental science day event for local 7$^{th}$ graders.

### Daylighting Effects on Bacterial Die-Off in the Saw Mill River

*Liliana M. Calix*
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*Kyle Quinn, Nelson Da Luz, Kevin J. Farley*
*Manhattan College*

In the early 1900s, the lower portion of the Saw Mill River was channelized and covered by concrete to allow for urbanization of downtown Yonkers. In 2011, a three-block section of the river in downtown Yonkers was uncovered and the adjacent land was converted into park land as part of a revitalization project. Although the daylighting of the river is considered a huge success, the potential benefit on water quality has received little attention. Previous studies on the river indicated high levels of bacterial contamination, particularly in Yonkers. This study evaluated the effects of daylighting on bacterial contamination in the daylighted section of the river. Fecal coliform and enterococcus concentrations were measured at the beginning and end of the daylighting. Bacterial concentrations were also measured over time in in-stream "light-dark" bottles to evaluate the effects of sunlight on bacterial die-off rates. Monitoring results showed a large (70-80%) and statistically-significant decrease in bacterial counts from the beginning to the end of the daylighting. This result was somewhat surprising given the relatively short travel time (approximately 45 minutes) through the three-block daylighted section. Light-dark bottle test results confirmed that the large decrease in bacterial counts was largely due to sunlight and daylighting. Enterococcus die-off followed first order kinetics in both light and

dark bottles, with rates 6-7 times faster in the light bottles. Fecal coliform die-off, which was also faster in the light bottles, followed biphasic behavior, with a fast initial rate followed by a slower die-off rate.

## Restoration of Shallow Water Habitat in the Upper Hudson River Estuary: Learning from the Columbia River Estuary

*Candice Constantine*
*cconstantine@interfluve.com*

*Caitlin Alcott, Matt Cox, Gardner Johnston*
*Inter-Fluve, Inc.*

The upper Hudson River Estuary has been heavily altered to support industry, agriculture, and population growth. One significant historical change has been the conversion of shallow water habitat to deep water and upland habitats as a result of dredge and fill activities for navigation. In recent years, restoration of ecosystem complexity and function have been recognized as key to ensuring the health and continued richness of the estuary for the benefit of nature and society alike. Progress in the restoration of other estuaries that have undergone similar historical transformations can provide valuable lessons and transferrable approaches to help facilitate restoration efforts.

The Columbia River Estuary, for example, has seen over 200 restoration/conservation projects covering over 23,000 acres since 2000. Much of this activity has focused on an objective shared with the Hudson River Estuary Program and other groups working in the estuary: Restoration of shallow water habitat, which provides important feeding and refuge areas for many species and life stages of fish, birds, amphibians, and invertebrates.

Inter-Fluve has been active in the restoration of the Columbia River Estuary since 2007. In this poster submission, we describe the ecosystem benefits of shallow water habitat and present case studies of completed off-channel restoration projects in the Columbia River Estuary along with post-construction observations of water quality and use by native fish species. We also include some practical considerations of designing and constructing estuary restoration projects and ways these lessons learned might be relevant to pending Hudson River Estuary initiatives.

## Trees for Tribs' Monitoring Program: Past and Future Directions

*Alex Curtze*
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*Beth Roessler*
*New York State Department of Environmental Conservation*

Trees for Tribs (TFT) is a program run by the New York State Department of Environmental Conservation (NYS DEC) that provides free trees and shrubs to public and private landowners for riparian buffer plantings. Every year, Student Conservation Association (SCA) members monitor previous TFT plantings in the Hudson Estuary watershed to assess seedling survival rates, health and size, and damage sources (e.g., browse) to better inform future management decisions and maximize seedling growth and survival. We present the analysis of monitoring data from 2011-2017 and the experimentation with a new monitoring methodology. The analysis showed that buffer age, plant type (i.e., shrub, tree), and certain damage sources significantly correlated with seedling survival. However, the monitoring protocol disproportionately sampled the smaller (<0.5 ha) and younger (<5-6 years) plantings because of time constraints in monitoring more complex and larger buffers. To address these hurdles, I am investigating a monitoring system that accommodates the heterogeneity of TFT plantings, can be easily implemented by future SCA members, is statistically valid, and is time efficient. Preliminary data suggest that using systematic fixed-area plot sampling may satisfy these criteria, but needs further field-testing before adoption.

## Comparison of two commonly used fecal indicator bacteria in waterways of the Hudson River Watershed


*Jennifer Epstein*
*jepstein@riverkeeper.org*

*John Lipscomb & Dan Shapley*
*Riverkeeper*

*Barbara Brabetz & Neil Law*
*SUNY Cobleskill*

*Eli Dueker*
*Bard College*

*Andrew Juhl & Carol Knudson*
*Lamont-Doherty Earth Observatory, Columbia University*

*Greg O'Mullan*
*CUNY Queens College*

*Carolyn Rodak*
*SUNY Polytechnic*


Management actions that aim to protect public health and improve the quality of waterways rely upon the use of standard methods for the collection and interpretation of monitoring data. *Enterococci* and *Escherichia coli* have each been recommended by the US Environmental Protection Agency (EPA) as fecal indicator bacteria (FIB) to assess recreational water quality in fresh water. The EPA's epidemiologically-based water quality thresholds are designed to be equally protective of human health, but occur at different concentrations for the two FIB groups, possibly reflecting differences in initial source concentrations and different ecological dynamics following discharge.

We collected samples to enumerate both FIB from waterways throughout the Hudson and Mohawk River valleys. These waterways represent a wide range of watershed size, salinity, land use, flow, and expected and observed fecal pollution. Samples were collected in both dry and wet weather. The geometric means of the two FIB were positively correlated across sites suggesting that the two indicators provided similar information about the magnitude and frequency of fecal contamination. However, compared to an expected ratio of ~3 based on the respective EPA criteria for the two FIB groups, observed *E. coli* to *Enterococci* ratios were variable for both single samples and geometric means. The observed variation in ratios may be related to characteristics of the fecal inputs, receiving water, contamination source, relative persistence, or other variables. The patterns for the two indicators, including their ratios in paired samples, are presented and explored within the context of monitoring and management decisions.

## Preliminary Evaluation of Post-Dredging PCBs in Upper Hudson River Surface Sediment

*Jay Field*
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*Lisa Rosman*
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More than 2.76 million cubic yards of PCB-contaminated sediment were dredged and subsequently backfilled or capped in the 40 mile stretch of the Hudson River (River Sections (RS)1-3) between Ft. Edward and the Federal Dam at Troy between 2009 and 2015 under the 2002 Record of Decision for the Hudson River PCBs Superfund Site. Less stringent cleanup triggers were selected for RS 2 and 3. Pre-dredging data for RS 2 and 3 revealed highly elevated PCBs in the sediment surface and at depth in the immediate vicinity of the planned dredging areas, but these PCB deposits were not dredged. Recent sampling efforts conducted by GE in 2016 and NYSDEC in 2017 were designed to provide a post-construction baseline of the top 2 inches of sediment PCBs for future evaluations of sediment recovery. We conducted a preliminary analysis of these data, calculating post-dredging surface weighted area concentrations and sediment decay rates, and comparing results obtained by different PCB analytical methodologies. This poster will present these preliminary analyses.

**Micro-Plastic Particle Analysis of Hudson River Surface Water Using Novel Flow-Through Imaging Raman Spectroscopy**

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It is estimated that an average of 5-13 million MT of single-use plastic products enter the world's ocean each year, degrade through photochemical and mechanical abrasion, and become what is known as microplastics (MP)- particulate plastics between 1 µm and 5 mm. This study provides an overview of the development of a flow-through particle sensor based on both particle microscopic imaging and Raman spectroscopy with results of a cruise along the entire Hudson River (the Battery to Albany) sampling surface water continuously. Most of the MPs were in the form of filaments 2 by 10 to 100 µm rather than particulates. A wide range of polymer types at the highest concentrations (> $10^4$ $L^{-1}$) were located near and just South of the Tappan Zee Bridge where the salt wedge drives upstream along the riverbed and fresh water flows downstream. Temperature-Salinity plots show that MPs were associated with density gradients between fresh surface water and salty bottom water regardless of polymer type or density. Some polymers (e.g., Polyacrylonitrile and Polyvinyl Chloride) were scattered in the northern sections of the river. These results point to the need to profile vertically to quantify MPs with respect to density gradients.

**The Hudson Valley Natural Resource Mapper**

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The Natural Resource Mapper is a new online, interactive tool to assist local land-use decision-makers in New York's Hudson Valley with identifying and understanding important habitat and water resources, the connections between them, and their broader regional context. It compiles geographic data for the 10-county Hudson River estuary watershed organized by themes including the estuary, streams and watersheds, wetlands, forests, biodiversity, and scenic and recreation resources. Estuarine resources shown include bathymetry, submerged aquatic vegetation, tidal wetlands, significant coastal fish and wildlife habitats, and migratory fish runs. Users can zoom in to an area of interest and turn on individual layers to create custom, printable

maps, as well as click on features to access data attributes and links to more information. The tool is intended for general information and planning purposes, and complements technical assistance available to municipalities and watershed groups from Hudson River Estuary Program staff. The Natural Resource Mapper can inform: public education and outreach, preliminary environmental review, identification of conservation priorities, natural resource inventories, comprehensive planning and zoning updates, watershed assessment and planning, and open space planning and land acquisition. This poster will provide an overview of the mapper's contents, functions, and applications, and a tablet will be available on hand for a live demo.

## Determining Water Quality of New York Harbor: Using a Citizen Science Network to Test for Enterococcus as an Indicator of Sewage Contamination

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*Citizen's Water Quality Testing Program Volunteers*
*The River Project's Marine Biology Interns*

A consequence of New York City's combined sewer system is that storm events can cause sewage to flow into local waters. Since 2012 The River Project, New York City Water Trail Association, Riverkeeper, and many other partners have created and run a citizen science network that samples NYC and adjacent waters for sewage indicators. The Citizens' Water Quality Testing Program (CWQTP) operates during the boating season to test water recreation sites not tested by government agencies. Our goal is to create a baseline of data for the public that can help predict bacterial concentrations per unit effluent. Samples are taken at all sampling sites weekly for 20 weeks. Samples are brought to designated labs where the Idexx Enterolert system is used to process then analyze samples for *Entercoccus spp*. Results are posted publicly each week. In the past six years almost 4,500 samples have been processed and analyzed through this citizen science program. It was found that all data is site specific, making a continuation of sampling necessary. To further understand results each site is individually matched up with physical and chemical environmental parameters.

**PCBs in select organisms of the Hudson River floodplain: amphibians, small mammals, birds.**

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Past and continuing discharges of polychlorinated biphenyls (PCBs) have contaminated the natural resources of the Hudson River. The Hudson River Natural Resource Trustees (Trustees) – New York State, the U.S. Department of Commerce, and the U.S. Department of the Interior – are conducting a natural resource damage assessment to assess and restore those natural resources injured by PCBs. Between 2009 and 2015, General Electric, under the direction of the U.S. Environmental Protection Agency, dredged a portion of the PCB-contaminated sediment out of the Hudson River between Ft. Edward and Troy, NY, but the Hudson River floodplain is also contaminated with PCBs from sediments deposited on the floodplain during high flow events. While dredging was underway on the river (2009-2015), the Trustees analyzed PCB concentrations in amphibians (n=30), small mammals (n=34), and birds (gray catbird, Dumetella carolinensis; n=34) living on the Hudson River floodplain from Hudson Falls to Schodack Island. All samples contained detectable levels of PCBs. Maximum PCB levels in upper Hudson River frogs, small mammals, and catbirds were 1.26, 6.30, 8.03 µg/g, respectively. Mean total PCBs for amphibians, mammals, and catbirds in the upper Hudson River (0.14, 1.01, 1.09 µg/g, respectively) were greater than those in the Hudson River below the Federal Dam at Troy (0.005, 0.02, 0.04 µg/g, respectively). The results of these studies confirm that PCBs are present in floodplain biota and a thorough investigation of the Hudson River floodplain is needed to determine the scope of contamination and an appropriate strategy for clean-up.

**Microplastic contamination within the Sparkill Watershed**

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The accumulation of anthropogenic litter, specifically plastics, has become a defining issue in the pollution of the environment. When plastics begin to degrade and breakdown to sizes less than 5 mm they begin to have new effects as pollutants. The scientific literature has well established that microplastics have the ability to work their way into the biota of an ecosystem via bioaccumulation. Once inside of an organism microplastics can cause an intestinal blockage which can lead to complications and even death. There have even been some studies that show their potential to concentrate polychlorinated biphenyls (PCBs) and introduce them into the food web. This study seeks to analyze what the current concentration of microplastics is in the Sparkill Watershed. Sediment cores and water samples will be taken at several sites throughout the watershed. The microplastics recovered will then be categorized and identified using FT-IR spectral analysis.

**How Do Changes in Precipitation and River Flow Relate to Interannual Variability in Fecal Contamination Indicators in the Hudson River Estuary over the Last Decade?**

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Surface water concentrations of enterococci bacteria were measured monthly (May-Oct) at 74 locations along the tidal Hudson River Estuary (HRE), including the interconnected waterways around Manhattan, from 2008 - 2017. Enterococci are commonly used as fecal contamination indicators and are the only bacterial group recommended by the USEPA for assessing fecal contamination, and associated public health risks, in brackish to marine waters. Annual geometric mean enterococci concentrations pooled across all 74 sampling locations in the HRE have generally decreased since 2011. A similar trend of improving water quality was seen in the percent of samples collected throughout the HRE each year that were below the EPA recommended beach action value. Most individual subregions of the HRE showed similar, though weaker, interannual trends. However, interannual enterococci data for the system and its subregions generally correlated with interannual differences in precipitation, as measured by freshwater flow into the HRE. This correlation was seen even after excluding samples collected during or soon after local rainfall. Thus, enterococci concentrations were systematically higher in "wet" years with high freshwater flow compared to "dry" years with low flow, and the interannual improvement in water quality since 2011 is therefore largely attributable to a recent series of dry years. Nevertheless, examining interannual trends at each sampling location individually does suggest that in several locations where management actions are known to have been recently undertaken to reduce fecal contamination, they have led to localized improvements in enterococci levels.

## Reaching and Educating Hudson River Fish Consumers About PCB Contamination in Fish.

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The Hudson River has one of the largest federal Superfund sites in the United States stretching 200-miles from Hudson Falls to New York City. Due to PCB contamination, the New York State Department of Health has fish consumption advisories for this extensive Superfund site. Women under 50 and children under 15 should not eat any fish from the project area, and for men and older women the advice varies by section:

- The Upper Hudson, which is the most contaminated, has the strictest regulations that prevent anyone from keeping the fish,
- the Mid Hudson has a slightly more relaxed advisory for men and older women but no one should eat the most desirable fish – the striped bass, and
- the Lower Hudson has the least restrictive advisory for men and older women but has the most diverse populations who speak many languages.

Reaching these vastly different populations with advice along 400 miles of shoreline is the project's mission. Since 2009, staff at the Hudson River Fish Advisory Outreach project have developed many tools to help convey the advisory and promote behavior change in anglers and their families. Working with trusted community partners and creating tailored materials for the different groups who fish the Hudson are strategies NYSDOH utilizes to communicate the advice. The poster will describe a variety of outreach techniques used including translated brochures, color-coded county maps that show what advisories apply to public access waters, and striped bass information packets that show fish PCB data to anglers.

**The Chemistry of Brine Used for Snow and Ice Control**

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Large quantities of road salt are needed to keep roads free of snow and ice in snow belt regions like the Hudson Valley. Although alternatives exist, the majority of deicing is done using sodium chloride salt. The overall mass of sodium chloride used can be significantly reduced by pretreating roads or pre-wetting dry rock salt with concentrated brine solutions. Brine solutions can be made from rock salt; however, an alternative source of brine for some communities is brine that is a waste product of oil and gas extraction. We compared contaminant chemistry of brine made from rock salt with literature on oil and gas well brine from conventional and unconventional (e.g., Marcellus shale gas) wells. In addition to a review of existing literature, we analyzed four rock salt samples for a suite of chemical constituents. Maximum reported levels of some harmful contaminants were higher for well brines than rock salt brines and were higher for unconventional than conventional well brines. Because the regulatory structure for using well brines varies among states, we recommend a consistent approval process for permitting the use of waste brines that includes specific maximum allowable limits for potentially harmful contaminants, and that each batch of solution be tested before use. Although the use of brine, including waste brine, can reduce the overall amount of salt needed for snow and ice control, adequate steps should be taken to ensure the safety of the brine solutions before they are used.

***Phragmites australis* niches for other biota are diverse and similar on three continents**

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Common reed (*Phragmites australis*) is one of the most widely distributed, most abundant, and best-studied vascular plants worldwide but there has been no broad comparative analysis of reed-associated biota on different continents. A survey of observational data on (mostly terrestrial) organisms using *P. australis* reedbeds revealed diverse biotas and ecological parallels among North America, Europe, and sub-Saharan Africa. I present examples for a selected group of 27 niches (i.e., features of the reed plant or reedbed used in particular ways by groups of organisms). Niches include animals eating particular portions of reed, birds roosting in reedbeds, and vines using reeds for support. These similarities in habitat functions in bioeographically distinct world regions suggest a fundamental character of reed ecological relationships related to the large size, extensive stands, high productivity, deep litter layers, and other traits of reed. Inasmuch as *Phragmites* effectively sequesters certain contaminants, studying biotic use of reedbeds can help predict exposure of food webs and humans to toxicants. The data also

underline the biodiversity support functions of reed and their similarity among continents. Managers can consider reed niches and user guilds to design management approaches and predict outcomes of conservation, management, or other environmental changes affecting reedbeds, whether native or introduced, over-abundant or under-abundant.

**Water Quality Testing in the Patroon Creek**

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The work described in the poster is a preliminary investigation of water quality of the Patroon Creek and with the same set of data the utility of the use of endotoxin concentration as an indicator of bacterial contamination in stream water. In this study, stream water samples were collected at five different locations within a single watershed and evaluated for the presence of viable bacteria, endotoxins, and physical characteristics (pH, water temperature, turbidity, total dissolved solids, conductivity, and specific conductivity). The Pearson Correlation Coefficient and linear regression were used to look for relationships between the water quality parameters, bacterial concentrations, and endotoxin concentrations of the samples.

The results showed that the concentration of colony-forming-units (CFU) of fecal bacteria species exceeded New York State regulatory standards for bacterial contamination of beaches in the vast majority of water samples. Water samples from one location, United States Geological Survey (USGS) Gage site, had the highest levels of enterococci, coliform, and endotoxin and also the greatest variability in concentration. Endotoxin concentration was found to be moderately associated with the number of CFU of enterococci, and coliform. The study sample size was small, and outlier results from individual samples could significantly impact correlation statistics.

**An assessment of the health of an urban stream: A case for implementation of green water infrastructure solutions**

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The adverse effects of urbanization on the quality and health of streams in urbanized areas are well known, such as the elevation of concentrations of contaminants and the diminishment of biotic richness. Parameters used to assess the quality of urban stream water include average temperature, specific conductivity, pH, water clarity, dissolved $O_2$, flow rate, and nutrient and bacterial levels. These parameters have been measured over time in the Fontynkill stream, located in Poughkeepsie, NY. In this study, these parameters were measured again and compared to prior measurements documented since 2012 to identify any change in the quality, or health, of the stream over the past 6 years. Water sondes (YSI 600XLMV2) were used to measure temperature, specific conductivity, pH, and turbidity, and data loggers (HOBO U20) were used to measure dissolved oxygen and flow rate. These instruments were deployed at three sites along the Fontynkill. Additional samples were collected to analyze nutrient and bacterial levels. The stream's ability to buffer changes induced by meteorological events was used as an index of its health. Today, although the water quality of the Fontynkill has improved, as indicated by baseline conditions and buffering abilities, it still does not meet the standards for swimmable fresh surface water as set by the New York State Department of Environmental Conservation. The addition of green water infrastructure (e.g. naturalized wetlands, rain gardens) has been shown to mitigate deleterious exogenous changes in stream conditions. Thus, due to the persistent poor health of the stream over the 6 year period analyzed, management plans that integrate green water infrastructure and urban streams to improve local wetland habitats should be implemented.

## The Effects of β-estradiol, polychlorinated biphenyls, and tamoxifen on pancreatic islet cell formation in zebrafish (*Danio rerio*)


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Estrogen and polychlorinated biphenyls (PCBs) are two substances that affect fish development found in high concentrations in waterways. Some environmental contaminants like PCBs intensify this issue through mimicking estrogen signaling. PCBs, are organic chemicals that have been released into the New York waterways and are found in high levels in the Hudson River. PCBs accumulate over time in the river sediment as they do not break down easily. Furthermore, PCBs readily enter embryos through bioaccumulation from the river sediment into mothers' fat which is then deposited in the egg. PCBs have been shown to cause abnormal organ development and cancer. PCB 104 and estrogen are known to bind to the same estrogen receptor. Tamoxifen is an estrogen receptor inhibitor and can prevent estrogen or PCBs from impacting affected cells. The purpose of this study is to understand the impact of estrogen and PCBs on pancreatic islet cell development in order to understand the effect of estrogen pathway activation by PCBs. This paper demonstrates that zebrafish treated with estrogen and PCBs will undergo precocious formation of pancreatic islets as a result of early activation of the estrogen receptor pathway. Moreover, zebrafish treated with estrogen or PCBs and then followed by treatment with tamoxifen will be rescued and undergo normal formation of pancreatic islets.

### Reconnecting our streams: Barrier mitigation within the Hudson River Estuary Watershed

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Poorly designed and failing road-stream crossings (e.g. culverts and bridges) present barriers to the movement of aquatic and semi-aquatic organisms (e.g. fish, turtles and salamanders), and hazards to communities by increasing the risk of flooding. As part of its Culvert Prioritization Project, the Hudson River Estuary Program of the New York State Department of Environmental Conservation (NYSDEC) has been working with interested partners to assess all road-stream crossings within the Hudson River Estuary Watershed, and to prioritize those crossings most in need of replacement. Prioritization is ranked based on a combination of a crossing's passability and capacity scores. Passability is an evaluation of how well aquatic and semi-aquatic organisms can move through a barrier, and is based on field surveys following protocols developed by the North Atlantic Aquatic Connectivity Collaborative (NAACC). Capacity represents the maximum storm size a culvert or bridge could successfully pass without water overtopping the road, and is determined by hydrology modelling conducted by the New York State Water Resources Institute at Cornell University (NYSWRI). Once priority crossings have been identified, Estuary Program staff coordinate with interested municipalities and local organizations to facilitate the replacement of those crossings, with the ultimate goal of removing barriers to organism movement and reducing flooding hazards for communities.

### Continuous Monitoring on the Hudson and Beyond with HRECOS: The Hudson River Environmental Conditions Observing System

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The Hudson River Environmental Conditions Observing System (HRECOS) is a robust river monitoring network operated and managed by a consortium of 15 governmental, academic, and private institutions with shared interest in high-frequency monitoring in the Hudson River watershed. Monitoring stations geographically distributed along the Hudson and Mohawk Rivers are equipped with sensors that continuously record a suite of water quality and weather parameters, with most stations operating year-round. Remote telemetry at each station transmits data in near real-time for the public to download and plot graphs at www.hrecos.org. HRECOS works to improve the capacity of regional river and watershed stakeholders to: understand the ecosystem and manage water resources, provide baseline monitoring data for applied research and modeling, promote the use of real-time data in educational settings, provide policy makers and emergency managers with data products to guide decision making, and provide information for safe and efficient commercial use and recreational activities. HRECOS synergizes upon long-standing monitoring programs of its partner organizations, such as the Hudson River National Estuarine Research Reserve (HRNERR), NYSDEC's Rotating Integrated Basin Studies (RIBS), USGS monitoring programs, Stevens Institute of Technology's New York Harbor Observing and Prediction System (NYHOPS), Cary Institute of Ecosystem Studies monitoring, and several others.

## Does the Impact of Particle Association on Fecal Indicator Bacteria Persistence Increase with Turbidity?

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Fecal indicator bacteria (FIB) are robust, easily culturable microbes that are released in sewage pollution and correlate with public health outcomes in epidemiological studies. They are therefore routinely used in water quality monitoring to indicate the presence of co-occurring fecal pathogens. Within the HRE and many other systems, sewage-related microbes display notable degrees of particle association. As a result, a sizeable, though variable fraction of FIB sink following discharge into receiving waters. Following a discharge into a water body, the extra-enteric ecology of FIB is dominated by various loss processes, with the primary loss being sunlight-induced mortality. Sinking decreases sunlight-induced mortality of FIB due to light attenuation with depth. However, to date, predictive models of FIB persistence do not account for potential impacts of particle association/sinking. Here, we present results from a 2-dimensional model of microbial persistence in both clear and turbid water columns. The model is parameterized for the FIB *Escherichia coli* with loss rates from Evison *et al.* 1988 and sinking rates from Garcia-Armisen & Servais 2009. We demonstrate that high turbidity increases persistence for both particle-associated and free-living *E. coli* because of light attenuation. Our results also show that the relative importance of particle association to overall *E. coli* persistence should increase for turbid systems like the HRE. For any aquatic system, we show that the potential impact of particle association to FIB persistence depends on the ratio of the light extinction coefficient to the FIB sinking rate.

### Enterococcus in Sediment in the Hudson River at 125th Street in Manhattan, New York

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This project tracks enterococcus levels in Hudson River water and sediment. Enterococcus is the federally recognized indicator bacteria for fecal matter in sewage waste and is used to predict concentrations of pathogenic bacteria in bodies of water. Samples are collected from the 125th Street pier and IDEXX enterolert is used to determine bacterial concentrations in each sample. Enterococci were present in all water and sediment samples but no significant correlation was found between enterococci in water and enterococci in sediment for paired samples.

### Ionic Concentrations & Water Quality in the Casperkill and Wappingers Creeks

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The Hudson River plays a large role in industry and tourism in the Hudson Valley, and its health and safety are integral to the entire region. Two prominent tributaries in the mid-Hudson region are the Casperkill and Wappinger Creeks. Today, streams are at a particularly high risk for being polluted due to the human propensity to settle around freshwater. Recent increases in the use of pesticides, fertilizers, and other industrial chemicals, the burning of fossil fuels, and the release of litter and wastewater have put streams at an extremely high risk of being chemically polluted. Because of this, both the Wappingers and Casperkill are at an increased risk of pollution, which in turn could impact the water chemistry of the Hudson.

Our project is beginning to quantify pollution levels in both the Wappingers and the Casperkill in order to best advise remediation efforts. Using Ion Chromatography, Inductively Coupled Plasma Mass Spectrometry, and X-ray fluorescence we compared the concentration of selected ions and elements collected across our sampling sites during the winter and spring of 2018. We found higher levels of both chloride and sulfate in the Casperkill compared to the Wappingers with the highest levels of both being found at our second samping site on the Vassar Farm and Ecological Preserve. Previous sampling, in fall 2017, found elevated levels of lead in stream sediments adjacent to this area of the Casperkill. Despite similarities in stream structure, the Casperkill shows higher ionic concentrations for all ions analyzed.

**Heavy Metals in the Hudson Marshes – How have things changed?**

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The Hudson Estuary, like coastal urban estuaries worldwide, is vulnerable to ongoing sea level rise, making preservation of marshes of paramount importance. These wetlands provide numerous vital benefits to Hudson residents, including humans. Through extraction of sediment cores from two estuarine marsh sites: Piermont Marsh (Piermont, NY), Iona Marsh (Bear Mt, NY) we are producing paleoclimate data along with pollutant data preserved in marsh sediment. Our research on sediment cores includes loss-on-ignition (LOI) from which we learn about inorganic and organic components of the sediments over thousands of years; pollen and macrofossil analysis from which we learn how the regional and local vegetation and climate have shifted, and x-ray fluorescence (XRF) of the top meter of sediment from which we learn how the heavy metals have impacted the Hudson Valley over the last 300 years.

**American Chestnut as a management strategy for vine-dominated light gaps in temperate forests**

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Invasive vines such as oriental bittersweet and porcelainberry tend to dominate forest light gaps, shifting the forest's successional trajectory or delaying succession for decades. Vines are becoming more prolific in temperate forests due to forest fragmentation, higher atmospheric $CO_2$ levels, and milder winters caused by climate change. Forest canopy gaps are increasing in abundance with the arrival of the emerald ash borer, an invasive beetle that kills ash. Our project examines the potential for mitigating vine gap expansion through shade management by planting American Chestnut trees. In 2016 we cleared six 10x10m vine-dominated gaps and planted American Chestnut in three plots, paired with three unplanted control plots. In anticipation of the emerald ash borer, we identified six 'pre-gap' plots that contained white ash, and planted American Chestnut in three of these plots, paired with three unplanted control plots. In 2017 we returned to these sites to check tree survival and document changes in species composition. We will compare the successional trajectories of the planted and unplanted plots to assess the effectiveness of this management strategy.

**Evaluation of Sediment Loads to the Tidal Freshwater Hudson: Implications for Sediment Trapping and PCB Transport**

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The Lower Hudson River receives sediment loads from the Upper Hudson and Mohawk Rivers at Federal Dam (Troy NY), and several other tributaries along the tidal freshwater section of the river. In recent years, New York U.S. Geologic Survey (NY-USGS) has conducted extensive monitoring of sediment loads from the Upper Hudson, the Mohawk River, Catskill Creek, Rondout Creek and several smaller tributaries. Objectives of this study were (i) to use NY-USGS monitoring data to develop and test a modified version of the Normalized Sediment Load (NSL) function for relating sediment loads to daily flows, (ii) to construct a continuous record of sediment loads from Lower Hudson tributaries, (iii) to compare the sediment load record to sediment loads at Poughkeepsie NY to evaluate trapping of sediment in the tidal freshwater section of the river, and (iv) to compare the modified NSL method to a multiplying factor approach for determining sediment loads from tributaries below Federal Dam. Results showed that approximately 18.4 million metric tons of sediment entered the tidal freshwater Hudson from October 2014 to September 2014. A large portion of this load was discharged during Tropical Storms Irene and Lee in August-September 2011. It was estimated that 7.5 million metric tons of sediment were trapped in the tidal freshwater portion of the river over a ten year period from October 2004 to September 2014. It was also concluded that the modified NSL method can give better long term predictions than the use of a multiplying factor to determine total sediment load.

**Analysis of bacterial community dynamics related to water quality along environmental gradients within the lower Hudson River Estuary**

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*The Riverkeeper water quality sampling team*

Combined Sewage Overflows (CSO), incomplete sewage treatment, and stormwater runoff pose a significant management challenge along the length of the lower Hudson River Estuary. The 153 mile stretch of the Hudson from river mouth near the New York City Battery to the lock at Waterford, north of Albany, represents a diverse and variable environment. Conditions range from highly saline to freshwater and the area has mixtures of land use from highly urban to rural. DNA was extracted from bacteria in water samples taken along the river in 2014-2017 during both wet and dry weather. Bacterial DNA sequences have been analyzed to understand how the Hudson's bacterial microbiome changes according to factors including salinity and sewage influence. Identified DNA of known sewage associated bacterial groups is evaluated against traditional culture based sewage indicators. Multi-ordinate analyses are used to help identify combinations of environmental variables that can be used to understand the dynamic bacterial community of the Hudson River Estuary.

**Title: Determining sources of fecal pollution and risks of recreation in a consistently-polluted Hudson River tributary**


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Since 2008, Riverkeeper and a network of partners have engaged community scientists to monitor fecal indicator bacteria (FIB) on as many as 440 locations on a monthly basis each year throughout the Hudson River and many of its tributaries. Data from these projects have highlighted tributaries with consistently high levels of fecal contamination – well in excess of Environmental Protection Agency guidelines for safe recreation. Effective strategies for mitigation of pollution require determining sources of the fecal pollution. To elucidate animal fecal sources, Cornell teamed with Riverkeeper in May-October 2017 to apply molecular biological tools to perform Microbial Source Tracking (MST) with specific MST biomarkers (human, bird, cow, horse) across twenty-four sites on a polluted Hudson tributary. We also quantified biomarker genes unique to a dozen human gastrointestinal pathogens *via* a high-throughput qPCR methodology. Collectively our datasets suggest that both human and bird feces contribute significantly to FIB levels at the sites sampled. Human sources may include sewage treatment plant outfalls, separate sewer overflows (SSOs), illicit sewer connections to stormwater systems, failing septic systems, and/or leaking sewer lines. Bird sources may include a large number of species, including waterfowl, geese and songbirds (but not chickens). Of the human diarrheal pathogens surveyed, a rotavirus strain was detected most frequently across the sites surveyed (89% of samples). The *E. coli eae* gene, human adenovirus, and *Giardia lamblia* were also detected with some regularity. Translating pathogen levels into risk levels will require the application of Quantitative Microbial Risk Assessment (QMRA) methods.

**The Effect of PCB104 on the Morphology of the Pancreas in Zebrafish (*Danio rerio*)**

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Polychlorinated biphenyls (PCBs) are highly toxic environmental pollutants. PCBs don't degrade easily, building up in the sediment of aquatic environments. Exposure to them leads to increased fish mortality via toxicity, besides increases in pericardial edema, curled tails, and swim bladder inflation failure. In humans, exposure leads to increased rates of cancer, liver problems, and other developmental defects.

In this study, we focused on the effects of PCB104 on the development of zebrafish pancreata. We had previously seen that exposure to PCB104 increases the frequency at which a 'split' morphology was seen-'split' being characterized by any variance from a single insulin-producing islet spot in the pancreas. Three categories have been defined: category I, where a single cell or multiple single cells have split from a primary spot; category II, where there are two to three spots of equal size; and category III, where there are more than three spots in various positions. Category three is rarest.
We treated 4-hour-old Tg(5x ERE:gfp/insulin:rfp) zebrafish embryos with DMSO and differing amounts of PCB104, leaving one group untreated as a control. However, our results contradict the lab's earlier findings. In untreated fish, the 'split pancreas' phenotype occurs in about 10% of the population. We observed no significant change in the phenotype's frequency between the two groups. This isn't to say that the pancreas itself is unaffected; only that the β- cells are unaffected.

## Turtles Rocking on the Half Shell: Presence of Diamondback Terrapin Nesting in the Rockaways

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Jamaica Bay is home to New York City's second largest studied population of Diamondback Terrapins *Malaclemys terrapin* on Ruler's Bar Hassock (RBH), second only to JFK. Recently, terrapin populations have been declining likely due in part to high depredation of nests by raccoons *Procyon lotor*. Surveys were conducted during summer 2016 along the Rockaway peninsula for terrapin nesting sign. Surveys included Bayswater Park, the Rockaway Coastal Front, Dubos Point and Edgemere landfill. Nesting sign was based on presence of depredated nests as well as test digs according to previously used methods. We found a potentially large and relatively new terrapin nesting site on Edgemere landfill. Edgemere is a 78 year old superfund site which was decommissioned in 1991. Historically, this site was marshland prior to the landfill's construction, it currently contains 70 ha of restored land. We found 65 predated nests and 111 test digs along the main gravel access road spanning the perimeter of the landfill. Tracks and sign indicated raccoons as the main predator here. The average distance terrapins traveled to nesting habitat at Edgemere averaged from 35 to 100 meters, which is a greater distance compared to RBH where terrapins routinely travel less than 30 meters to available nesting habitat. Surveys at Dubos Point indicated much lower densities of nesting; only 3 depredated nests were found in accessible areas. No signs of nesting were identified other sites. Edgemere landfill may indicate the presence of a terrapin population comparable in size to the population at RBH.

## Municipal Wastewater in the Hudson River Watershed

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When the Hudson River reaches New York Harbor, as much as 11% of its freshwater inputs have come from municipally owned wastewater treatment plants. Where does that treated

wastewater originate? A Riverkeeper analysis of publicly available data gathered by the Department of Environmental Conservation's Hudson River Estuary Program, supplemented with information from other sources, shows that, on average, 349 million gallons per day (MGD) of wastewater from municipally owned treatment plants is discharged into the Hudson River Watershed. Of this, 58% is discharged directly to the Estuary 24% to the Mohawk River, 10% to the Upper Hudson and 8% to Estuary tributaries. However, most of the 163 municipal wastewater treatment plants in the watershed are found in Estuary tributaries (54%), followed by the Estuary (28%), Mohawk (12%) and Upper Hudson (6%). Of the 202 MGD of direct discharges to the Hudson River Estuary, the Capital District (Albany and Rensselaer counties) accounts for 22%, the mid-Hudson region (Greene, Columbia, Ulster, Dutchess, Orange and Putnam counties) 19% and the Lower Hudson (Westchester and Rockland counties) 59%. The Yonkers Joint Wastewater Treatment Plant, which serves 506,000 people in 22 Westchester County municipalities, accounts for 22% of all discharges to the Hudson River Watershed. Of the non-tidal portions of tributaries to the Estuary, the Wallkill/Rondout Watershed, the largest tributary to the estuary, accounts for two-thirds (66%) of the municipal wastewater discharge.

## The Reclassification and Mapping of the Vassar Farm and Ecological Preserve

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An accurate map of ecological communities is essential to making land management decisions and planning ecological research. We updated the 1996 Vassar ecological communities map by collecting field data and reclassifying communities within standardized classification systems. Comparing the two maps allows users to observe trends in how ecological communities change and make predictions about how these communities might change in the future. To produce the updated map, teams of field researchers gathered information about species composition and various environmental features at distributed plots. These data were used to classify plots using classifications from New York Natural Heritage and the United States National Vegetation Classification. A revised map was produced with six communities removed and nineteen added, including six novel communities created specifically for the VFEP. The accuracy assessment resulted in a 73.5% overall accuracy and mapped community boundaries were adjusted accordingly. Future work will include another round of accuracy assessment, exploring the expanding role of invasive species in plant communities and classification systems, and using the data gathered in this project to explore more ecological questions. The data and results from this project will provide Vassar students, faculty, and land managers with a launching point for various types of projects, while also serving as a pilot for surveying at other sites in the Environmental Monitoring and Management Alliance (EMMA). Potential uses for the ecological

communities map data include modeling species habitat, carbon sequestration, invasive species expansion, and climate change impacts.

### Hudson River Estuarium: Making the Invisible Visible

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This poster describes the current planning for the exhibit space at the Hudson River Estuarium, to be operated by Clarkson University at Pier 26 in Manhattan. The fundamental desire is to make the invisible visible through state of the art interactive dynamic digital exhibits incorporating augmented reality to enable visitors to explore and learn by answering their own "what if" questions. The Estuarium exhibits will examine the estuary on multiple scales – in time, space and biological complexity. The anticipated opening date is in 2019. The mission statement includes the following: "Engaging an audience from kindergarten through the most advanced levels of graduate research, the Estuarium makes possible an unprecedented experiential exploration of epochs of natural history through augmented reality. The physical and virtual space allows the visitor to experience the Hudson on many levels: in it, around it, above it. Time as well as space is visualized and personalized, from the pristine primordial past to the river's vulnerable present and onward into a range of its possible futures. The most advanced interactive digital technology deployed in a museum-level exhibition space (created by the internationally renowned architect Rafael Vinoly), the Estuarium represents a new kind of education center to inspire and enlighten visitors of all ages and levels of thought. Drawing on current estuarine science and data, the fullest possible picture of the river's history and prognosis are made vividly real."

### Salinity effect on microorganism transport

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Urbanization in coastal areas can be a significant source of pathogenic microorganisms, such as viruses and fecal bacteria. They can be discharged accidentally into surface water bodies through run-off or combined sewer overflows. High concentrations of fecal bacteria exceeding the EPA quality standard have been measured in the Hudson River. Bacteria and viruses can migrate long distances though porous media, such as beaches and coarse sediments, because of their biological characteristics, i.e., their size and motility. The attachment process of microorganism onto soil grains can retard the microorganism transport and it can be increased by the high salinity of the coastal water.

Here, a study that explores the effect of salinity on the transport of microorganism in saturated porous media is presented. A one dimensional transport model was developed. The model consists of two mass conservation equations of the microorganism and the salt concentration coupled through the constitutive equations of attachment/detachment mechanism. Simulations show in the presence of a salinity gradient and hydrodynamic dispersion, a pulse of microorganisms forms that travels at the average fluid velocity ahead of a retarded front due to attachment of the bacteria into the porous medium wall. The model will be used to create regime diagrams of microorganism transport behavior in porous media under variable salinity. Moreover, the model is used to design column-flood tests to investigate the transport of a selected microorganism (namely, *Escherichia Coli*) through a porous medium made of sediments (sand, silt, and organic matter at variable fractions) under different salinity conditions.