NEW YORK STATE WATER RESOURCES INSTITUTE

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Water Resource Infrastructure in New York: Assessment, Management, & Planning

Prepared November 26, 2018

USGS science for a changing world

NEW YORK STATE OF OPPORTUNITY | Hudson River Estuary Program

The **New York State Water Resources Institute (NYS WRI),** with funding from the **United States Geological Survey (USGS),** and the **New York State Department of Environmental Conservation (DEC) Hudson River Estuary Program (HREP)** has undertaken a coordinated research effort on water resource infrastructure in New York State, with a focus on the Hudson and Mohawk River basins.

The primary objective of this multi-year program is to bring innovative research and analysis to watershed planning and management. In particular, WRI-HREP is working to address the related topics of water infrastructure, environmental water quality, and economic vitality, especially as they pertain to land use planning and management in the Hudson and Mohawk watersheds. The WRI-HREP program coordinates individual research efforts so as to fit within the context of, and be responsive to, New York State's growing concerns about aging public infrastructure, economic constraints on public investment, and the recent requirement for State planning agencies to incorporate principals of "smart growth" as promulgated in the 2010 Smart Growth Public Infrastructure Policy Act.

In the following pages we report on progress made in 2017. Projects are discussed within the following broad themes:

1) **Infrastructure Assessment** - Water-related infrastructure including water supply and wastewater treatment facilities, distribution networks, decentralized treatment installations, dams, constructed wetlands, "green" infrastructure, etc., and their current state and effectiveness at providing water and ecosystem services regionally at reasonable cost
2) **Climate Change Resilience -** Assessing and managing risks of climate change on water infrastructure and communities
3) **Environmental Monitoring -** Detection and characterization of surface and ground water contaminants related to land use and wastewater discharges
4) **Ecological Assessment** – Assessing the current state and trends of watershed ecological characteristics to inform management efforts
5) **Environmental Policy & Socio-Economic Analysis -** Integration of scientific, economic, planning/governmental and/or social expertise to build comprehensive strategies for public asset and watershed management

Following this summary we also include:

- A link to the full versions of final reports, which are available at our website http://wri.cals.cornell.edu/grants-funding
- Outreach efforts currently underway
- How we are adapting our efforts to support research and create effective outreach products
- A list of recently funded projects

For a copy of previous summary reports, please contact Brian Rahm (bgr4@cornell.edu), or go to https://wri.cals.cornell.edu/grants-funding

Cover images from Jeremy Dietrich, Emily Vail, and Chester Zarnoch.

Infrastructure Assessment - Water-related infrastructure including water supply and wastewater treatment facilities, distribution networks, decentralized treatment installations, dams, constructed wetlands, "green" infrastructure, etc., and their current state and effectiveness at providing water services regionally at reasonable cost

<u>Cross-cutting impressions</u>

Previous research suggested that stormwater and wastewater infrastructure systems, including ditches, on-site wastewater treatment systems and "green" infrastructure, can be effective under certain conditions, but their design and management often lacks rigor, can be inconsistent, and/or is at odds with water and air quality goals. Urban environments pose the additional design requirement of balancing practical needs, such as providing parking area and pedestrian access, with goals such as reducing stormwater runoff. Our understanding of how this balance changes dynamically overtime is advancing with onsite observations and historical research.

Current research demonstrates the potential for infrastructure, and strategic infrastructure management, to achieve water quality improvement goals. We learned that well-designed green infrastructure and reconstructed wetlands can greatly reduce water quantity and nutrient concentrations, respectively. Management arose as a common theme. Using adaptive management and sharing "lessons learned" are key to the success of green infrastructure installations. Dam removal showed potential to improve benthic macroinvertebrate community structures at impacted sites. Additional research to determine the specific factors that lead to this improvement will be key to strategic dam management and barrier removal in the future.

<u>What researchers found</u>

Project Title: **Assessing the effectiveness of green infrastructure**
PI: **Todd Walter** (Cornell University; Biological & Environmental Engineering)
Funding source: HREP

Bioretention area in Kingston's Uptown parking lot

Although green infrastructure is accepted as a technique to reduce runoff and improve water quality, questions remain about its effectiveness in the field. This study has three components: a quantitative assessment of runoff reduction in two municipal parking lots, a qualitative assessment of design features, and an analysis of the history of the Tannery Brook to provide context for modern restoration. In fall 2016, two municipal parking lots in Kingston, NY were reconstructed with several green infrastructure practices. Water level within 2 rain gardens, 3 bioretention areas, and 5 dry wells was measured for 28 storms May-November 2017 to better understand runoff reduction. Although certain maintenance issues have been identified, the practices are overall performing very well. The Tannery Brook is an excellent case study of how urban water management has changed over time. By sharing the Tannery Brook's story, we can better understand urban waterbodies and what it might take to improve them in the future. Key findings include:

- The bioretention areas, rain gardens, and dry wells **reduce runoff** quickly, particularly the dry wells.
- After construction, the City of Kingston made several changes to improve the parking lots. Lessons learned from **adaptive management** can inform future green infrastructure projects.
- The **history of the Tannery Brook provides context** for modern-day water quality and flooding problems, along with opportunities for restoration.

Project Title: **Quantifying the ecosystem services of nitrogen removal and carbon sequestration in restored urban tidal wetlands**
PI: **Chester Zarnoch** (Baruch College)
Funding source: USGS

Large scale wetland restoration efforts are common worldwide, and often motivated towards regaining lost ecosystem services such as nitrogen (N) removal and carbon (C) sequestration. Despite large monetary investment in wetland construction, research on the capacity for restored wetlands to retain C and remove N in eutrophic environments lags far behind. It is critical, however, to document these ecosystem services to help justify costs of restoration. In 2015-16 NYC Parks completed an assessment of 22 restored tidal wetlands in NYC that included measurements of habitat value and marsh structure but did not quantify N assimilation, N removal, or C sequestration. We measured C and N pools, and N fluxes including denitrification at four restored tidal wetland sites in the Harlem River. Key findings include:

- Rates of denitrification at all sites were higher than other reported values for natural and restored marshes suggesting that restored wetlands are hot spots for N removal in the Harlem River. The wetlands were also a sink for dissolved inorganic N. **Nitrogen removal and retention** should be considered an **important ecosystem service** provided by these restored habitats.
- The wetlands **sequestered an average of 50 metric tons of C per acre** which would have an **economic value of $2,000 per acre**. The C sequestered at Harlem River wetlands is similar to values reported in natural wetlands.

Project Title: **Hudson tributary dam removal**
PI: **Pat Sullivan** (Cornell University; Natural Resources)
Funding source: HREP

Wynantskill site

During 2017 a second collection effort was performed to obtain data regarding aquatic macroinvertebrates and substrate characteristics at Hudson River tributary sites collected during initial study in 2016. Five tributary sites were sampled: Wynantskill, Annandale Dam – Sawkill; Shapp Pond – East Branch Wappingers Creek; Brown's Pond – Otterkill; and Oscawana Dam – Furnace Brook. Since the 2016 sampling effort, the Shapp Pond dam was completely removed. Thus, 2017 sampling represents the first post-removal data at that site. The barrier on the Wynantskill was removed in May 2016, therefore the 2017 effort represents the second post-removal data collection at that site. Barriers at Brown's Pond, Oscawana Dam, and Annandale Dam remained intact during the 2017 sampling effort. Key findings include:

- Both **barrier removal** sites demonstrated **improvement** in benthic macroinvertebrate community assemblages and/or Biological Assessment Profile scores.
- The **rate of improvement** at the site level may be affected by **multiple factors**, including local hydrology, taxa distribution, and landscape context.
- Identification of causative factors to ecological improvement across sites in the Hudson River watershed could provide a **framework to prioritize future removal efforts** aimed at maximizing habitat connectivity, accessibility, and ecological vitality.

Climate Change Resilience - Assessing and managing risks of climate change on water infrastructure and communities

Cross-cutting impressions

Previous research suggested university partnerships can provide critical technical resources to community stakeholders and enhance municipal capacity to manage water and scenic resources in the face of a changing climate.

Current research continues to build the community, academic, and education benefits of a climate design studio partnership with Hudson River municipalities with high flooding risk. Partners are exploring how to turn design concepts into on-the-ground projects that make tangible improvements to community vitality and resilience. Additionally, the potential threats of projected extreme precipitation events to the NYC drinking water watershed were explored through dynamic linear models, raising the capacity of the NYC Department of Environmental Protection to adapt to future climate scenarios.

What researchers found

Project Title: **Design for climate-resilient Hudson River Communities**
PI: **Josh Cerra** (Cornell University; Landscape Architecture)
Funding source: HREP

The Cornell Climate-adaptive Design (CAD) studio program continued in the Hudson Valley, working with Kingston, New York on a new site location and with new municipal partner Village of Piermont on their waterfront. A total of ten alternative design strategies were developed for City of Kingston in Spring 2017 for the Kingston Point Park area and five alternative design strategies were developed for the Village of Piermont waterfront in Fall 2017.

Students from the 2016 Climate Adaptive Design studio present to stakeholders

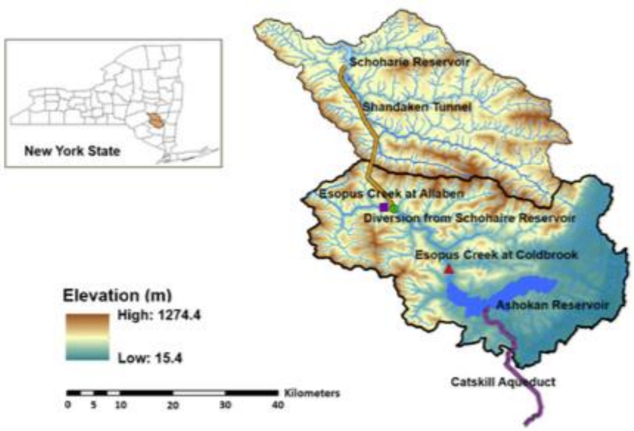
Collaboration between students from a Cornell University Watershed Engineering course and the Climate-adaptive Design studio continued on the Piermont project, with the goals of enhancing design effectiveness and student interdisciplinary engagement. Key findings include:

- One of the CAD design teams (Hong Gao MLA'19, Luyao Kong MLA'18, Qianli Feng MLA'18) was awarded a **national Student General Design Honor Award** by the American Society of Landscape Architects for their project "Weaving the Waterfront," a climate-adaptive design concept proposed for **Kingston Point Park**.
- Exhibitions of project work were **presented to stakeholders** and the public in Kingston in May 2017 and in Piermont in December 2017.
- As a complement to WRI grant support for the CAD program, a **grant from Engaged Cornell** was awarded to evaluate the effectiveness of the CAD program in generating a combination of **community, research and education benefits**. The research includes surveys of students, stakeholders, and faculty and is led by principal investigators Josh Cerra, Todd Walter, Shorna Allred, and Kimberly Williams.

Project Title: **Dynamic sediment-discharge rating curve models to support climate-smart management of water quality in the New York City water supply system**

PI: **Scott Steinschneider** (Cornell University; Biological & Environmental Engineering)

Funding source: USGS



Map of the Esopus Creek watershed

The research conducted in this work developed dynamic (i.e., time-varying) sediment–discharge rating curves for the Esopus Creek, a tributary in the Hudson River Estuary Basin and a major source of water supply for New York City (NYC). These dynamic rating curves were created to help the NYC Department of Environmental Protection (DEP) understand 1) how sediment yield per unit of streamflow has changed over time at multiple temporal scales (daily-decadal), 2) what aspects of climate variability are responsible for these fluctuations, and 3) how these fluctuations could be modeled under future climate scenarios. The analysis emphasized the lasting impact of major floods on the flow-sediment relationship. This information is critically important because high suspended sediment following major floods threatens the ability of DEP to meet the requirements of NYC's Filtration Avoidance Determination, which saves the city billions of dollars in avoided infrastructure costs for drinking water filtration. These events also disturb creek-side communities and aquatic ecosystems downstream on the Esopus Creek in Ulster County. This work will better enable NYC DEP to accurately generate and plan for scenarios of sedimentation under future climate with intensifying extreme events. Key findings include:

- An application of the Dynamic Linear Model (DLM) framework in the **Esopus Creek Watershed** in NY revealed interesting flood-induced positive hysteresis in sediment yield.
- This behavior can be modeled using a latent variable regression model to support **long-term climate change impact assessments**.
- Long-term **projections of sediment yield can vary** substantially under future climate uncertainty depending on whether flood-induced positive hysteresis is considered.

Environmental Monitoring - Detection and characterization of surface and ground water contaminants related to land use and wastewater discharges

Cross-cutting impressions

Previous research focused on defining the scope of nutrient, bacterial and emerging contaminant pollution in New York State waterbodies, and linking this pollution to potential sources as well as potential impacts. Some point sources, such as sewage treatment plant outfalls and combined sewer overflows, emerged as important sources of organic chemical and bacterial pollution, respectively. Pinpointing nutrient sources in the studied watersheds proved difficult; general correlations could not be made between septic system leach field density and either nutrient concentrations in surface water or algal density. Temporal variation of pollutant concentration arose as an important consideration. Monitoring in agricultural areas supported our understanding that these areas can be important sources of nutrient loading to a watershed, especially in the fall and winter. Ongoing microplastic sampling advanced our understanding of how the concentration of this emerging pollutant could vary seasonally to daily with stream discharge.

Current research further refined our understanding of spatial and temporal pollution dynamics. Spatially, several tributaries of the Hudson River Estuary watershed were identified as sources of specific micropollutant types. With respect to microplastics, dams and fish appear to play a role in contaminant spatial distribution, with higher concentrations found in reservoir sediment and lower concentrations found in the fish gut compared to surface water samples. Elsewhere, microbial monitoring confirmed our understanding that urban land uses, and particularly the occurrence of combined sewer overflows, can lead to higher levels of bacteria in stream water. Temporally, stream discharge and rain events impacted contaminant concentration. Microplastic concentrations increased during seasonal low flow periods, and bacterial counts increased during rain events. Both results suggest these pollutants are present on the landscape.

What researchers found

Project Title: **Using multivariate analysis and USGS stream gage data to improve source tracking of micropollutants in the Hudson River Estuary**
PI: **Damian Helbling** (Cornell University; Civil & Environmental Engineering)
Funding source: HREP

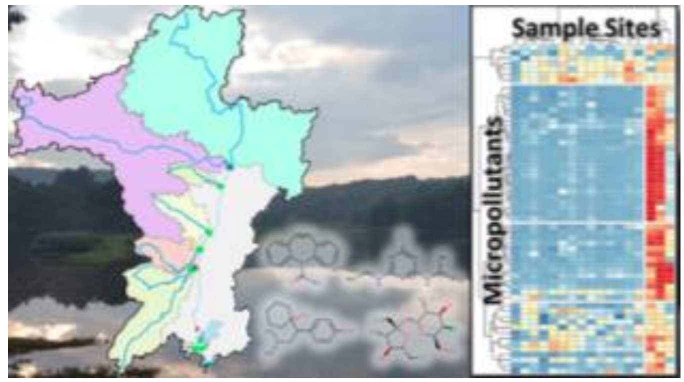


Image and abstract taken from ES&T publication

The objective of this study was to identify sources of micropollutants in the Hudson River Estuary (HRE). We collected 127 grab samples at 17 sites along the HRE over 2 years and screened for up to 200 micropollutants. We quantified 168 of the micropollutants in at least one of the samples. Atrazine, gabapentin, metolachlor, and sucralose were measured in every sample. We used data-driven unsupervised methods to cluster the micropollutants on the basis of their spatiotemporal occurrence and normalized-concentration patterns. Key findings include:

- **Three major clusters of micropollutants** were identified: **ubiquitous and mixed-use** (core micropollutants), sourced from **sewage treatment plant outfalls** (STP micropollutants), and derived from **diffuse upstream sources** (diffuse micropollutants).
- The **Mohawk River** and **Rondout Creek** are major contributors of most core micropollutants and STP micropollutants. The **upper HRE** is a major contributor of diffuse micropollutants.
- These data provide the **first comprehensive evaluation of micropollutants in the HRE** and define distinct spatiotemporal micropollutant clusters that are linked to sources and conserved across surface water systems around the world.

Project Title: **Characterizing microplastics in surface water**
PI: **Todd Walter** (Cornell University; Biological & Environmental Engineering)
Funding source: HREP

Water samples for microplastic enumeration

Microplastic pollution in freshwater is increasingly studied in the waterways of New York State. Detrimental to organisms, both through physical mechanisms such as false satiation and through chemical mechanisms due to contaminant adsorption and particle leaching, microplastics originate from a variety of yet-to-be-quantified sources. This ongoing study aims to support the quantification and source identification of microplastic pollution in the Hudson River through investigative studies to uncover patterns in microplastic concentrations. The past funding cycle supported four projects. Two found plastic concentrations in rivers vary based on time of sampling and presence of dams. A third found that fish collected from the Hudson River showed signs of avoiding consumption of plastic particles. The forth study is still ongoing and looks to compare samples collected using a grab technique to samples collected using a neuston net. Key findings include:

- On dammed streams, microplastic concentrations are highest in the **sediment upstream of the dam**.
- In the two study streams, microplastic concentrations were highest during **low flow**.
- When Hudson fish gut contents are compared to surface water microplastic concentrations, it appears **fish are selecting against microplastics** when feeding.
- Initial findings point toward differences in measured microplastic concentration at a given location based solely on the **sampling technique** used.

Project title: **Bacterial and viral source tracking in the Pocantico and Sparkill watersheds**
PI: **Bernadette Connors** (Dominican College)
Funding source: HREP

In New York State, 792 waterbodies are on the "Impaired/TMDL" list, which identifies bodies of water that might require remediation. The Sparkill Creek, placed on the list first in 2010, empties into the Hudson River. It faces issues with stormwater runoff, causing elevated levels of pathogens in the creek and decreased oxygen availability. The Pocantico River, located in Westchester County, faces many of these same issues. Both were tested for microbial and coliphage loads and diversity as related to weather events. Coliform and *E. coli* levels were measured, with a significant increase found with a rainfall event for both sampling locations. The coliphage numbers and diversity were also significantly different with a rain event. Microbial community analyses were also completed. Of note was increased prevalence of *Enterobacter* and *Escherichia* three miles from the mouth of the creek. Future studies include a more thorough analysis of the microbial community data in both time and space, along with further testing of the fungal, bacterial, and algal populations. Key findings include:

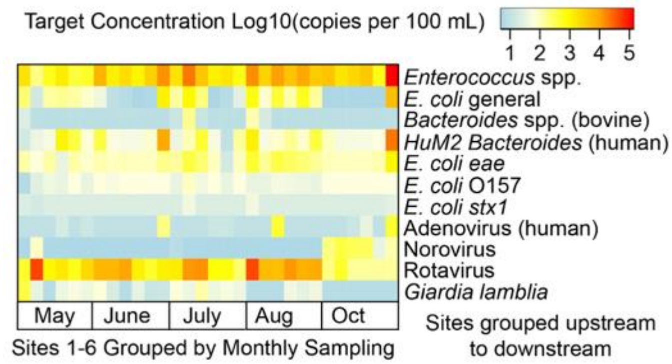
- **Microbial community profiling** yields a more comprehensive view of challenges faced by aquatic ecosystems.
- **Coliphage load**, in addition to coliform levels, provide valuable insights for tracking sources.
- Educational benefits from a project that centers on a local problem allows **undergraduate researchers** an opportunity to **connect with a broader community**.

Project Title: **Community engagement through water quality monitoring along the Mohawk River 2017: Year three of a longitudinal study**
PI: **Neil Law** (SUNY Cobleskill)
Funding source: HREP

Surface water quality is of concern to all citizens in New York state, as drinking water sources, places of recreation, and wildlife habitat. Forty-four sites were sampled in 2017 along the 121-mile length of the Mohawk River (Delta Lake to the confluence with the Hudson River), typically, within a 10-24 h period by boat or from the river's edge in order to generate single day "snap-shot" data sets. Each sample was analyzed for fecal indicator bacteria (Enterococcus) using IDEXX's Enterolert method (EPA Standard Method 9230D). Fifty-two percent of all samples failed the EPA's Beach Action Value of 60 colony forming units/100 ml of sample (CFU/100 ml) for Enterococcus. Of the sampling sites, only Delta Lake passed 100% of the time. Other fecal indicator bacteria, total coliform, and *E. coli*, were measured in samples from selected sites using the IDEXX Colilert system (EPA Standard Method 9223B). These bacteria may enter the waterway through combined sewer overflows, separate sewer system failures, septic system failures, and urban surface water run-off, or agricultural run-off (including domestic and wildlife sources). The 2017 dataset indicates that contamination is greatest after precipitation events in both tributaries and the main stem. Key findings include:

- The **Mohawk River and tributaries** were sampled in 9.5-24 hour periods to create a "snap-shot" of water quality
- Sampling events deemed "**wet weather**" showed **increased bacterial counts** over "dry" consistent with precedents
- **Increased fecal indicator counts** occur at more **urban sites**, near some CSOs, leaks, or other contaminant input sites

Project Title: **Identifying sources of pollution and risks of waterborne pathogens in the Hudson River Watershed**
PI: **Ruth Richardson** (Cornell University; Civil & Environmental Engineering)
Funding source: HREP



Absolute levels heat map of PathogenPanel targets each month from upstream to downstream, left to right

Coordinated volunteer monthly monitoring in the main channel and tributaries of the Hudson River estuary from 2009-present has highlighted certain tributaries with consistently high levels of the fecal indicator bacteria (FIB) Enterococcus. Of the tributaries to the Hudson River that show exceedances of acceptable Enterococci levels, the Wallkill/Rondout River complex is the largest, in both flow rate and in FIB loading levels to the Hudson watershed. However, the presence of FIB do not directly assess drinking or recreational contact risk, but are only "indicators" of pathogen risk. Additionally, FIB do not provide insight into exact FIB sources – knowledge that is important for effective mitigation approaches. Results Here revealed that human and bird feces (and to a lesser extent bovine feces) are significant sources of pollution in some tributaries. Several pathogens (rotavirus, *E. coli* strain EAE, adenovirus, and *Giardia*) were detected in >45% of samples using our high throughput qPCR "PathogenPanel" (on the OpenArray platform by ThermoFisher). Key findings include:

- Both **human** and **bird** feces are substantial contributors to **fecal pollution** in the Wallkill/Rondout tributaries of the Hudson River
- Fecal **pathogens are also present** in some water samples - especially rotavirus, Giardia and specific pathogenic *E. coli* strains
- Some **fecal pathogen levels** showed strong clustering with general and **human** fecal indicators while others (the highly abundant rotavirus) showed clustering with **bovine** fecal indicators

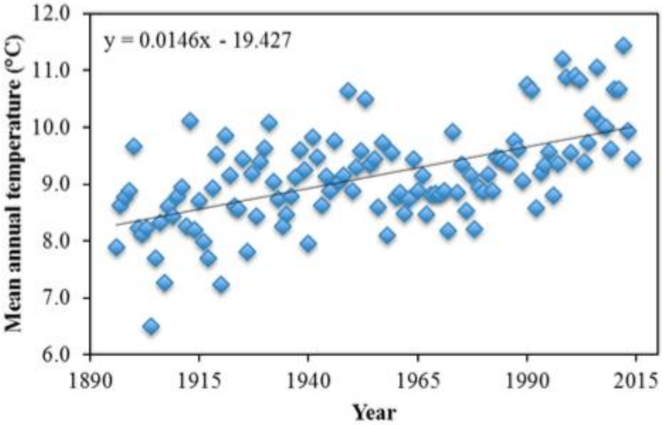
Ecological Assessment – Assessing the current state and trends of watershed ecological characteristics to inform management efforts

Cross-cutting impressions

Current research investigates temporal trends occurring in headwater lakes and riparian buffers within the Hudson River Estuary watershed, with important implications for management. The Sky Lakes were found to be warming and demonstrate stronger stratification over the last 12 decades, which may cause the lakes to become more eutrophic and favor harmful algal blooms. Regionally, narrow riparian buffers were found to have decreasing vegetation coverage. Researchers also demonstrated that resolution of aerial imagery impacts estimates of vegetation coverage, with lower resolution imagery underestimating coverage. Managers looking to rapidly delineate buffer vegetation should consider this limitation.

What researchers found

Project Title: **Variability in water quality and the effect of climate change and teleconnections on lake thermal structure in the Sky Lakes of Shawangunk Ridge**
PI: **David Richardson** (SUNY New Paltz)
Funding source: USGS



Annual air temperature for the Shawangunk Ridge over the last 119 years (1896-2014)

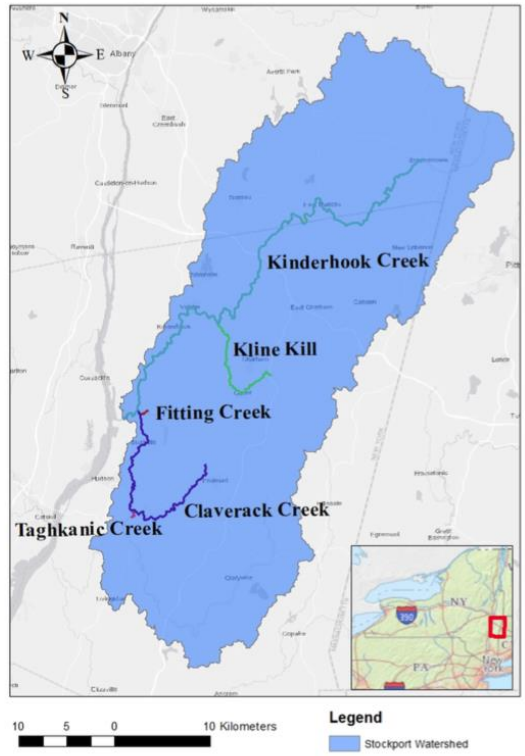
We examined how watershed and climate drivers affect ecosystem structure and function in the critical headwater Sky Lakes along the Shawangunk Ridge of the Appalachian Mountains in the Hudson Valley. We examined longitudinal differences in water quality, including lake physics, biology, and chemistry. We also used a focal lake with long-term temperature data to determine the effects of climate change on the Sky Lakes. This project connected various regional research partners and managers and provided training for an undergraduate research student. Finally, we created 2 short documentaries about the project that can be used for outreach by our various partners. Key findings include:

- We found **three different levels of trophic status** across the Sky Lakes that are close in proximity.
- **Chlorophyta** were the most common algae in all three lakes, followed by Bacillariophyta (diatoms). Cyanobacteria were present only in Mohonk Lake. There was a **weak relationship** between nutrient concentrations and the phytoplankton communities.
- Summer **surface temperatures are warming** at ~0.5°C per decade, and summer stratification is getting stronger over time. Increasingly warm surface temperatures **could favor harmful cyanobacterial algal blooms** and transition lakes towards eutrophication.
- The two documentaries can be seen on the **Richardson lab YouTube channel**.

Project Title: **Geospatial assessment of riparian zones: A case study in the Hudson River Estuary – Stockport Creek Watershed**
PI: **Lindi Quanckenbush** (SUNY ESF)
Funding source: HREP

Riparian restoration and protection provide key benefits in terms of both clean water and resilient communities. Unfortunately, key knowledge gaps exist in terms of understanding the current state and effectiveness of riparian corridors in New York State. The primary objective of this study was to develop a method to delineate buffer vegetation and quantify the spatiotemporal patterns of buffer vegetation variation over time. We tested our method in a sub-watershed of the Hudson River-Stockport Creek Watershed. With an overall accuracy of classifying vegetation and non-vegetation regions within aerial photos above 97%, we were able to confidently determine spatial trends in buffer vegetation for 2006 and 2015. We tested four different buffer sizes and found that there were more areas of vegetation than non-vegetation regardless of size. Hotspot analysis reveals that 15–22% of buffer areas have clusters of vegetation degradation within each year, 30–40% of buffer areas are persistently degraded across the time span studied. Ultimately, our approach can enable stakeholders, managers and community groups to not only rapidly delineate buffer vegetation from high spatial resolution aerial images, but also enable them to assess the spatiotemporal patterns of vegetation variations. Key findings include:

- We found **decreasing trends of vegetation cover** in **30–90 m buffers** over time. However, the 120 m buffer showed an increasing trend.
- Compared to 1 m aerial imagery, results show traditional mapping products based on **30 m satellite images underestimate** the proportion of **buffer vegetation** while overestimating agriculture and other non-vegetation land cover.
- Results of cluster analysis provided further insights into spatial and temporal patterns of buffer vegetation degradation. Such information can be directly utilized to **aid buffer management and restoration efforts** on the ground.



Stockport watershed in southeastern New York State showing creeks included in study: Claverack Creek, Fitting Creek, Kinderhook Creek, Kline Kill, and Taghkanic Creek

Project Title: **Linking land use and climate dynamics to ecological responses of amphibians and reptiles within New York State watersheds: An integrative approach using citizen science**
PI: **James Gibbs** (SUNY ESF)
Funding source: HREP

For more information on this project, please visit the NY Herp Atlas, https://nyherpatlas.org/.

Environmental Policy & Socio-Economic Analysis - Integration of scientific, economic, planning, governmental and/or social expertise to build comprehensive strategies for public asset and watershed management

Cross-cutting impressions

Previous research suggested municipal-university partnerships can lead to useful and educational policy analysis opportunities, and can enhance capacity for watershed management, especially in places where municipalities lack resources.

Current research addresses policy related to stormwater management. Students provided stormwater management recommendations to the Towns of New Windsor and Newburgh, based on NYS stormwater systems design standards. Elsewhere, interviews with professionals and local residents provided insight to the perceptions of flood risk in Troy, NY. Results from both studies can help these communities shape their responses to managing excess water, through both infrastructure or outreach approaches.

What researchers found

Project Title: **Support for Land Use/Environmental Planning Field Workshop**
PI: **George Frantz** (Cornell University; City & Regional Planning)
Funding source: HREP

The Cornell University Land Use & Environmental Planning field workshop in the Spring of 2018 conducted studies of drainage and stormwater runoff and stormwater management systems in the Patton Brook and Silver Stream watersheds that supply the City of Newburgh's public water supply reservoir at Lake Washington. The studies are part of a larger response to the contamination of Lake Washington with the chemical PFOS. The goal of the studies was to develop a more holistic approach to stormwater management from all sources, in order to better protect municipal drinking water supplies. Course objectives included providing students with a working knowledge of stormwater runoff calculations, New York State design standards for managing stormwater, and the innovative uses of green stormwater infrastructure in runoff management. Key findings include:

- The project involved a **whole watershed approach** to **stormwater management** in the two watersheds supplying the Lake Washington reservoir.
- Student teams compiled data on stormwater management practices in the **Town of New Windsor** and **Town of Newburgh**, and identified specific issue areas within the study areas.
- Students developed a working knowledge of **NYS stormwater systems design standards** as well as innovative green stormwater infrastructure practices from around the world.

The CRP 3072/5072 Land Use & Environmental Planning field workshop in the Fall of 2017

Project Title: **The Socioeconomic Implications of Changing Flood Risk in the Hudson/Mohawk Watersheds**

PI: **David Kay** (Cornell University; Community and Regional Development Institute)

Funding source: HREP

Troy, New York in 1911

The purpose of the project includes developing a better understanding of (1) the dimensions of flood risk in an estuarine system – critical with climate change related impacts, (2) how perceptions of flood risk are related to adaptation and mitigation strategies, (3) how responses to risks vary from one community to another, and (4) how varying perceptions of risk should inform/influence outreach strategies at the local level. The exploratory work has been focused on our central goal of developing an understanding of the social landscape of flooding risk and perception in the target cities -- honing in on Troy, NY as our initial in-depth point of exploration. The work in Troy has entailed a review of local press coverage, 10 semi-structured interviews with local professionals and residents, and 2 neighborhood-based focus groups. Our work thus far suggests a series of insights that fall into four thematic areas: (1) Unknown flooding risk; (2) Uneven exposure to material and financial risks; (3) Factors influencing perceptions of risk; (4) Community/Civic capacity. This project seeks to inform local outreach strategies around flood risk, adaptation and mitigation. Key findings include:

- **Flood risk** is multidimensional and **not well understood**, and lacks universally accepted measures within technical as well as community frameworks.
- **Perception of risk** is influenced by **many factors**, including demographics, geography, ideology, awareness, and how specific risks are framed.
- **Community and civic capacity** can enhance or limit flood resiliency – efforts need to be responsive, coordinated, visible, and easily accessed.

Full versions of final reports are available at http://wri.cals.cornell.edu/grants-funding

Outreach – How do we communicate our work?

For a complete listing of outreach activities performed by WRI and HREP staff, please see our website at http://wri.cals.cornell.edu/news

2018-2019 – Funded projects for the next year

Funded projects fall within two administrative categories. Competitive research involves investigators from institutions across the state who responded to a formal request for proposals. These researchers will work largely independently, but can be contacted regarding opportunities for cooperation and outreach. Coordinated research involves Cornell faculty who have agreed to meet quarterly to facilitate discussion and synergy among individuals, as well as with staff from WRI, HREP and the Mohawk River Basin Program.

Competitive Projects

Project Title: **Public Participation in Dam Removal Action: A Cultural- Historical- Environmental Assessment in the Hudson River Estuary** (Karin Limburg – SUNY ESF)

Project Title: **Assessing stakeholder perceptions and facilitating collaboration in the Pocantico River Watershed** (Michael Finewood – Pace University)

Project Title: **Mid-Hudson Young Environmental Scientist Project in Urban Stream Ecology (MH- YES)** (Alan Berkowitz – Cary Institute)

Project Title: **Effect of climate change on nutrient limitation and algal blooms in headwater lakes of the Hudson River** (David Richardson – SUNY New Paltz)

Project Title: **The Pathogen Panel for rapid quantification of 17 waterborne viral, bacterial and protozoal pathogens and fecal indicators at New York State Beaches** (Ruth Richardson – Cornell University; Civil and Environmental Engineering)

Project Title: **Are invasive round goby a new contaminant vector in Northeastern U.S. inland waterbodies?** (Suresh Sethi – Cornell University; Natural Resources)

Project Title: **Turning Vacant Lots into Green Infrastructure: Application of A Multi-objective Optimization Tool in the City of Buffalo** (Zhenduo Zhu - University at Buffalo)

Project Title: **Balancing cyanotoxin removal and N-nitrosamine formation control during ozonation of harmful algal bloom-impacted source waters** (Teng Zeng - Syracuse University)

Coordinated Projects

Project Title: **Design for climate-resilient Hudson River Communities** (Josh Cerra – Cornell University; Landscape Architecture)

Project Title: **The Socioeconomic Implications of Changing Flood Risk in the Hudson/Mohawk Watersheds: Phase II** (David Kay - Cornell University; Community and Regional Development Institute)

Project Title: **Scoping Green Infrastructure in Troy** (Brian Davis – Cornell University; Landscape Architecture)

Project Title: **Sustainable oyster restoration requires oyster reproduction: Variation in reproduction across Hudson/Raritan Estuary environments** (Matt Hare – Cornell University; Natural Resources)

Project Title: **Communicating results of a 2016-2017 micropollutant monitoring campaign to stakeholders in the Hudson River Estuary** (Damian Helbling – Cornell University; Civil and Environmental Engineering)

Project Title: **Hudson Tributary Dam Removal** (Pat Sullivan – Cornell University; Natural Resources)

Project Title: **Assessing Green Infrastructure** (Todd Walter – Cornell University; Biological and Environmental Engineering)

Project Title: **Culvert Assessment** (Todd Walter – Cornell University; Biological and Environmental Engineering)

For more information on these efforts please contact Brian Rahm (bgr4@cornell.edu).

For more information on the HREP Action Agenda, please see: http://www.dec.ny.gov/lands/5104.html