Mohawk Watershed Symposium 2024

Abstracts and Program
College Park Hall, Union College
Schenectady NY
15 March 2024

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Edited by

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ISBN: **978-1-939968-23-4**

Digital version of MWS 2024 abstract volume available as a free PDF download format from the main Mohawk Watershed Symposium website, under the 2024 symposium link: http://minerva.union.edu/garverj/mws/mws.html

Suggested Citation:
Garver, J.I., Smith, J.A., and Rodak, C. 2024. Proceedings of the 2024 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 15, 2024, Volume 14, 90 pages.

On the Cover

The Mohawk River in the late winter (looking west). Here the Mohawk flows past Arrowhead Marina (on right) and Kiwanis Park (on left). These are two recreational hubs - mostly dormant in the winter - that facilitate enjoyment of the River, especially in the navigation season. At this point the Mohawk flows over the Great Flats Aquifer, which is one of the most productive sole-source aquifers in the Watershed. This view is between Lock E8 and Lock E9 on the Erie Canal, but the removable dams are up, so the water level is low. The Watershed has seen remarkable change in the last few years, and warmer winters with less ice may be the new normal. (Photo: JI Garver)

Table of Contents

Abstracts

Preface to the 2024 Mohawk Watershed Symposium

The 14th Mohawk Watershed Symposium offers an exciting and diverse set of presentations on water quality, fisheries and habitats, flooding and resilience, and recreation and stewardship. The 2021-2026 Mohawk River Basin Action Agenda, our critical guiding document, focuses on conserving, preserving, and restoring the Mohawk River Watershed while helping to manage the ecosystem services for a sustainable future. Much of the defining discussion by stakeholders occurs at the annual Mohawk Watershed Symposium, and given this watershed blueprint and ongoing environmental change, we see that the challenge ahead is enormous.

We are experiencing a firehose of environmental change. This last year (2023) was globally the warmest year on record. Winter in the Mohawk Watershed and in the Northeast US was also the warmest on record. The Great Lakes - a source of moisture to the Mohawk Watershed - have the lowest levels of ice cover ever recorded, which affects lake-effect precipitation. The North Atlantic - another source of moisture for the Watershed - is warming remarkably quickly. The Northeast has experienced the largest increase in extreme precipitation in the nation.

There are important warning signs that we may be at a key inflection point. Changes have already occurred in the Watershed, and there is widespread recognition by the public that a response is needed. We as stakeholders need to understand quickly how these changes manifest themselves in the Watershed, and we also need to develop and implement strategies to build resilience and adaptation. The firehose of change affects water quality and drinking water, fisheries, flooding, and infrastructure. If we layer on problems with our aging pipes, bridges, and dams, it is not hard to see that the problems are acute. If we proceed at a business-as-usual pace, we will fail. A critical question is how we respond to these changes and how fast we can respond. Key players in all of this are the stakeholders in the basin who can direct and shape the response.

Flooding remains a central concern of many stakeholders. Flood dynamics are changing in a significant way due to warmer winters and an increase in extreme weather events. The release of the Upstate NY Flood Mitigation task force report in July 2023 was welcome because it illuminated the flood hazard and mitigation options here in the Mohawk Watershed and in the adjacent Oswego Watershed. One thing this report did was highlight the vulnerability of our infrastructure to damaging floods. The report stressed the need for a numerical watershed model for the Mohawk, which will be critically important for understanding flood events and how the channels and floodplains are modified by extreme weather events. The task force report also highlighted the need to address sedimentation in the main stem that is driven by erosion in tributaries; this will be a major challenge.

Water quality remains a central issue in the Watershed. and a large number of stakeholders are focused on improving water quality. For a healthy and vibrant ecosystem and the ecosystem services that the River provides, we need clean water, including drinking water. Fortunately, the quality of drinking water in the Watershed is receiving more and more scrutiny due to legislation associated with the EPA Lead and Copper Rule, lead-testing in schools, and PFAS testing.

Road salt is causing considerable damage to our aquatic ecosystems and drinking water supplies. In September 2023 the Adirondack Road Salt Reduction Task Force released its long-awaited report on assessment and recommendations for salt reduction in the Adirondacks. There is hope that this report will pave the way for a statewide approach to reducing salt, because, as the report shows, the most severe problems are outside the Blue Line, and this is especially true in urban areas in the Mohawk Watershed. A critical piece of the task force report is a much-needed discussion of the regulatory standard for chloride in surface waters.

Our understanding of aquatic organisms and pollution has advanced in remarkable ways in part due to the ability to identify genetic material in water. Environmental DNA (eDNA) is being used to track invasive species that are accessing the Mohawk Watershed through the Erie Canal, and to understand how dams are keeping some native migratory fish from accessing the Watershed. Water-quality monitoring benefits from dramatic reduction in cost, and in addition the source of bacteria in polluted waters can be pinpointed using host-specific genetic markers in water samples (qPCR) using Microbial Source tracking (MST). Molecular methods are also being coupled with nutrient sampling to explore microbial populations in the Mohawk and the potential for formation of toxic algal blooms. Therefore we are at a point where we are addressing old problems with new analytical tools, and addressing new problems with those same tools.

A major concern are threats to ecosystem integrity in the Mohawk Watershed from aquatic invasive species (AIS). As we have seen in the past few years, the invasive pressure is primarily west to east, and mainly along the Erie Canal Corridor. We have watched the stunning success of the Round Goby, which entered the Mohawk and worked its way into the Hudson River. With such a high density of invasive species in the Great Lakes due to dumping of ballast water, there is pressure to stem the flow of AIS that are entering the Hudson-Mohawk from the west. This is complicated and difficult, and involves multiple levels of stakeholder engagement.

Hopefully we are entering a new era of increased communication and stakeholder engagement in the Mohawk Watershed. Stewardship and education at the community level are a critical piece of effective watershed management. Youth education programs centered on water quality and ecosystem health ensure that all our waterways pass into the hands of the next generation with active, engaged, and knowledgeable stewards in place.

The 2024 Mohawk Watershed Symposium features 34 presentations that cover a wide range of topics. We are delighted to see so many familiar names and welcome those new to the Symposium.

Enjoy the day.

John I. Garver, Geosciences Department, Union College

Jacqueline A. Smith, Geosciences Department, Union College

Carolyn M. Rodak, Civil and Environmental Engineering, Union College

MWS 2024 Co-chairs

Major Financial Support for MWS 2024

Major Financial support for MWS 2024 was provided by the **New York State Department of Environmental Conservation though the Mohawk River Basin Program**.

The Mohawk River Basin Program (MRBP) is a multi-disciplinary environmental management program focused on conserving, preserving and restoring the environmental, economic, and cultural elements of the Mohawk River Watershed. Through facilitation of partnerships among local, state and federal governments, the MRBP works to achieve the goals outlined in the Mohawk River Basin Action Agenda (2012-2016). The MRBP sees the continuation of the Union College Mohawk Watershed Symposium as an ideal platform for communication among stakeholders at all levels.

The MRBP partners with organizations such as the **New York State Water Resources Institute (WRI)**, a government mandated institution located **at Cornell University**, whose mission is to improve the management of water resources. This year, through the cooperative relationship between the MRBP and Cornell University (WRI), funding was offered to help support and sponsor the Symposium.

Riverkeeper's mission is to protect the environmental, recreational and commercial integrity of the Hudson River and its tributaries. Visit the webpage to learn more: Riverkeeper.org.

2024 Mohawk Watershed Symposium - Exhibitors

Capital-Region Partnership for Regional Invasive Species Management (PRISM) Covering the counties of Albany, Columbia, Montgomery, Rensselaer, Schenectady and portions of Fulton, Greene, Herkimer, Saratoga, Warren, and Washington, the Mission of the Capital Mohawk PRISM is to: *"Detect, prevent, and control invasive species through direct action and education to protect biodiversity, the natural environment, economy and quality of life." www.capitalregionprism.org*

Cornell University – The NYS Water Resources Institute (WRI)
Through the Federal Water Resources Research Act of 1984, WRI was established under state law in 1987 to address water resource quality and management through research, outreach and education, grant and funding opportunities, and building relationships with state agencies, professional organizations and citizen stakeholder groups. *https://cals.cornell.edu/water-resources-institute*

Day in the Life of the Hudson & Harbor (DITL)
A field-based, collaborative student-focused community science project supported by the NYSDEC Hudson River Estuary Program and operated in partnership with the National Estuarine Research Reserve and Lamont-Doherty Earth Observatory centered on sampling in the Hudson River Estuary and extending to wider reaches of the watershed. Teachers and education partners team up to bring students to the water's edge to collect samples and learn from the river to both celebrate the Hudson River and its watershed and to educate participants on the uniqueness of these valuable local resources. *Student & Educator Programs: Day in the Life of the Hudson & Harbor | Lamont-Doherty Earth Observatory (columbia.edu)*

Drinking Water Source Protection Program (DWSP2)
DWSP2 is a locally led, state-supported program that empowers municipalities to take action to improve and protect their public water sources and surrounding environment. Communities work with technical assistance providers to develop and initiate implementation of Drinking Water Source Protection Programs to protect their drinking water sources now and into the future.
https://dec.ny.gov/environmental-protection/water/water-quality/dwsp2

Hudson River Watershed Alliance The Hudson River Watershed Alliance's mission is to unite and empower communities to protect our shared waters. The Alliance works across the Hudson River watershed to support watershed groups, help communities work together on water issues, and communicate as a collective voice, empowering effective stewardship to ensure the availability of clean, abundant water today and into the future. *https://hudsonwatershed.org/*

iMapInvasives – New York Natural Heritage Program (NYNHP)
NYNHP administers i*MapInvasives* as the official centralized invasive species database for New York State. Conservation partners across the state use *iMap* to document surveys, track management efforts, and gather information to inform management decisions. NYNHP is a program of the State University of New York College Environmental Science and Forestry (SUNY-ESF) funded primarily by the NYS Department of Environmental Conservation (NYSDEC). *www.imapinvasives.org*

Mohawk Hudson Land Conservancy
The Mohawk Hudson Land Conservancy's mission is to conserve and steward lands and waters of the Mohawk and Hudson River Valleys for the benefit of people and the environment. Our conservation work protects natural resources to ensure clean water, clean air, and working landscapes for farming and forestry for a healthier Capital Region for current residents and for future generations.

2024 Mohawk Watershed Symposium - Exhibitors

Mohawk River Basin Program

DEC's Mohawk River Basin Program (MRBP) works to promote the integrated and coordinated management of the many environmental resources of the Mohawk River and its unique watershed. As a partnership-based initiative, the MRBP fosters collaborative decision-making based on an understanding of the entire ecosystem, recognizing that the complex issues within the region cannot be fully resolved by managing certain sectors, species, or pollutants on an individual basis.
https://dec.ny.gov/nature/waterbodies/lakes-rivers/mohawk-river-watershed

New York Sea Grant

New York Sea Grant (NYSG) is a statewide network of research, education and extension services promoting coastal community economic vitality, environmental sustainability and citizen awareness about the State's marine and Great Lakes resources. NYSG is a federal academic partnership between National Oceanic and Atmospheric Administration (NOAA), Cornell University and the State University of New York. *https://seagrant.sunysb.edu*

New York State Canal Corporation

The New York State Canal Corporation operates and maintains the 524-mile New York State Canal System, a network of waterways and trails, available for public use. The Canal Corporation is committed to environmental stewardship and regularly collaborates with many organizations on aquatic invasive species risks throughout the canal corridor.
canals.ny.gov/community/environmental/Invasive_Species.html

Riverkeeper

A member of the Mohawk River Basin Program's steering committee, Riverkeeper is a non-profit organization formed in 1966 and devoted to protecting the Hudson River and its tributaries. Riverkeeper's work in the Mohawk River watershed began in 2014, when Capt. John Lipscomb extended his Hudson River patrols into the Mohawk and continues with water quality monitoring in partnership with SUNY Cobleskill and SUNY Polytechnic.
www.riverkeeper.org

Schoharie River Center – Environmental Study Teams

Established in 1999, the Schoharie River Center (SRC) is a not-for-profit organization dedicated to educational and cultural programming about Schoharie Creek and surrounding communities. SRC operates and sponsors Environmental Study Team (EST) programs designed to engage middle and high school youth to study, monitor and improve water quality of local streams, rivers, and lakes. While learning about their environment, EST members go hiking, swimming, biking, cross-country skiing, snowshoeing, canoeing, kayaking, and sailing, and in the spring can learn how to make maple syrup in the Center's maple syrup sugar shack.
www.schoharierivercenter.org

United States Geological Survey (USGS)

As the Nation's largest water, earth, and biological science and civilian mapping agency, USGS collects, monitors, analyzes, and provides science about natural resource conditions, issues, and problems. USGS' diverse expertise enables them to carry out large-scale, multidisciplinary investigations and provide impartial scientific information to resource managers, planners, and others. In partnership with the Mohawk River Basin Program, USGS has taken the lead on projects such as Ice Jam Monitoring, Sediment Monitoring, Fish Assemblages of the Mohawk, and assisting with outreach and education efforts. *www.usgs.gov*

Mohawk Watershed Symposium - 2024

15 March 2024, College Park Hall, Union College, Schenectady NY

Oral session (College Park) - Registration and badges required. No photography

7:30 AM	8:00 AM	***Registration, Coffee - College Park***
8:00 AM	8:05 AM	**Introductory Remarks** *Carolyn Rodak, MWS Co-chair, Civil and Environmental Engineering, Union College, Schenectady, NY*
8:05 AM	8:20 AM	**Flood of October 31 to November 3, 2019, East Canada Creek, West Canada Creek, and Sacandaga River Basins** *Alexander P. Graziano, U. S. Geological Survey – New York Water Science Center, Troy, NY*
8:20 AM	8:45 AM	**Upstate Flood Mitigation Task Force Report** *Kenneth Kemp, New York Power Authority and New York Canal Corporation, Albany, NY*
8:45 AM	9:00 AM	**Submerse NY: creative approaches to flood risk communication and outreach through public art** *Kristen Hychka, NYS Water Resources Institute, Cornell University, Ithaca, NY*
9:00 AM	9:15 AM	**Invasive Water Chestnut and sediment accumulation above the Crescent Dam threaten navigation in the Erie Canal** *John Garver, MWS Co-chair, Geosciences Department, Union College, Schenectady, NY*
9:15 AM	9:30 AM	**Salinity tolerance of Round Goby: informing expansion potential in the Hudson River Estuary** *Kelsey Alvarez del Castillo, Dept. of Natural Resources and the Environment, Cornell University, Ithaca, NY*
9:30 AM	10:15 AM	***COFFEE and POSTERS (see next page for listing)***
10:15 AM	10:30 AM	**Use of environmental DNA to assess American Eel distribution, abundance, and barriers in the Mohawk-Hudson river system** *Scott George, U.S. Geological Survey, New York Water Science Center, Troy, NY*
10:30 AM	10:45 AM	**Blueback Herring Alosa aestivalis in the Mohawk River: The Good, the Bad and the Ugly** *Wes Eakin, Department of Natural Resources and the Environment, Cornell University, Ithaca, NY*
10:45 AM	11:00 AM	**Canals and aquatic invasive species: protecting New York's waterways from harmful species** *Kate Littrell, New York Power Authority and New York Canal Corporation, Albany, NY*
11:00 AM	11:15 AM	**Addressing aquatic invasive species movement through the Champlain Canal: partnership efforts working toward solutions** *Meg Modley Gilbertson, Lake Champlain Basin Program and New England Interstate Water Pollution Control Commission, Grand Isle, VT*
11:15 AM	11:40 AM	**Why is managing invasive species such a hard problem?** *Stuart Findlay, Senior Scientist Emeritus, Cary Institute of Ecosystem Studies, Millbrook, NY*
11:40 AM	1:05 PM	***LUNCH and POSTERS - Lunch at College Park Hall***
1:05 PM	1:30 PM	**Nitrogen in the Mohawk River and comparable freshwater systems: sources, cycling, and effects on primary production and harmful algae** *Julian Damashek, Hamilton College, Clinton, NY*
1:30 PM	1:45 PM	**What's in the water? Critical statistics from sewage release reports and your "Right to Know"** *Carolyn Rodak, MWS Co-chair, Civil and Environmental Engineering Department, Union College, Schenectady, NY*
1:45 PM	2:00 PM	**The New York State Climate Impacts Assessment: ecosystem effects in the Mohawk watershed** *Douglas Burns, U.S. Geological Survey, New York Water Science Center, Troy, NY*
2:00 PM	2:25 PM	**Drinking water quality and source water protection: challenges in a changing climate** *Shannon Roback, Riverkeeper, Ossining, NY*
2:25 PM	2:50 PM	**A Day in the Life of the Hudson & Harbor** *Rebecca Houser, Education and Outreach Specialist, NYSDEC Hudson River Estuary Program, New Paltz NY*
2:50 PM	3:45 PM	***COFFEE and POSTERS (see next page for listing)***
3:45 PM	4:10 PM	**Watershed-scale organizing in the Hudson River Watershed: lessons learned and opportunities** *Emily Vail, Hudson River Watershed Alliance, Kingston, NY*
4:10 PM	4:25 PM	**My time on the Mohawk** *John Lipscomb, Riverkeeper, Ossining, NY*
4:25 PM	4:55 PM	**Congressman Paul Tonko, NY 20th District**
4:55 PM	5:00 PM	**Concluding Remarks** *John Garver, MWS Co-chair, Geosciences Department, Union College, Schenectady, NY*

*The lead or presenting author(s) is(are) listed here; for complete author listings and affiliations please refer to the abstract.

5:00 PM	7:00 PM	***Symposium Reception in College Park Hall Lobby, 5:00 - 7:00 PM***

Poster session (all day)

P1 **Problems, progress, and prognoses on the North Chuctanunda Creek and urban trail through Amsterdam**
John Naple, Friends of North Chuctanunda Incorporated, 128 Market Street, Amsterdam, NY

P2 **United States Geological Survey Ice Jam Monitoring Network on the Mohawk River in Schenectady, NY**
Chris Gazoorian, U.S. Geological Survey, New York Water Science Center, Troy, NY

P3 **Rapid, long-range movement and establishment of Round Goby in the Hudson River, NY confirmed through traditional fish sampling, eDNA, and otolith microchemistry**
Rich Pendleton, Cornell University in cooperation with NYS Dept. of Environmental Conservation, New Paltz, NY

P4 **Survey of recreational boating in the Mohawk Watershed**
Daniel Miller, US Coast Guard Auxiliary, Sacandaga-Mohawk Flotilla, Glenville, NY

P5 **Engaging community through art: an ecological field class on the Mohawk River**
Anna Mehlhorn, Department of Natural Resources and the Environment, Cornell University, Ithaca, NY

P6 **PFAS concentration in whole-body fish tissue over 7 years of monitoring downstream of AFFF spill, Rome, NY**
Adam Haines, NYSDEC, Department of Fish and wildlife, Bureau of Ecosystem Health, Albany, NY

P7 **The Schenectady Environmental Education Center: connecting communities, parks, and schools through environmental literacy education and neighborhood-based stewardship activities**
John McKeeby, Executive Director, Schoharie River Center, Inc., Burtonsville, NY

P8 **Risk communication and the MyCoast App: an exploration of the challenges and benefits of applications for documenting flooding in the Lower Hudson Valley**
Michael H. Finewood,Department of Environmental Studies and Science, Pace University, Westchester, NY

P9 **Fluoride as a tracer of municipal water: the Hans Groot Kill case study in Schenectady, NY**
John Garver, MWS Co-chair, Geosciences Department, Union College, Schenectady, NY

P10 **Water quality of the Kromme Kill and Collins Lake system, Scotia and Glenville NY: septic failure and salinization**
Emma L. Phillips, Environmental Science and Policy Program, Union College, Schenectady, NY

P11 **Microplastic analysis of high-flow and low-flow streams located in Rensselaer County: final results**
Inara Ilse, Columbia High School, East Greenbush, NY

P12 **Impacts of road salt on drinking water quality**
Louis Albanese, Bennington College Endeavor Fellows, Bennington, VT, and Riverkeeper, Ossining, NY

P13 **Configuration and time-related deformation of isolated islands within the Schoharie Creek**
Ashraf Ghaly, Civil and Environmental Engineering, Union College, Schenectady, NY

P14 **Dam removal: logical or controversial?**
Ashraf Ghaly, Civil and Environmental Engineering, Union College, Schenectady, NY

P15 **Observations from longitudinal monitoring of fecal indicator bacteria (*Enterococci* and *Escherichia coli*) in the Mohawk River Watershed**
Neil Law, Department of Natural Sciences, SUNY Cobleskill, Cobleskill, NY

P16 **DNA barcoding for the detection of invasive species in the Hudson River: a molecular approach for ecosystem monitoring**
Shalini Varma, BCP Department, Hudson Valley Community College. Troy, NY

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Symposium Reception in College Park Hall Lobby, 5:00 - 7:00 PM

John Lipscomb
Riverkeeper

John Lipscomb has been a longtime advocate for the Mohawk River, especially since he established water-quality testing and patrols in 2014. John is the Patrol Boat Captain and Vice President for Advocacy at Riverkeeper. He started patrolling the Hudson for Riverkeeper in 2000 on the *R. Ian Fletcher,* a 36-foot Chesapeake-Bay-style wooden vessel. The boat is an icon, and when it enters the Waterford Flight to patrol the Mohawk, both the boat and John are instantly recognized by lock tenders.

John has a natural ability to connect with people he encounters on his patrols, and on the Mohawk this includes lock tenders, boaters, scientists, and public officials. His presence on the Mohawk was no accident. Bob Boyle was one of the first and earliest advocates for the Mohawk Watershed Symposium, and he was the first keynote speaker in 2009. Over half a century ago Bob was instrumental in the founding of the Hudson River Fishermen's Association, which was the predecessor of Riverkeeper. Bob appreciated how badly the Mohawk River needed an advocate and a presence. At the urging of Bob, John Lipscomb was invited to be the keynote speaker at the 2016 Mohawk Watershed Symposium, which introduced John to many stakeholders in the Watershed. John's patrols along the Mohawk then became routine, and Riverkeeper has since had an expanding presence in the Mohawk.

John loves the Mohawk, and he has remarked that the river has a totally different feel from the Hudson, mainly because it is rural and less hectic - certainly compared to the lower Hudson. In February 2024, after 22 years of patrols, John announced that he will be retiring from Riverkeeper after the end of the 2023 patrol season, and thus it is time for a transition.

Stakeholders in the basin appreciate the advocacy that John has done for the River, and we know that this River will also be forever a part of him. We welcome him back to the Mohawk Watershed Symposium, and we thank him for his years of service and inspiration.

Congressman Paul Tonko
NY 20th Congressional District

Congressman Paul D. Tonko is an eight-term member of the U.S. House of Representatives, representing New York's 20th Congressional District in the Capital Region, including most of the lower part of the Mohawk Watershed. Paul serves on the Energy and Commerce Committee, the oldest standing committee in the House. He is the Ranking Member of the Energy and Commerce Subcommittee on Environment, Manufacturing, & Critical Materials. In addition to serving on the Energy and Commerce Subcommittee on Energy, Climate, and Grid Security, and Subcommittee on Oversight & Investigations, he is also a member of the Committee on Science, Space, and Technology.

In 2021, Congressman Tonko introduced the NY-NJ Watershed Protection Act. He has long advocated for watershed protection and economic development along our historic and iconic waterways - including the Mohawk River. Early versions of the bill were first introduced as the Hudson-Mohawk River Basin Act of 2012, and that bill was modified and reintroduced to the US House as the Hudson-Mohawk River Basin Act in December 2016 and then in December 2018. The NY-NJ Watershed Protection Act, which was reintroduced in April 2023, grew from these earlier efforts on the Mohawk River.

Paul Tonko grew up on the Mohawk, and he has long advocated for watershed protection. Part of his early focus in the Watershed was on his *Mighty Waters* task force. In July 2010, he hosted the first Mighty Waters Conference at the Schenectady County Community College. This conference focused on promoting sustainable and responsible waterfront development projects to improve the quality of life in communities along the Hudson and Mohawk Rivers and Erie Canal. In early 2011 the Mighty Waters effort had developed a mission statement, which read: *"The mission of the Mighty Waters Task Force is to help create a climate of investment, recovery and public awareness for the waterways and communities of the upper Hudson and Mohawk Rivers, Erie Canal and related waterways by mobilizing federal resources that encourage policy reform, economic development, public access and enjoyment and effective environmental and cultural resource management."*

Congressman Tonko has long been a champion for clean energy and the environment. Prior to serving in Congress, he was the president and CEO of the New York State Energy Research and Development Authority. Before that, he served in the New York State Assembly for 25 years, serving for 15 years as Chairman of the Committee on Energy. Tonko graduated from Clarkson University with a degree in mechanical and industrial engineering and is a former engineer for the New York State Public Service Commission.

We welcome Congressman Tonko back to the Mohawk Watershed Symposium.

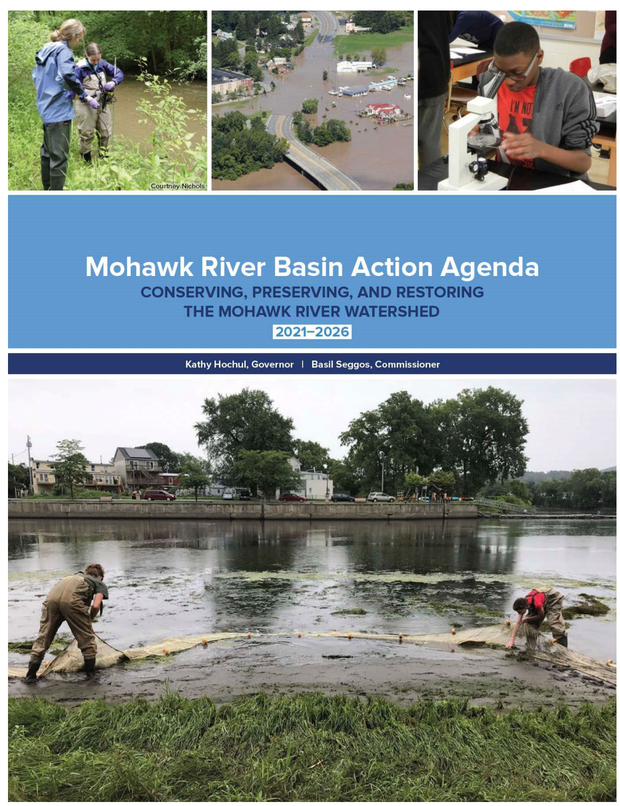
Katherine M. Czajkowski

Mohawk Watershed Coordinator
NYS Water Resources Institute at Cornell University

Kathy is the Mohawk Watershed Coordinator, and directly assists the NYS DEC with coordination and implementation of the Mohawk River Basin Program and Mohawk River Basin Action Agenda. Kathy has focused much of her professional work in the Watershed protecting and restoring the environment. Two decades ago, she was involved with the FEMA Flood Protection and Stormwater Program. She worked as a stormwater specialist with Schenectady County Soil and Water Conservation District. She came to appreciate the wisdom of working at the watershed scale, and of course this meant problems and solutions crossed political boundaries.

Following the devastating flooding of Hurricane Irene and Tropical Storm Lee in 2011, Kathy accepted the position as the Mohawk River Watershed Coordinator through the NY Water Resources Institute at Cornell. Her tasks include implementing the department's Mohawk River Action Agenda, designed to focus on the protection and restoration of the River, its watershed and its communities.

As Watershed Coordinator, she has played an important role in facilitating stakeholder engagement and implementing the Mohawk River Action Agenda. This action agenda is our guiding document - our blueprint for action in the basin. The mission of the Action Agenda is to conserve, preserve, and restore the environmental quality of the Mohawk River, helping to manage the watershed's resources for a sustainable future. Kathy has played a key role in juggling a variety of interests and organizations that have had a hand both in writing the Action Agenda and in implementing it.



In an interview with her alma mater, University at Albany, Kathy said "Your chosen career is something that you should be doing because it is something that inspires you..." Stakeholders in the Watershed appreciate her guiding hand with the Mohawk River Action Agenda and all the effort and energy that has resulted in improvements across the basin.

Kathy will be retiring this year and she will be greatly missed.

Impacts of road salt on drinking water quality

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Introduction

Road salt, in the form of rock salt, has been used for decades as the most commonly used de-icing agent in New York State and throughout the U.S., with use increasing markedly since the 1990s and doubling since the 1970s. Best management practices, including by switching to salt brine, can dramatically reduce the amount of salt required to produce the same safe roads, have likewise been well established for well over a decade, if not more (American Geosciences Institute, 2014; Cary Institute, 2010).

Riverkeeper analyzed the publicly available Annual Water Quality Reports for communities in our mission area, the Hudson River Watershed, which covers approximately 25% of the land area of New York State. Our research looked at 145 water supplies serving 2.65 million New Yorkers. More than half of these New York State residents have been delivered tap water that should not be consumed by those on very low sodium diets. These 78 water supplies have delivered water to 1.239 million New Yorkers with sodium concentrations above 20 mg/L. As each Annual Water Quality Report states – in footnotes that would be easily missed by all but the most informed readers – "Water containing more than 20 mg/L of sodium should not be used for drinking by people on severely restricted sodium diets." As with many environmental threats, road salt's effect on drinking water appears to have a disproportionate impact on communities in New York State identified as Potential Environmental Justice Areas (PEJA) or Disadvantaged Communities, based on their demographics and incomes. Out of the 78 water supplies that reported concentrations above 20 mg/L of sodium in their drinking water, 46 serve Potential Environmental Justice Areas with a population of 1,046,817 (Hudson Watershed AWQR's, 2021 & 2022).

Public Health implications

As of 2016, an estimated 31.7% of New York State residents had been diagnosed with hypertension, or high blood pressure, one of the leading risk factors for cardiovascular disease and stroke (NYS DOH, 2018). Heart disease is the leading cause of death in New York State (NYS DOH, 2010-2020). Reducing sodium intake is the top lifestyle recommendation for all those diagnosed with hypertension. (International Society for Hypertension, 2020 & Mayo Clinic). In addition to direct concerns about dietary intake of sodium, sodium chloride can change the chemistry of water, potentially leading to:

- increased leaching of lead from water distribution pipes (Kelsey, 2018);
- increased risk of other harmful metals mobilized from source waters (Wu & Hwidong, 2017);
- increased risk of Harmful Algal Blooms (Hintz & Relyea, 2019).

Results

Table 1. Population affected by concentrations of sodium exceeding 20 mg/L in drinking water.

	Population	Number of communities studied	Number of PEJA communities studied	PEJA communities - population	Number of disadvantaged communities studied	Disadvantaged communities - population
TOTAL	2,653,821	145	80	2,067,998	73	1,486,780
ABOVE 20 MG/L SODIUM	1,390,597	78	46	1,046,817	38	454,141
BELOW 20 MG/L SODIUM	1,196,582	50	28	991,198	31	1,008,785
SODIUM LEVELS NOT PROVIDED	66,642	17	6	29,983	4	23,854

References

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Salinity tolerance of Round Goby: informing expansion potential in the Hudson River Estuary

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Background

Round goby (*Neogobius melanostomus*) is one of the fastest spreading non-native fish species in North America. Since their introduction in the Great Lakes in the 1990s, round goby has spread eastward across New York via the Erie Canal and Mohawk River and were first documented in the Hudson River estuary in the summer of 2021. Round goby are a small benthic fish, that can cause major impacts to ecosystems they invade by outcompeting native species, consuming fish eggs, and are a vector for multiple diseases. Conversely, round goby serves as a food source for many fish species and consume invasive dreissenid mussels. Questions arise as to how far throughout the estuary and connected marine environments round goby can spread given the lack of information regarding salinity tolerance of populations in North American coastal watersheds. Here we assess salinity tolerance of round goby through two, lab-based trials.

Methods

For the first trial, round gobies were taken from two distinct locations on the eastward expansion front: Oneida lake and the Mohawk-Hudson River confluence. Study specimens were held at an energetically optimal temperature of 20°C and subjected to regular salinity increases of 3ppt per week, concluding at 33ppt. Round gobies from only Oneida Lake were used in the second trial due to no significant ($p<0.05$) difference in mortality rate between Mohawk River and Oneida Lake round gobies in the first trial. The second trial consisted of tanks held at a 26°C and 5°C, representing temperature extremities expected in the Hudson River watershed to determine whether temperature impacts round goby salinity tolerance.

Results and Conclusions

When held at 20°C there was 0% mortality up to 24ppt salinity, which increased to 17.5% at 27ppt, 78.5% at 30ppt, and 100% by 33ppt. Mortality in the warm water treatment (26°C) occurred earlier than at 20°C with 1% mortality at 21ppt, and increased to 12% at 24ppt, 62% at 27ppt, 93% at 30ppt, and 100% by 33ppt. Earlier mortality in the warm water was anticipated as warmer water increases metabolism and osmoregulation rates. We believe experimental fish in the warm water could not meet the energy requirements needed to keep up with the increased physiological demands associated with temperature and salinity stress. In contrast, at 5°C water only 14% mortality occurred throughout the trial, while the remaining round gobies persisted at the endpoint salinity of 33ppt until the experiment concluded. These results indicate that round goby may be able to overwinter in high salinity waters, at least temporarily. No control fish died in either the 20°C or 26°C treatment, however there was background mortality in the control tanks at 5°C, resulting in no significant difference between experimental and control tanks in the cold-water treatment.

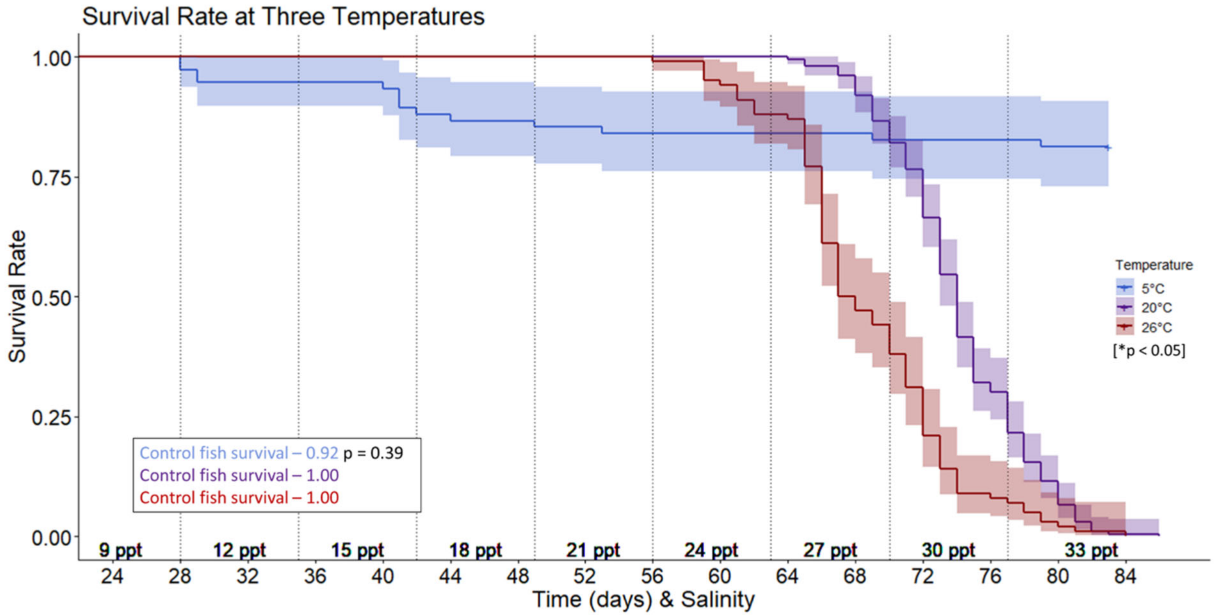

Figure 1: Survival rate of experimental round gobies during three temperature-modulated salinity trials.

Combined with observations on experimental fish condition, results indicate that round goby may tolerate salinities consistent with a large portion of Hudson River estuary waters throughout a majority of the year, however, this species may be unlikely to survive full strength marine salinities year-round. Further understanding about the ability of round goby to reproduce and establish sustainable populations in higher salinities remains an important knowledge need to understand the spread potential of this introduced species to brackish and marine environments in North America.

The New York State Climate Impacts Assessment: ecosystem effects in the Mohawk watershed

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New York State has released a climate impacts assessment report that encompasses eight sectors, including: agriculture, buildings, ecosystems, energy, human health and safety, society and economy, transportation, and water resources. Each sector was led by a group of expert authors and advised by a larger group with specific areas of expertise within each sector. The goal of the report is to describe ongoing and projected future impacts of climate change and to inform climate adaptation policies in New York State. The report does not focus directly on quantification and mitigation of greenhouse gas emissions but dovetails with separate statewide policy-informing efforts that address those topics. In this presentation, I will present results from the ecosystems chapter of the assessment by highlighting findings that are particularly relevant to the Mohawk watershed while emphasizing past, current, and projected future climate change impacts.

Several of the chapter key findings are relevant to the Mohawk watershed including the: (1) increasing consequences of extreme climatic events, (2) effects of rising water temperatures on coldwater aquatic species, (3) amplification of ecosystem impacts by human activities such as land use and management, and (4) acceleration of the spread of many invasive species. Chapter case studies of interest in the Mohawk watershed will be described such as the role of climate in promoting harmful algal blooms and accelerating the spread of hemlock wooly adelgid. High priority was given to environmental justice concerns, and the ecosystems chapter highlights topics of special concern to Native American Nations.

The assessment report is available on-line at https://nysclimateimpacts.org/explore-the-assessment/, and soon in the Annals of the New York Academy of Sciences.

Nitrogen in the Mohawk River and comparable freshwater systems: sources, cycling, and effects on primary production and harmful algae

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Introduction

Given widespread use of the Mohawk River and its tributaries for drinking water, sanitation, and recreation, it is critical to understand the drivers of many water quality parameters throughout the Mohawk watershed. Recent research along the Mohawk has greatly advanced understanding of its water quality, primarily focusing on sources of human pathogens and nutrientns. In turn, this research and monitoring has produced actionable products such as public water quality alerts and development of a phosphorus Total Maximum Daily Load (TMDL). However, nutrient loading to the river has remained relatively high, prompting concern about current and future effects on water quality.

This presentation will focus on nitrogen, a complimentary but less resolved aspect of Mohawk River water quality that has both direct and indirect effects on ecosystem productivity, eutrophication, and toxic algal blooms. First, I will discuss historical and present understanding of nitrogen in freshwater ecosystems, including sources, cycling processes, effects on nutrient limitation, and harmful algae. This will be followed by presentation of data my undergraduate research lab has produced on nitrogen cycling in the Mohawk River, primarily focused on nitrogen sources and their relation to land use. Finally, I will look toward unknowns in our understanding of nutrient cycling in this river, emphasizing how nitrogen inputs and cycling can have rapid (and sometimes unexpected) effects on local and regional ecosystem dynamics, and stressing the need to expand monitoring of specific nutrients beyond standard measurements of phosphate and combined nitrate/nitrite.

For decades, freshwater ecologists and water managers have directed nearly all resources on freshwater nutrient cycling to understanding phosphorus, for an understandable reason: lab- and field-based assessments of primary production suggest phosphorus is the primary limiting nutrient in most freshwater ecosystems (Schindler et al. 2008). This focus is also reflected in policies geared toward minimizing freshwater eutrophication, which almost universally center only on phosphorus. However, both phosphorus and nitrogen are brought to rivers via sewage discharge, urban runoff, and agricultural runoff, all of which tend to increase as local populations grow. There is increasing evidence that the "phosphorus-only" approach to mitigating freshwater eutrophication produces mixed results. In some cases, water quality improvements following phosphorus mitigation have proved short lived, fueling questions about changing conditions or alternate factors. Furthermore, there is a growing literature suggesting nitrogen limitation may occur much more frequently in freshwaters than previously thought, and a wealth of data (including whole-lake manipulations) now suggests co-limitation by nitrogen and phosphorus may be much more important than limitation by either nutrient alone (e.g., Elser et al. 2008, Paerl et al. 2016). In the Mohawk River, as in other systems, this suggests more effort is needed to determine the potentially synergistic effects of different nutrients on ecosystem productivity.

Beyond the question of rate-limiting nutrients, recent research points to nitrogen as an important driver in the growth and toxicity of harmful algal blooms (HABs) in freshwaters. HABs are one of the most critical water quality issues in freshwaters globally, and have been increasing in frequency throughout nearly all of New York State. Though the main stem of the Mohawk remains relatively unscathed, massive algal blooms have occasionally occurred in smaller tributary creeks to the Mohawk and the Hudson, and may be increasing in frequency. Furthermore, any alterations in river flow that lead to transitory stagnant

Garver, J.I., Smith, J.A., and Rodak, C. 2024. Proceedings of the 2024 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 15, 2024, Volume 14, 90 pages.

stretches of water may be ideal nutrient-rich zones for rapid algal growth. The relatively high nutrient load of the Mohawk may make this system "primed" for algal blooms and HABs if favorable conditions materialize, even temporarily. This is a concern for the entire river, but particularly relevant where the river is used as a drinking water source.

A growing body of research indicates nitrogen can be a prime driver of HAB growth and toxicity, and suggests that not all nitrogen is created equal: instead, reduced forms of nitrogen such as urea and ammonium appear to often have direct impacts on HAB-forming species. Though general trends remain elusive, there are some toxin-producing cyanobacteria and algae that grow faster when supplied with urea or ammonium as their nitrogen source (e.g., Steffen et al. 2017, Cai et al. 2021). Furthermore, even when not limiting primary production, both lab and field data suggest increased ratios of nitrogen to phosphorus can drive autotrophic communities toward harmful cyanobacteria, likely due to the high cellular nitrogen demand required for toxin synthesis (e.g., Donald et al. 2011, Erratt et al. 2020). Like many similar freshwater ecosystems, a greater understanding of nutrient ratios and the cycling of specific nitrogen compounds is now a necessary step toward determining the potential risk of high nitrogen loads to the Mohawk River.

Data from the Mohawk River, selected tributaries, and a number of nearby lakes indicate high nitrogen concentrations throughout much of this watershed. Differentiation of nitrogen compounds appears to track different input sources, with elevated nitrate in waters draining agricultural land and higher levels of ammonium and urea near urban centers and sewage discharge sites. Unlike nearby lake sites, the majority of river and stream samples have nitrogen to phosphorus ratios above the canonical Redfield ratio (a common benchmark for nutrient limitation of phytoplankton and algae), indicating a more thorough analysis of nutrient limitation is needed. Microbial sequence data shows numerous stretches of the Mohawk River and tributary creeks contain significant communities of cyanobacteria, including many families with known toxic species, though with the important caveats that our sample size is relatively small and the methods used are not able to reliably distinguish taxonomic identity below the genus level (precluding knowledge about specific cyanobacterial strains). However, these preliminary data suggest both agricultural and urban inputs of nitrogen into the Mohawk River are sustaining elevated concentrations of numerous nitrogen compounds, with the potential to stimulate productivity and harmful algae if conditions favorable to their growth develop.

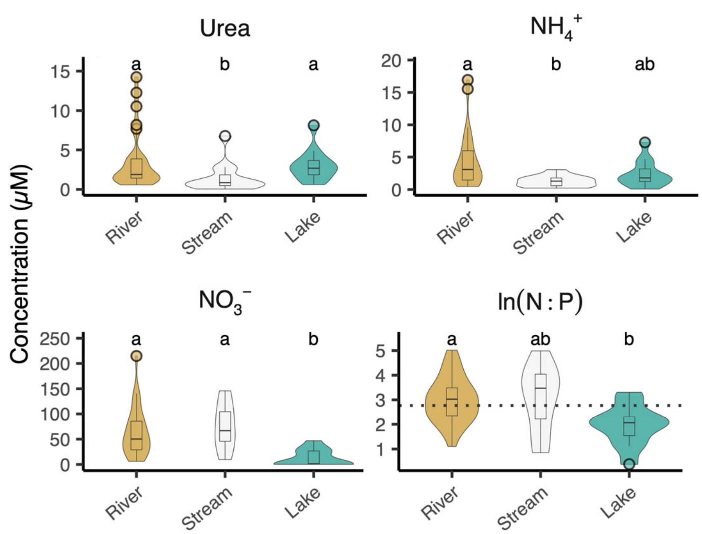

Figure 1. Aggregated nutrient concentrations in the Mohawk River, tributary creeks, and nearby lakes. Width of each violin plot indicates data density. Statistically significant groupings are indicated by lowercase letters. The y-axes show concentration (µM), with the except of the ratio panel.

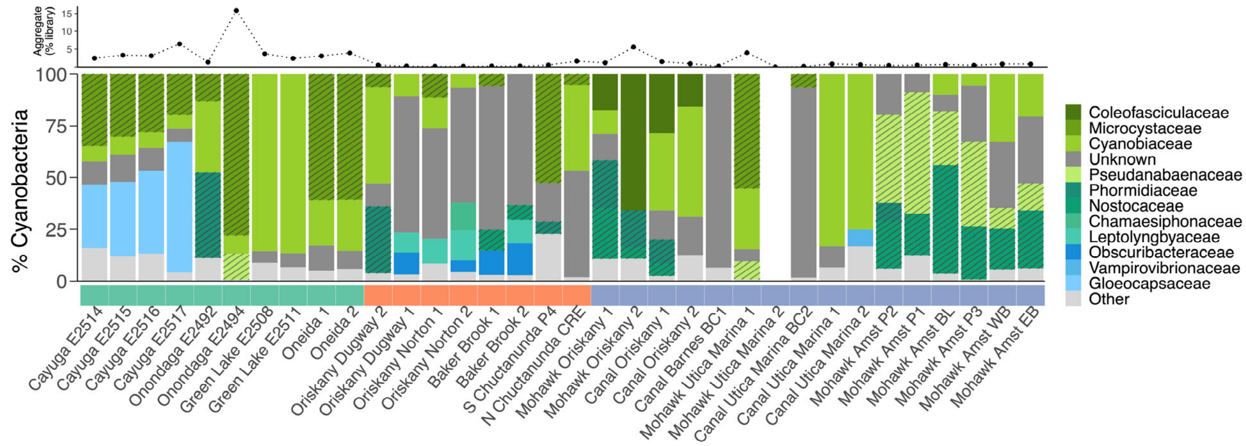

Figure 2. Relative abundance of cyanobacterial reads in 16S rRNA gene amplicon libraries. Stacked bars show the relative abundance of different families, with slashes denoting those containing known toxic species.

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Blueback Herring *Alosa aestivalis* in the Mohawk River: The Good, the Bad and the Ugly

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Introduction

The management of anadromous fishes is inherently complicated as this suite of species exhibit complex life-histories in multiple habitats and are subject to varying natural and anthropogenic influences during discrete ontogenetic periods. Life-history based simulation models have been increasingly adopted by fishery scientists and managers to help understand potential effects of management decisions on fish populations while incorporating uncertainty in life-history, climate, and other components of resource management systems. We applied one such model to Blueback Herring *Alosa aestivalis* in the Hudson River watershed, NY, USA.

Our goal was to better understand influences of historical habitat loss on anadromous fishes and determine to what extent and under what conditions novel habitat created by canal infrastructure might confer increased population abundance. We found that access to historical habitat in the upper Hudson River increased population abundance at all upstream dam passage rates with sufficient downstream survival of adult and juvenile Blueback Herring, but that abundance decreased with increasing upstream passage relative to the "no passage" scenario when downstream survival through dams was not sufficiently high (Figure 1).

Access to novel spawning habitat in the Mohawk River canal system resulted in increased abundance of Blueback Herring when downstream survival of adults and juveniles was at least 0.80 per dam and both upstream passage and probability of using the Mohawk River were both greater than about 0.25. Both mortality during upstream passage of locks in the Mohawk River and marine fishery mortality had the potential to reduce Blueback Herring abundance below historic population abundance despite access to novel spawning habitat (Figure 2 and Figure 3). These results highlight the complexity associated with effects of upstream and downstream fish passage standards on population responses while emphasizing similarities observed in other diadromous species and watersheds.

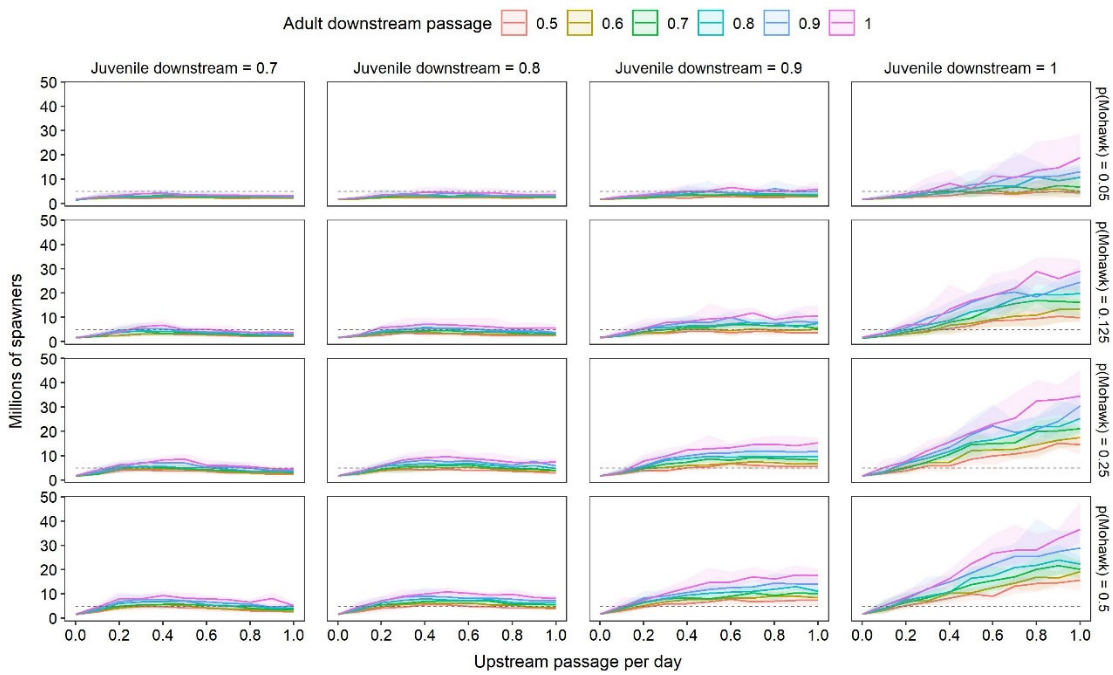

Figure 1. Predicted abundance of spawning Blueback Herring *Alosa aestivalis* in the Hudson River, NY, under varying upstream and downstream fish passage standards and probability of using the Mohawk River without access to spawning habitat in the upper Hudson River. The horizontal dashed line represents the expected population abundance under the "no dam" scenario for historic habitat in the Upper Hudson River. Colored lines represent mean model prediction, and colored polygons are 95% confidence intervals. A total of 10,000 simulations was run, randomly sampling combinations of all input parameters.

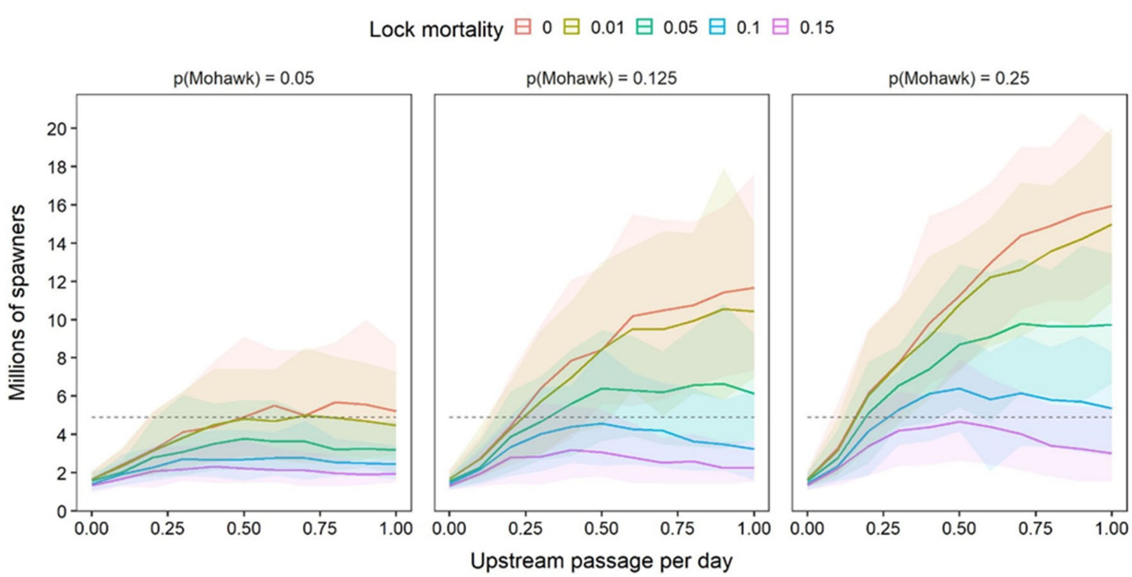

Figure 2. Predicted abundance of spawning Blueback Herring *Alosa aestivalis* in the Hudson River, NY, under varying upstream fish passage (x-axis), probability of using the Mohawk River (panels), and upstream mortality during lock passage (colors) given fixed adult downstream survival through dams of 0.80 and juvenile downstream survival through dams of 0.95. The horizontal dashed line represents the expected population abundance under the "no dam" scenario for historic habitat in the Upper Hudson River. Colored lines represent mean model prediction, and colored polygons are 95% confidence intervals. A total of 10,000 simulations was run randomly sampling combinations of variable parameters.

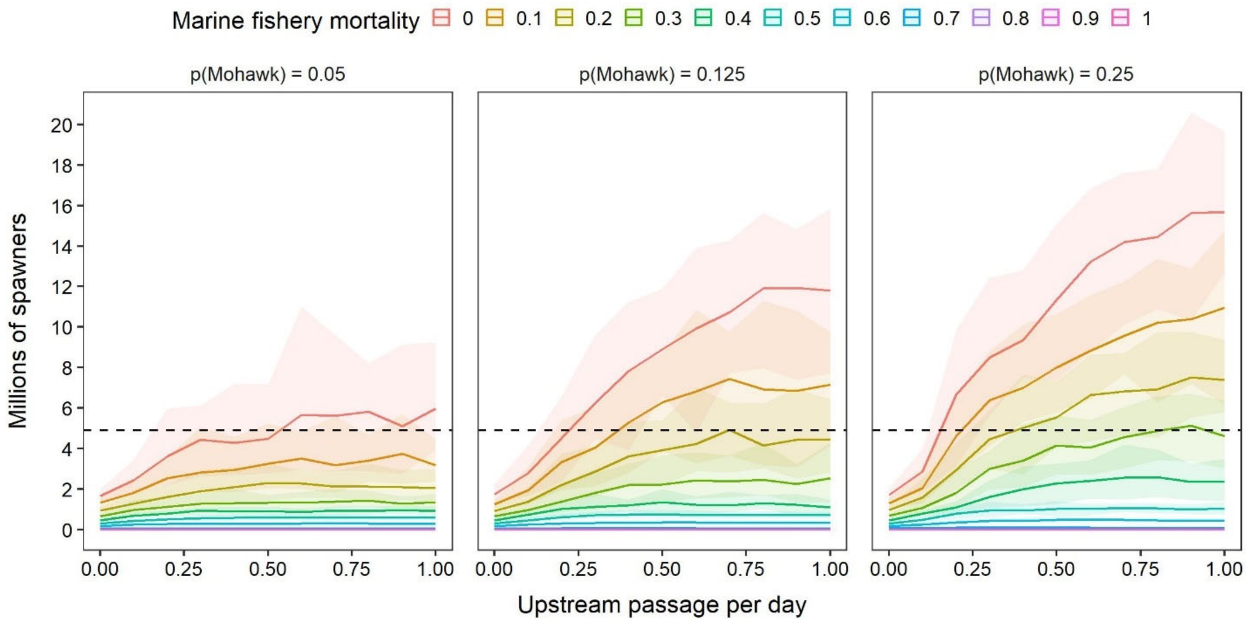

Figure 3. Millions of spawning Blueback Herring *Alosa aestivalis* predicted to return to the Hudson River, NY, USA under varying upstream passage, probability of using the Mohawk River, and annual marine fishery mortality rates with no passage into the upper Hudson River, with adult downstream survival = 0.80, and juvenile downstream survival = 0.95. The horizontal dashed line represents the expected population abundance under the "no dam" scenario for historic habitat in the Upper Hudson River. Colored lines represent mean model prediction, and colored polygons are 95% confidence intervals for 10,000 simulations using randomly sampled combinations of parameters.

Life-history-based simulation models described above suggest potential benefits if dam passage mortality is sufficiently low. However, actual mortality rates remain unknown. A field investigation planned for 2024, involving the tagging of Blueback Herring with 135 acoustic tags, aims to determine mortality rates and answer crucial questions about access to the Mohawk River. We will leverage an existing acoustic receiver array in the Hudson River and deploy 25 additional receivers in the Mohawk River, resulting in an array of ~90 receivers providing extensive coverage of our study area. The study emphasizes complex management challenges posed by dams and locks, acknowledging potential threats while recognizing the opportunity to enhance conservation efforts for this valuable species. The results aim to inform decisions on managing the Mohawk River and Erie Canal system for the benefit of Blueback Herring populations.

Why is managing invasive species such a hard problem?

Stuart Findlay

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Economic and ecological effects of invasive species are recognized regionally, nationally and internationally as a major problem. New and well-founded estimates of costs for damage by and managing existing invasive species in the US are on the order of 25 Billion $/year (Ahmed et al. 2023, Diagne et al. 2021), and most of these expenditures will continue and even grow into the future. At the same time, pathways for new invaders have been identified (Turbelin et al. 2022) and range from fairly intentional movements of plants and animals in the pet and horticultural trades to "come one, come all" vectors such as ballast water, movement of firewood and open waterways interconnecting basins. A Web of Science search (Feb 2024) returned over 9,000 records dealing with prediction of invasive species. These studies used a variety of approaches from tracking historical spread to identifying potential niches open to invaders. So, given this is a well-recognized widespread problem with reasonably well understood causes why have we done (and are doing) such a poor job on preventing future invasions?

I will put forward what I believe to be three broad reasons for our poor performance on solving this problem and while the applicability to any particular case will vary, I feel it is useful to discuss and debate the generic attributes of this problem that have impeded progress.

Firstly, actions or regulations to block a particular pathway of invasion often impose specific costs or restrictions on an identifiable group or entity while the costs of inaction are widely distributed and often borne by public funds. For example, many wood-eating insects known to cause significant damage in our forests (EAB, Asian Longhorn etc.) came to the US in wooden shipping pallets. The solution is to either heat all pallets to kill embedded pests or switch to non-wood pallets neither of which would involve rocket science. Shipping companies, understandably, raised a unified and fairly loud opposition to regulations on their practices and even with pressure to comply, progress has been slow and incomplete. On the consequences side, huge areas of public and private land have suffered loss of trees with costs spread among private individuals, public recreation areas and the forest products industry. Only recently has there been an effort to coordinate voices calling for better management of this pathway of invasion (https://www.caryinstitute.org/science/tree-smart-trade).

Secondly, while the costs and consequences of an invasive species established in a region are usually well understood, we aren't as confident about precisely which species will arrive, become established and have large negative effects. The scientific projection models referenced above can give us a sense of the species pool of invasives and we obviously know what species are approaching our neighborhood but there will always be uncertainty as to who will actually get here, whether they can gain a foothold and whether they will have large consequences in a novel ecosystem. This imprecision in identifying the next invader often makes it difficult to galvanize preventive action; people are generally not good preparing for vague problems. Despite lack of confidence as to exactly who the next invader might be, the numbers game is not encouraging. It is estimated that each year a new species arrives in the Hudson (Strayer 2006) system and although most of these don't survive or become abundant historical patterns suggest 1/10 will become a major player in the system. So, based on the past record, which is almost certainly an underestimate, each decade will bring a new, influential species into the system. For species already on the doorstep the prediction of entrance and establishment and even consequences are known with much higher confidence but the geographic proximity also means the time frame for preventive actions may be too short.

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For species likely to arrive there is sometimes an argument that "it won't be that bad" or possibly have some beneficial effects. For instance, the Zebra Mussel has improved water clarity in Lake Erie (Limburg et al. 2010) and does help prevent algal blooms in the Hudson (Caraco et al. 1997). This however is a very dangerous point of view because even if a prediction for Species X may be correct and there is some sort of silver lining, there is zero reason to imagine that Species X + 1 will also prove to be benign and solution of the broader problem has just been postponed. If there is a demonstrated need for a new species to fulfill some role (biological control or replacement of species lost to rapid climate change might be reasons) then we should cautiously and knowingly bring in such a species with some sort of fail-safe mechanism.

The last point related to uncertainty in the next invader is that costs and efforts to attempt control of existing problem species gets priority over preventive measures. Public pressure to deal with the problem at hand ("the Devil we know") is greater than pressure to address some unknown problem over the horizon particularly in light of limited funds intended to address current and future threats.

Lastly, solutions to the broad problem of managing pathways of invasion will involve trade-offs among diverse owners/users of the particular pathway. There have been several assessments of current uses and economic benefits of the NYS Canal system often with a view to increasing economic benefits for local communities (ReImagine). These studies have identified significant value in fishing, recreational boating, historic interest and others. Solutions to having the Canal system as an open highway for invasion will differentially cost the various user groups and balancing their costs/benefits is not a simple task. Multi-party conflict resolution is hardly unique to this issue and there are established guidelines on how to proceed.

So, how do we proceed given that solution is impeded by 1) unequal distribution of costs/consequences 2) uncertainty in who might arrive next and 3) balancing among several user groups.

On the good news front we have at least some information on the costs of various solutions and the value of uses/activities that may be affected by a particular solution. The costs of action appear to be lower than the costs of inaction particularly considering the costs of inaction stretch for years into the future. What is needed is the public/political pressure to allocate funds to carry out the solutions which has proven difficult in part because funding is prioritized to clear and present danger rather than uncertain threats in the future. Progress will also depend on an equalization of input so that the diffuse voices carry as much weight as the concerted comments from one or two major groups.

To address the uncertainty of who is coming next we need management and political entities to take a longer view on this issue while at the same time acting rapidly. Given the history of invasions there is little doubt that there will be large negative and expensive consequences to inaction. While constrictors in the Everglades and Gobies in NY are currently catalyzing some activity we need to also (not in place of) address the unknown risks in the future. Some courses of action will generate opposition from one group or another and fully recognizing those so as to be able to offer mitigation will take time. Of course, funding, political will and engineering capacity will also take time but that only argues for getting started quickly.

Lastly, the multi-party balancing that is needed requires open, transparent, honest, equitable debate about what is to be gained/lost with any particular course of action. Time is too short for gradually unveiling hidden agendas or realizing that a significant group has been left out of the discussion.

There is no simple solution and we won't stop every invader but I believe the facts underlying the problem call for a significant change in how we as a society address this problem.

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Risk communication and the MyCoast App: an exploration of the challenges and benefits of applications for documenting flooding in the Lower Hudson Valley

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As global climate change intensifies, more intense wet water events and increasing sea level rise are having significant impacts on coastal regions. Among the many challenges these communities face (including the broad necessity to adapt to climate change impacts), risk management and communication strategies have become key arenas that must be developed and implemented by municipalities. Risk communication is the effective communication of information about both the likelihood that a community will be impacted by a particular event (such as flooding or storms) as well as information that community members can use to remain safe during and after an event. There are several strategies for risk communication, but the need to evaluate and improve on those strategies are imperative.

To understand how we can improve risk communication, planning, and response to storms and flooding, we can study the tools used to document such events, such as: national weather data, social media, weather forecasts, gauge data, news media, and personal anecdotes. Although most individuals tend to only use one or two of these platforms to make decisions, studying them both individually and comprehensively can help tell a more complete story as well as helping to inform future communication strategies. For this presentation, we will discuss research we are conducting to study the community-driven flood reporting platform MyCoast and its application in the Lower Hudson River Watershed.

Our project—a collaboration between New York Sea Grant and Pace University, supported by the New York State Water Resources Institute—focused on the ways storm event and flooding information was collected and interpreted by MyCoast, with the additional goal of developing information to improve the application. MyCoast is a crowd-sourced, community science phone “app” for New York (in partnership with the Water Resources Institute) that depends on stakeholder participation and documentation of flooding and storm events. MyCoast provides a platform for people to document as well as ascertain additional information about events, such as precipitation and river levels. We developed an assessment protocol to better understand the efficacy of MyCoast in documenting events. We also mined data from other sources (e.g., local and national news outlets, social media accounts, weather databases, river gauges, and conversations with National Weather Service meteorologists) to compare with what was reported on MyCoast. Through our research and analysis, we developed a better understanding of how data is reported and utilized by communities. Additionally, we have been able to pinpoint some key strengths and weaknesses of the platform to improve usage. Our presentation will outline the framework, methods, and analysis we used for this project, concluding with ways to think more critically about risk communication in the Lower Hudson Valley and beyond.

We would like to acknowledge the support of the New York State Water Resources Institute, New York Sea Grant, and Pace University.

Invasive Water Chestnut and sediment accumulation above the Crescent Dam threaten navigation in the Erie Canal

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Invasive Water Chestnut (*Trapa natans*) is a shallow-water invasive aquatic plant that has colonized vast stretches in the lower Mohawk River in a spectacular way [1,3]. Growth has been dramatic in the last decade and the primary driver for the ecosystem may be rapid sediment accumulation behind the Crescent Dam (see 4). Water Chestnut has long been present in the Mohawk River, having been introduced in Collins Pond well over a century ago. But an increase in storm magnitude and dramatic flooding in the headwaters in the last few decades – especially the Schoharie Creek that drains northward from the Catskills – has changed the ecosystem dramatically due to sediment accumulation behind the Crescent Dam. This sediment is manifested in dramatic infilling that has resulted in shallows and island growth - a perfect habitat for Water Chestnut. Explosive growth in the last decade is choking marinas and impairing boating, and at this point eradication is unlikely [6].

The Crescent Dam and Vischer Ferry Dam are the last major obstacles to sediment transport in the Mohawk River, and because they are permanent dams, coarse sediment (bedload) is trapped and unable to get flushed downstream to the Hudson River. Upriver, at least to the confluence with the Schoharie, all the other dams are removable and retracted in the winter, so sediment is able to move downriver.

Lower Mohawk problem. Water Chestnut infestation in the lower Mohawk is extensive, and it is easily imaged using satellite images. The map below is only part of the Crescent pool, and the areas on the river that have the correct spectral color for Water Chestnut are shown in shades of magenta. Rectangles superimposed on this map indicate the two areas of detailed analysis where island growth and sediment accumulation have been remarkable.

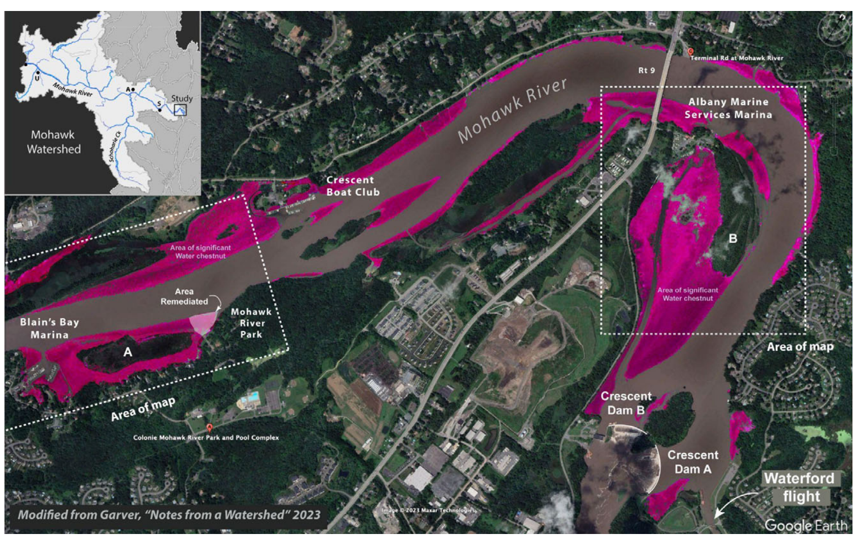

Figure 1. Mapping of the extent of Water Chestnut above the Crescent Dam on the lower Mohawk River. Areas with significant Water Chestnut are shown in magenta. Water Chestnut thrives in shallow water (<10 ft). A site of remediation by the Town of Colonie (in 2023) is adjacent to Mohawk River Park. The timeline of the growth of land masses A and B (on map) are shown in the graph below (Figure 4). Google Earth satellite image from July 2021. Inset modified from Mohawk Action Agenda.

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The Crescent pool. The Crescent pool (between E6 and E7) is flat, wide, and supported by the Crescent Dam, which is made up of two dams (one 52' high, one 32' high) that were constructed in 1908 [5]. Thus this dam has been in place and has collected sediment for 115 years, but the sediment related to big recent floods has significantly filled channel fringes in a dramatic way for the last several decades. Given the infilling of shallow waters and side channels, it is clear that infilling has been especially profound since Hurricane Irene (2011) - the biggest and most significant event in the Catskill-draining part of the watershed since the dam was constructed [11].

The explosive growth of this noxious aquatic plant in the lower part of the Mohawk River may be due to sediment infilling and expansion of its preferred shallow-water ecological niche. It is possible that much of the sediment originated from the Schoharie Creek, which has seen the magnitude of the 100-year flood almost double in the last four decades. Hurricane Irene was a 500-yr event in the Schoharie and tremendous volumes of sediment were washed into the Mohawk [11]. Sediment from tributaries includes both suspended load (fine silt and mud), and bedload (sand and gravel). The fate of the bedload has been elusive and difficult to track. It is almost certain that most of this sediment has bypassed the removable dams, which are lifted out of the water in the winter, and collected in the two lower pools on the Mohawk that are supported by permanent dams - the Vischer Ferry Dam (E7) and the Crescent Dam (E6).

Sediment infilling indicated by island growth. Measuring sediment accumulation behind a dam in a river setting requires collection of river profile data over time so that comparisons can be made concerning infilling and depth reduction. These data are difficult and expensive to obtain. One simple way to approach this problem is to measure the accumulation of sediment that builds up above the normal river level, and this can be done with satellite images that record changes in the landscape over time. For this area, Google Earth has high-resolution images going back to 2001. Using those images I mapped the change in island geometry, and then calculated the change in the size of islands that were exposed and able to support non-aquatic vegetation. The plot below (Figure 2) shows the result from two of those islands. Both have emerged from a very small nucleus, and the rate of growth was most dramatic following the 2011 floods of Irene (and Lee). Note also that the frequency of extreme rainfall events in the region has increased [8,10, 12].

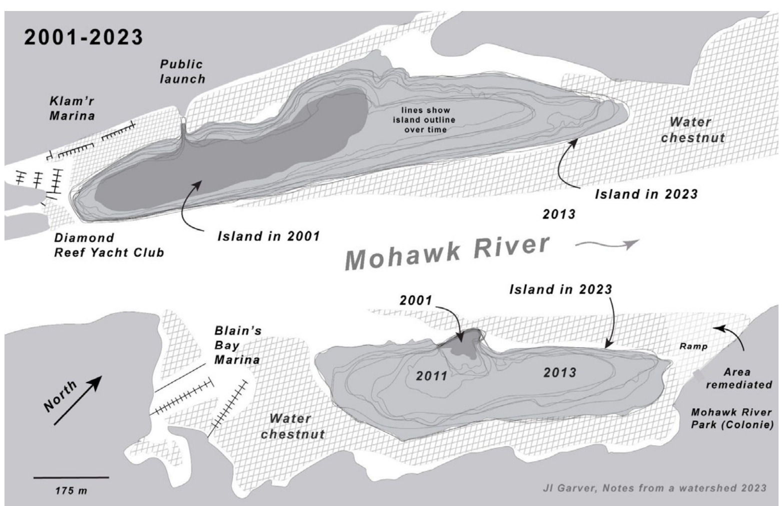

Figure 2. This map shows the dramatic growth of vegetated islands due to sediment accumulation in the lower Mohawk River in the area of the Mohawk River Park (Colonie), Blain's Bay, Klam'r, and Diamond Reef marinas (base map from 2001). The rate of island growth (in Blain's Bay) in terms of exposed vegetated area is plotted in the graph below (Figure 4, blue/circles). The most dramatic growth is in the few years directly following Hurricane Irene in 2011, which was a 500-yr event in the Schoharie Creek, a major tributary to the Mohawk that drains the Catskill Mountains.

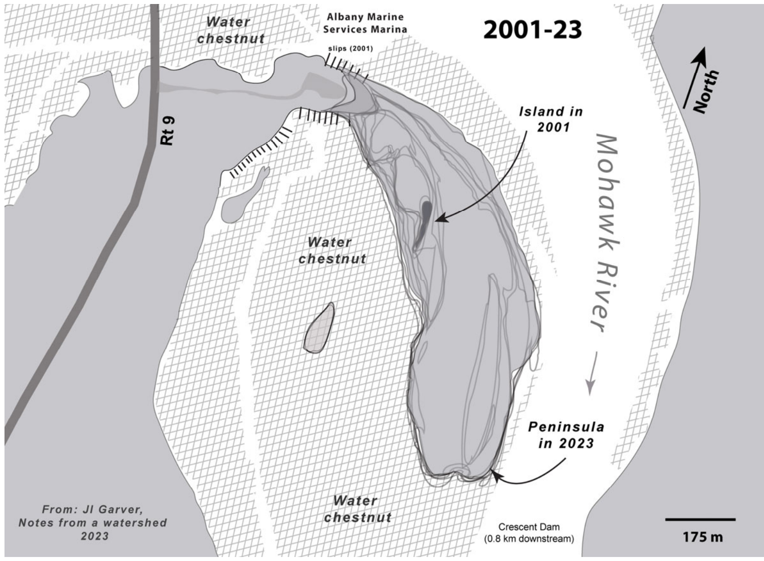

Figure 3. This map shows the growth of vegetated islands due to sediment accumulation in the lower Mohawk River in the area just above the Crescent Dam (base map from 2001). The rate of island growth in terms of exposed vegetated area is plotted in the graph below (Figure 4, pink/squares). As in the example from Blain's Bay, the most significant growth occurred in the few years directly following Hurricane Irene (2011).

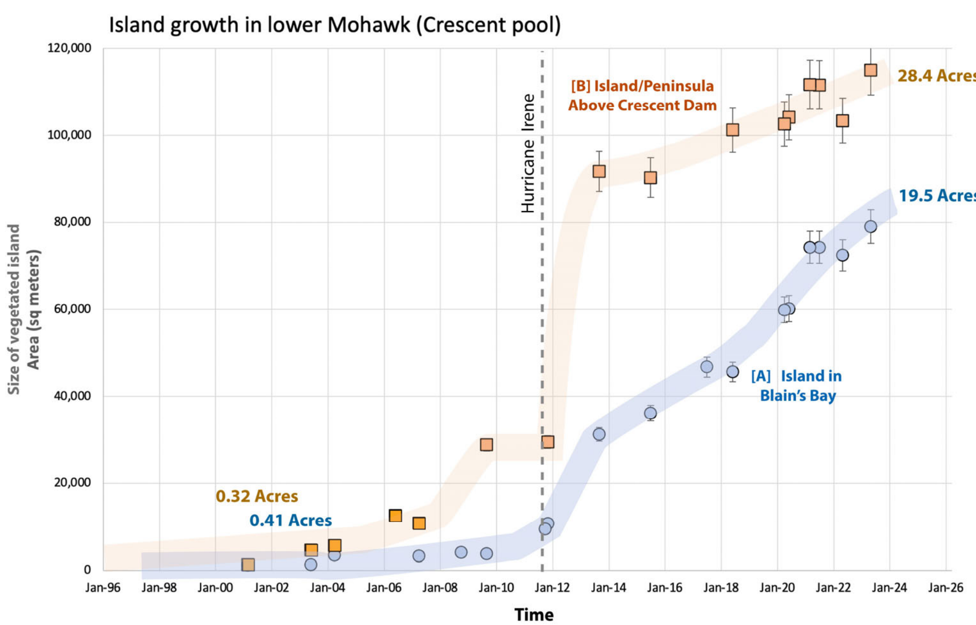

Figure 4. Plot of the vegetated area of two islands in the lower Mohawk above the Crescent dam (see "A" and "B" on Figure 1). The larger island is now a 28-acre peninsula that has impaired operations at the Albany Marine Service Marina. Sediment accumulation behind the Crescent Dam has been dramatic since Hurricane Irene liberated substantial volumes of sediment, especially in the Schoharie Creek. Sediment continues to fill these areas and the islands continue to grow.

Marinas, boats, and recreation. Along this stretch of the Mohawk there has been a major economic impact and reduction of the quality of life due to reduction of waterfront activity and engagement with the river. Several marinas in this reach of the Mohawk have been harmed economically. The Town of Colonie has initiated Water Chestnut remediation using funding from the Mohawk River Basin Grants

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Program [2]. But despite this sort of local effort, sediment will continue to build behind the dam, and Water Chestnut will continue to choke the shallows, and thus we will lose this precious resource.

Relicensing of the Crescent Hydroelectric Project (at the Crescent Dam) requires, among other things, an evaluation of recreational activity and accessibility in the project area. An important component of the FERC relicensing process has been to determine whether the operation of hydroelectric schemes have an environmental impact and how they may impact recreational opportunities.

Proactive invasive species management is difficult [1,3]. It requires using science to address a known threat that may have uncertainties associated with the timeline of invasion, economic impact, and ecosystem impairment. Everyone involved with invasive species mitigation emphasizes that prevention is the most effective strategy. A well-known pathway for aquatic invasive species is the Erie Canal, and there has long been the recognition that we need an "All AIS approach" to prevent the spread of invasive species along this corridor. This is complicated because the Erie Canal is one of the most iconic and historic waterways in the country, and the challenge is to implement effective proactive measures but also keep boats moving through the corridor. There are a number of disrupting invasive species on the horizon that may have very high environmental impacts. The fast-growing *Hydrilla*, which thrives in even deeper water than Water Chestnut, is in the canal system, and if it spreads to the lower Mohawk it will be incredibly problematic for boating on the Erie Canal, especially in this reach of the river [see 6].

Solutions. This invasive species problem has been facilitated by sediment accumulation that is driven by bigger storms, more summer/fall precipitation, and greater sediment transport. Three solutions need to be implemented. First, we need to support efforts to mitigate Water Chestnut by mechanical harvesting on a large scale. Second, we need to address sediment accumulation in the lower Mohawk. Third, we need to proactively contain other looming AIS threats that are using the Canal to hitchhike and spread along the corridor [7,8]. For the immediate problem in the Crescent pool, NYPA/Canals needs to outline and adopt a sediment management plan, and ideally this should be part of the FERC relicensing for the Vischer and Crescent projects.

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Fluoride as a tracer of municipal water: the Hans Groot Kill case study in Schenectady, NY

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When municipal water is introduced to surface streams, it alters stream chemistry and can harm aquatic ecosystems. Municipal water includes both drinking water (finished water) and sewage; the latter is more problematic because it adds pathogens, chemicals, and nutrients that upset ecosystem balance. A major focus of many water quality studies is to understand the source and fate of municipal sewage that finds its way into our waterways. In communities that use fluoridation of municipal water for dental health, this conservative trace element can be used as a tracer. Thus in those settings where raw untreated sewage (and/or drinking water) finds its way into streams and rivers, mainly through illicit discharge or through cracks and leaks in sanitary sewer lines (pipes), fluoride can be used as a chemical fingerprint.

The common halide anions in surface water, wastewater, and drinking water include fluoride (F^-), chloride (Cl^-), and bromide (Br^-). These have different sources, but in almost all cases they are mostly conservative in the aquatic environment, and they are little affected by processes involved in finishing drinking water, municipal use, and sewage treatment.

These anions all have a relatively low natural abundance in rocks and minerals common to the lower Mohawk Watershed. Road salt imposes a remarkably high chemical burden on surface and groundwater in the Mohawk watershed, and as a result of winter application, chloride is by far the most common halide anion. Use of road salt (as well as domestic use of salt) contaminates surface waters with chloride (and sodium), and this is especially pronounced in the late winter (March), when runoff and recharge involves winter meltwater. Chloride is so pervasive that it has altered groundwater chemistry, and our data show that concentrations are still high in the late summer and fall, well beyond their introduction from the previous winter (Garver and Smith, 2023).

Fluoride in water. Fluoride occurs naturally and is present in natural waters, but typically in minute concentrations, and in this part of NY State, geogenic (from rocks) fluoride concentrations are low. Analyses from nearby surface streams served by non-fluoridated municipal water are typically ~60 to 80 µg/l. This range includes our measurements of surface streams and municipal water that has interacted with glacial deposits and shallow bedrock made of sedimentary rocks (shale/limestone).

Many, but not all, municipalities in New York add fluoride to drinking water for dental health, and they are required by the NYS DOH to report fluoridation in their Annual Drinking Water Quality reports. In 2015, the NYS DOH recommended that public water utilities strive for a fluoride level of 0.7 mg/l (or 700 µg/l). Prior to this change, the recommended level was 1 mg/l. The City of Schenectady uses fluoridation with a target level of 0.7 mg/l. In an interesting twist to the experiments we were running in the fall of 2023, Schenectady shut down fluoridation on 17 October 2023 for repairs. Most of our samples were collected before shutdown, but some were collected afterward, and this allows us to see how the system responded to the change in water chemistry. Fluoridated drinking water and wastewater derived from that fluoridated drinking water have essentially the same concentration of fluoride. Studies have shown that the volume of household-derived fluoride (i.e., toothpaste) is unlikely to be high enough to significantly elevate fluoride in wastewater (Vengosh and Pankratov, 1998; Sebastian and Siddanna, 2015).

Tracer for municipal water. Fluoride has been used as a geochemical tracer of municipal water in other settings. Lockmiller and others (2019) used fluoride, optical brighteners (from detergent), and boron isotopes to quantify drinking water and wastewater contribution to urban and rural streams in St. Louis, MO. In rural streams they measured F- concentrations of 75 ± 20 µg/l (geogenic), but values as high as 475 µg/l where fluoridated municipal water was a significant component of streamflow. In the small Deer Creek watershed they reported fluoride concentrations between 96 and 490 µg/l with an average of 252 ± 64 µg/l. They calculated that about one third (33%) of stream discharge was municipal water - about equal quantities of drinking water and wastewater.

Fluoride concentrations in drinking water and wastewater are similar, so fluoride alone cannot be used to quantify the difference between these potential municipal inputs to natural waterways. The difference, obviously, is that wastewater is distinctive and problematic because it contains a wide range of pathogens including viruses, parasites, and bacteria. We can use fecal indicator bacteria (FIB) to determine concentrations of sewage-related bacteria, but quantification of sewage loading is more complicated.

Hans Groot Kill. The Hans Groot Kill (HGK) is a small urban stream in Schenectady NY that has been integrated into the stormwater collection system, but it is no longer supposed to be susceptible to combined sewer overflows because the City has transitioned to a municipal separate storm sewer system (MS4). For some time it has been recognized that despite this transition, the creek is impaired with sewage, especially during rainfall events. Fecal indicator bacteria testing (*Enterococcus*) was first used by Willard-Bauer and others (2020) to show impairment of the entire aboveground part of the creek, and repeated sampling showed that several outfalls have particularly high pathogen levels.

The suspicion is that untreated sewage enters the creek from broken, cracked, or otherwise impaired sanitary sewer lines, and therefore a primary driver of fecal indicator bacteria (FIB) may be exfiltration from these sanitary sewer lines. In 2022 the City used Microbial Source Tracking (MST) to evaluate the potential source of the pathogens. They used HF182, a genetic marker distinctive to human sewage, to show that the contamination could be definitively tied to human sewage, and concentrations of HF182 increased up-creek to the headwaters at West Alley where the Hans Groot Kill is fed by three major stormwater pipes.

Since that time, continued FIB testing by our group at Union College, the NYSDEC, and an environmental consulting firm has demonstrated that the contamination persists despite some mitigation attempts (see Garver, 2022; Garver and Smith, 2022; Garver and Smith, 2023). While raw sewage is a primary concern because of the obvious health implications, there has been little attention paid to the possibility that drinking water pipes may also be leaking and contributing municipal water to the creek. This matters because if both sanitary pipes and drinking water pipes leak, sewage and pathogens can co-mingle if there is a loss of pressure in the drinking water lines (i.e., exfiltration and infiltration). This is relevant because there have been outbreaks of enteric disease following a local water main break and contaminated municipal water is a suspect (Garver, 2020).

Methods

We conducted simultaneous FIB pathogen testing and analysis of cations and anions in selected samples in the Fall of 2021 and the Fall of 2023. We measured *Enterococcus* using IDEXX Enterolert where samples are collected, diluted with DI water, incubated, and then read after 24 hours (see Willard-Bauer et al., 2020). For ion chromatography, samples are filtered and then run with check standards on Dionex Ion Chromatograph. Here we are mainly interested in the levels of FIB in relation to sewage, and in using the concentration of fluoride to estimate the fraction of municipal water. We use a simple two-component mixing model, which is most effective in low-flow conditions. We use a geogenic level of 0.070 mg/l and municipal level of 0.70 mg/l. We are most interested in an estimate of the fraction of municipal water entering the creek at base flow or low flow because that fraction of chronic leaking water is a primary target for remediation.

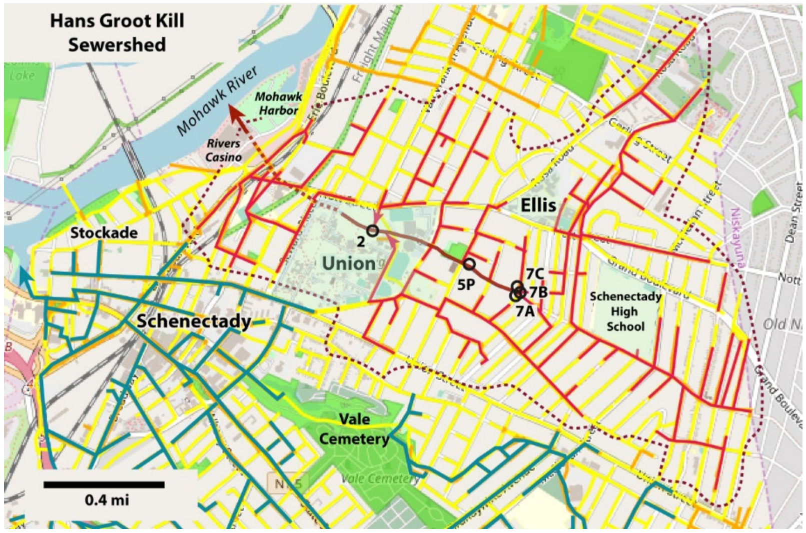

Figure 1. Map of the sewershed of the Hans Groot Kill in Schenectady, NY, showing key sampling locations.

Results

The pathogen data show the HGK is severely impaired: every sample exceeds the EPA beach advisory value (BAV) of 60 MPN/100 ml. There is a clear relationship between rainfall and FIB, but there are also a number of samples with high FIB in low-flow conditions, and this means that some fraction of sewage leaks are chronic. We have identified two pipes (Wendell Ave - 5P, and Lowell Bridge - crack) that are severely contaminated even in low-flow conditions. The FIB data also show that there is a sewage leak, underground, on the Union Campus between Lowell and Jackson's Garden.

Table 1: Geochemistry and pathogens for key sites in the Hans Groot Kill

	Jackson's Garden HGK -2	Wendell pipe HGK-5P	West Alley (right) HGK-7A	West Alley (center) HGK-7B	West Alley (left/mix) HGK-7C
F- (ppm)	0.31	0.43	0.28	0.28	0.30
Br- (ppm)	0.10	0.04	0.08	0.08	0.12
Cl- (ppm)	233	199	140	203	258
NO_3 (ppm)	5.4	13.2	4.2	5.4	5.2
Enterococcus	331	523	155	220	348
% municipal water	38%	58%	33%	33%	37%

Note: Samples taken 26, 28 September 2023, except HGK 2, which were taken 21, 28 Sept.
All dates are under "dry" conditions where 48 hr precip is <0.02 inches.
Entero is Enterococcus in mpn/100 ml (acceptable is 60 mpn or less)

All samples from the HGK have elevated fluoride concentrations compared to rural counterparts, and hence there are undoubtedly significant amounts of municipal water in the creek. We focus these results on five sites: HGK-2 (Jackson's Garden); HGK-5P (Wendell pipe); and the three headwater pipes that feed the upper HGK from West Alley (7A, 7B, 7C) (Table 1, map).

Our measurements indicate that municipal water has very low levels of bromide (~20 ppb or less), but elevated bromide can be one of the characteristics of sewage (Davis et al., 1998). In this area, the halide triad is complicated by high concentrations of chloride, which is introduced mainly from road salt, but also from sewage. The Cl:Br ratio (wt%) in typical mined massive salt that is used in deicing (in NYS) is typically 2000 or greater, and the ratio in our sewage-impaired HGK data is slightly lower, so there is a possibility that bromide can be used as a tracer of sewage (Koglin, 1984), but we do not pursue that here.

We are most curious about stream chemistry and pathogen loads in low-flow conditions where the stream is fed by base flow, which is complicated in an urban setting because it includes groundwater, active and abandoned pipes, and flow through artificial fill (collectively "urban karst").

Forensic analyses of sewage pollution in the HGK have focused on addressing the sewage source with an unstated hope that there is a single point source that can be easily remediated. Our data suggest that the problem is systemic, pervasive, and profound. The three "headwater pipes" in the upper reach of the daylit HGK (7A, 7B, 7C) are more or less equally impaired, and about one third of the water at low flow is municipal. Of the three, the left (north) pipe (which drains neighborhoods adjacent to Ellis Hospital) has higher FIB values (and a slightly higher fraction of municipal water). Downstream, the Wendell pipe (5P) has the highest pathogen loads and the highest fraction of municipal water (note that the leak from Lowell Ave bridge had a two-day dry-condition average *Enterococcus* of 2650 MPN/100 ml).

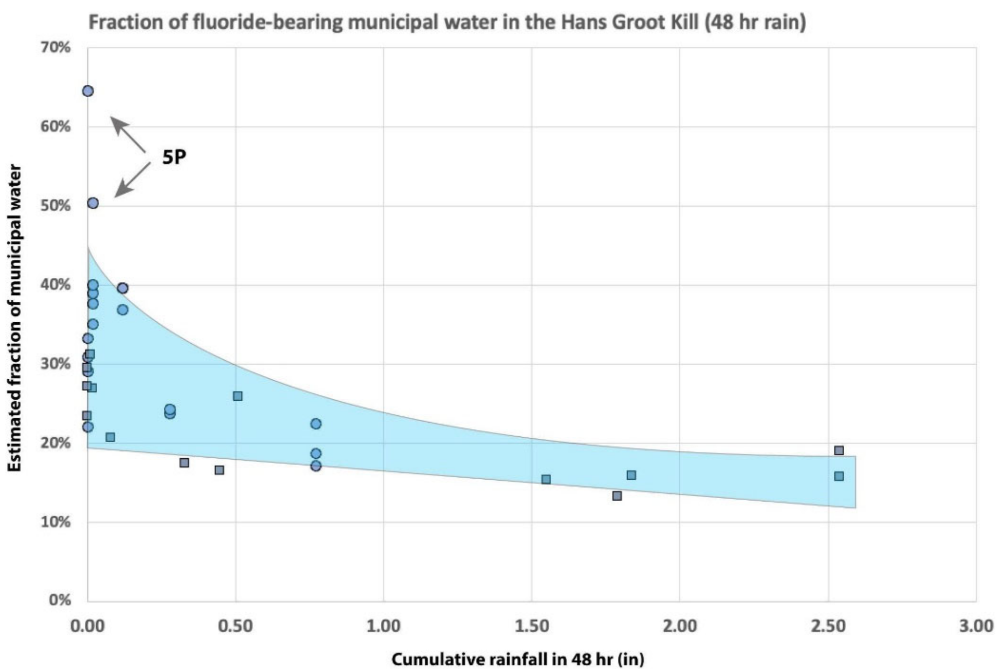

Figure 2. A two-component mixing model allows us to use fluoride concentrations in stream water to estimate the fraction of municipal water in the creek. Fluoride concentrations are higher at low flow, hence municipal water makes up a greater fraction of the water, and in this case it is typically 20-40%. The Wendell Pipe has very high pathogen levels (5P at Wendell Ave, first identified by Willard-Bauer et al., 2020) and appears to be 50-65% municipal water. Note that 5P has the highest pathogen levels, on average, of any site.

If we look at both the 2023 and 2021 data sets, we begin to see the significant role that municipal water plays in sustaining flow in this creek. In low-flow conditions (<0.02" rain in 48 hr), the in-stream municipal water fraction is between 20% and 40% with an average in 2023 of ~33%. There is considerable variability in the high-flow numbers, but the municipal water fraction is generally 20% or less. The Wendell pipe (5P) is certainly distinctive because more than half the water appears to be municipal, and thus it is an obvious remediation target.

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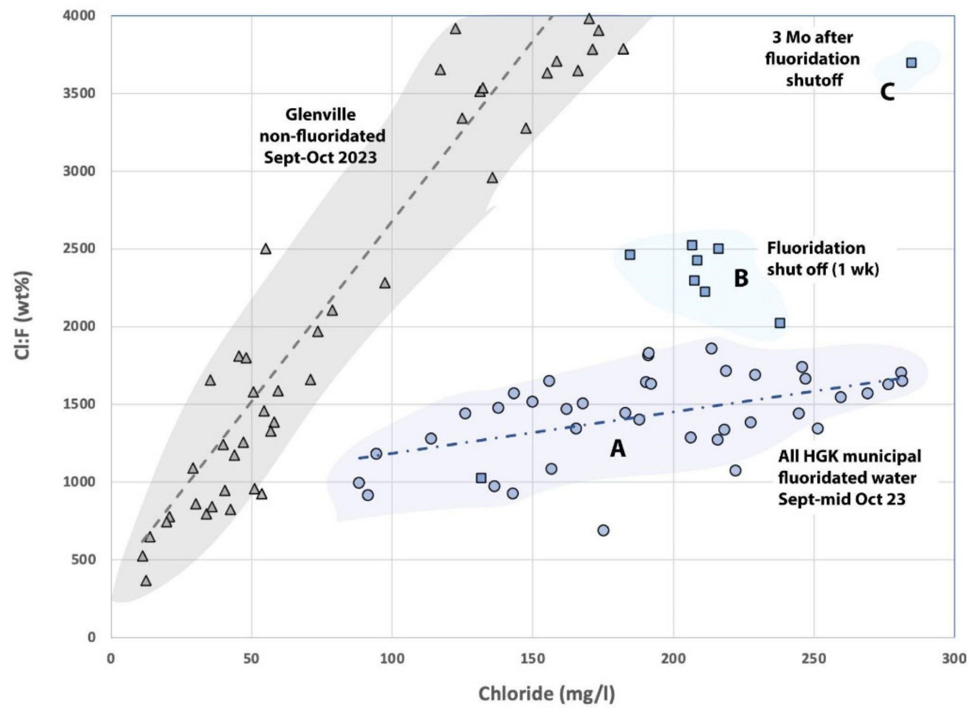

Figure 3. The Cl:F ratio is distinctive for surface waters contaminated with fluoridated municipal water. Here sites in Glenville (non-fluoridated) reflect geogenic levels of fluoride but contamination from road salt (gray area). The HGK samples (A,B,C) include fluoridated samples from before 17 October (A), samples immediately after when fluoridation was discontinued (B), and three months later in the winter (C). The result shows both surface water and groundwater are contaminated with fluoridated municipal water.

Part of our 2023 sample set was collected from the HGK after the City shut down fluoridation in mid-October. Complete fluoride reduction was not immediate, which suggests that like chloride, fluoride is abundant in groundwater from chronic exposure. But after shutdown, fluoride values drop and the Cl:Fl ratio increases (see A to B in figure).

Using fluoride as a tracer of municipal water provides the remarkable result that about one third of the water in the HGK at low-flow conditions is from the City water supply. What we cannot tell from these data is what fraction of the municipal water is drinking water vs. municipal sewage water. Clearly there is a significant sewage load in this stream as indicated by high and persistent FIB that make this water unsafe for contact. Because this creek is in an urban setting (and on a College Campus) there is some urgency to remediate and reduce the public exposure to the health hazard. We predict that some drinking water is leaking into the creek and it is possible that pipes that supply drinking water are leaking. Leaking drinking water pipes are a major concern because infiltration of water with pathogens may occur if there is loss of pressure, and this has obvious implications for public health.

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United States Geological Survey Ice Jam Monitoring Network on the Mohawk River in Schenectady, NY

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Overview

The United States Geological Survey (USGS) has continuously monitored the Mohawk River between Lock 7 and Lock 9 of the New York State Barge Canal since 2011. There was a brief period, from 1914 to 1919, when a streamgage was operated at Vischer Ferry Dam (Lock 7), however, frequent damage to the gage from ice-jam related flooding in 1914 (figure 1) and 1916 resulted in establishing the Mohawk River streamgage at Cohoes, NY (USGS station ID 01357500) in 1917 and discontinuing the Vischer Ferry streamgage in 1919. The current monitoring network includes measurements of gage height (water level) and water temperature at various points within the reach, streamflow at Freeman's Bridge, and real-time imagery from multiple pan-tilt-zoom web cameras, all of which provide situational awareness to the public, emergency managers, and other stakeholders during periods of ice-jam flooding. The USGS operates and maintains these stations in cooperation with the New York Power Authority, New York State Department of Environmental Conservation, Union College, and Brookfield Renewable Power.

The Freeman's Bridge streamgage (01354500, figure 2) was installed in 2011 to measure gage height and streamflow using a novel index-velocity computational method (Levesque and Oberg, 2012). This methodology allowed, for the first time in the reach, accurate, near real-time monitoring of streamflow, that is largely independent of river ice conditions. Also in 2011, a webcam was installed on the Union College boathouse in the Stockade District of Schenectady. Additional gage height stations and web cameras were installed at Lock 8 (01354330) in 2011, Lock 7 (01356000) and Rexford (01355475) in 2014, and at Lock 9 (01354230) in 2019. The most recent enhancements, in 2021 and 2022, included monitoring temperature at Lock 9 as well as at stations upstream of Schenectady in Amsterdam, NY (01354083), Fonda, NY (01349527), and the Schoharie Creek at Fort Hunter, NY (01353995). The USGS maintains a public website to easily access data, information, and imagery from this network at: https://ny.water.usgs.gov/maps/mohawk-icejam/.

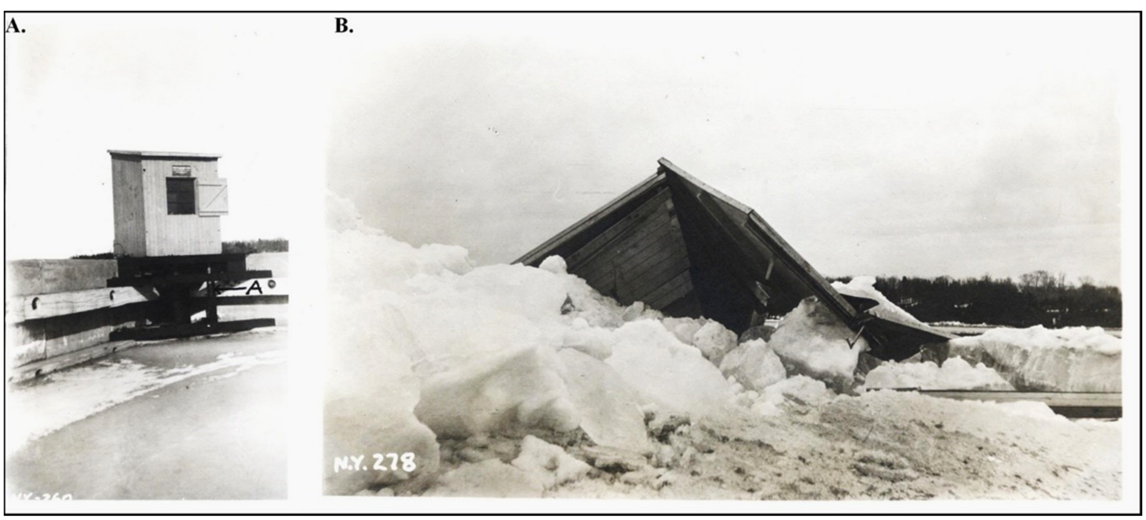

Figure 1. U.S. Geological Survey station no. 01356000 – Mohawk River at Vischer Ferry Dam, NY: (A) before flood of 1914; (B) after flood of 1914 (March 28, 1914).

Figure 2. U.S. Geological Survey station no. 01354500 – Mohawk River at Freeman's Bridge, NY

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Use of environmental DNA to assess American Eel distribution, abundance, and barriers in the Mohawk-Hudson river system

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Background

The American Eel (*Anguilla rostrata*) historically was one of the most common fish species in Atlantic coast watersheds, but extensive dam construction and other factors caused a widespread population decline (Busch et al. 1998). One of the areas where American Eel have declined considerably is the Mohawk River watershed in eastern and central New York (NYSDEC 2014). Historical evidence suggests that American Eel were widespread and potentially abundant in the watershed. This evidence includes historical accounts, the presence of old eel weirs, and the Dutch translation of a tributary stream, the Alplaus Kill, as "place of eels" (Van Epps 1998; Machut et al. 2010; Carlson et al. 2016; Garver 2022). More recently, however, eels are seldom found in the watershed, with only 16 documented observations upstream of a series of barriers near the river mouth since 1988 (NYSDEC 2022). Recent attempts to characterize the distribution and abundance of American Eel in this watershed have been ineffective, and the extent to which a series of locks and dams on the Hudson River and lower Mohawk River limits use of the watershed was unclear.

Methods

A two-phase study was conducted during 2020-2021 to assess the ability of environmental DNA (eDNA) to improve our understanding of the distribution and abundance of American Eel in the Mohawk River watershed (George et al. 2023). In the first phase (Hudson Tributary Calibration Survey), 15 tributaries to the Hudson River spanning a range in eel density were sampled using paired eDNA and 3-pass depletion electrofishing surveys (Figure 1) to develop a model of the relation between eel density and eDNA concentration. In the second phase (Mohawk Watershed Screening), we used this model to interpret eDNA data collected twice from 36 sites across the Mohawk River watershed and make inferences about the distribution and abundance of American Eel.

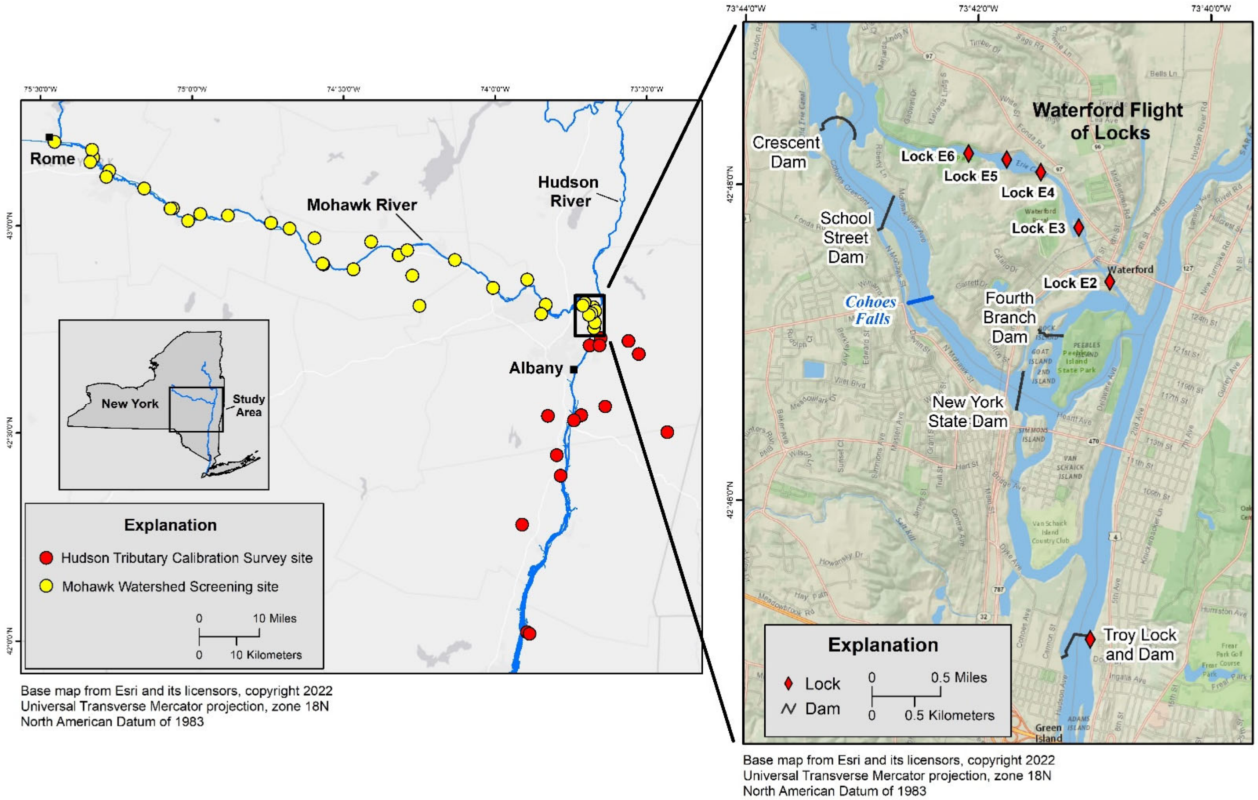


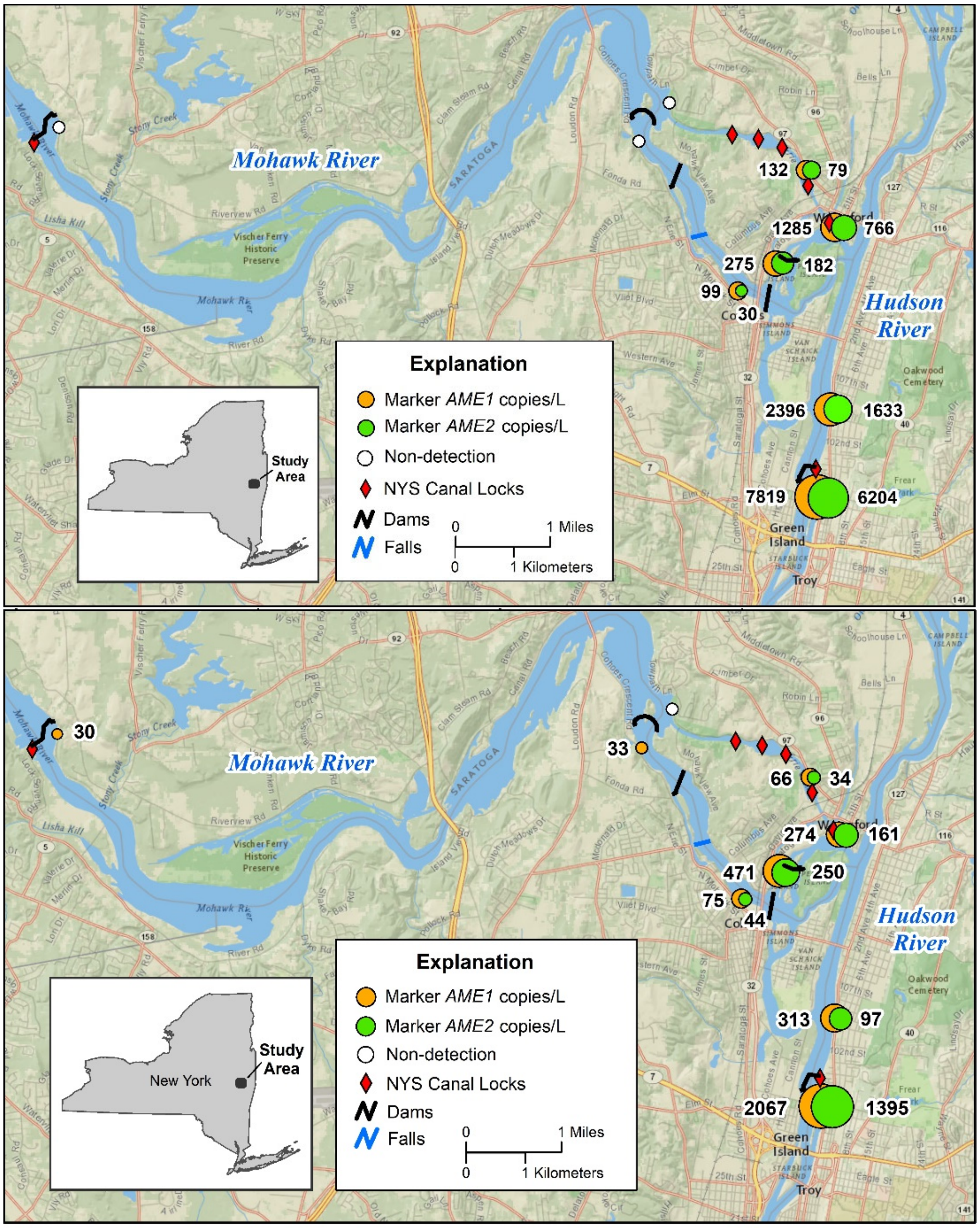
Figure 1: Sampling sites for the Hudson Tributary Calibration Survey (red) and the Mohawk Watershed Screening (yellow), as well as locations of dams, locks, and natural barriers at the confluence of the Mohawk and Hudson rivers.

Results

The data from the Hudson Tributary Calibration Survey were used to develop a model in which the concentration of American Eel DNA in water samples explained up to 65% of the variability in eel density and 56% of the variability in eel biomass. This model was then used to interpret eDNA data collected as part of the Mohawk Watershed Screening described below.

Results of the Mohawk Watershed Screening showed that American Eel DNA was detected almost exclusively in the downstream-most 4 km of the Mohawk River within a series of barriers (Figure 2). The concentration of DNA was reduced by approximately 80% across each successive upstream barrier before becoming too low to detect consistently. American Eel DNA was not detected in the Mohawk River watershed in any sample taken upstream of the Crescent Dam and the Waterford Flight of Locks, with the exceptions of a single positive PCR replicate downstream of the Lock E7 dam and a single positive PCR replicate at Lasher Creek.

Using the model from the Hudson Tributary Calibration Survey, the data from the Mohawk Watershed Screening suggest that eel population density was high in the Hudson River estuary, declined rapidly through the lower Mohawk River, and the species was nearly absent or undetectable in the Mohawk River and its tributaries upstream of the Crescent Dam and the Waterford Flight of Locks.



Base map from: ESRI National Geographic digital data, 2022
Universal Transverse Mercator projection, Zone 18N
North American Datum of 1983

Figure 2: Mean concentration of American Eel DNA (copies/L) at nine sites near the confluence of the Hudson and Mohawk rivers estimated using two eDNA markers (AME1 and AME2, (Moyer et al. 2022)) during spring 2021 (top panel) and summer 2021 (bottom panel). Circle size reflects the relative concentration of DNA.

Conclusions

The DNA concentration and associated estimates of population density declined markedly above each of the first three barriers. Thus, barriers appear to be largely restricting American Eel from reaching over 99% of the Mohawk River watershed. These data suggest that efforts aimed at improving upstream eel passage in this system will produce the greatest benefit at the downstream-most barriers. The full journal article describing this study is available in George et al., (2023) and all associated data are published in a USGS data release in George et al., (2022).

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Dam removal: logical or controversial?

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Dams are barriers built across waterways to serve a variety of purposes including hydropower generation, creating reservoirs to store water for agricultural, residential, and industrial uses, or to make a river less turbulent and navigable year-round. The first half of the twentieth century witnessed the construction of some of the largest dams in the United States. Dams are subjected to a risk-benefit analysis before a decision is made to proceed with construction. Such a decision is usually based on the factors that impact the construction and the performance of the dam during operation. At the height of the dam building era, the risk-benefit analysis considered the effect of the environment on the construction and operation of a proposed dam rather than the effect of dam construction and operation on its surrounding environment.

Starting with the last couple of decades of the twentieth century, and with concern being voiced regarding such giant structures, risk-benefit analysis involved an environmental feasibility study. This lately extended to questioning the viability of existing dams that were built at a time when the effect of dam construction on its surrounding environment was not one of the considered factors. It is worth noting that the decision to construct a dam is an extremely serious one due to the cost and effort required to complete the task. Hence, one should be equally careful when contemplating the removal of a dam. Dam removal is presently done to achieve one or more of the following goals: restore river health and surrounding habitats, public safety, and/or climate resilience. These are worthy goals but one should be mindful that the act of removing a dam would reverse what was viewed as valid reasons to build the dam in the first place. This presentation is geared toward sounding a cautionary note that decisions concerning dam removal should only be made after exhaustive studies to conclude that the positive outcomes significantly outweigh the negatives of the status quo.

Configuration and time-related deformation of isolated islands within the Schoharie Creek

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The Schoharie Creek is the major tributary of the Mohawk River in New York State. It is 150 kilometers long and flows north from its origin at the Indian Head Mountain in the Catskills. The creek runs through the Schoharie Valley up to its confluence with the Mohawk River. As the Schoharie Creek runs in a south-north course, its drainage system includes twelve tributaries on the east side and seventeen tributaries on the west side. The United States Geological Survey (USGS) uses stream gages to monitor the flow in the creek. Measured discharge varies widely with minimum and maximum recorded discharges of 0.14 and 1150 cubic meter per second, respectively.

The Schoharie creek exhibits many meandering sections with significantly sharp twists along its path. There exist also many locations where the water in the creek is parted by isolated islands that vary significantly in size. Scour and sediment transport is a phenomenon that can be observed at many locations where there has been a noticeable time-related deformation in the shape and configuration of the islands within the creek and of the banks of the creek itself.

This study presents examples of fifty isolated islands that have been identified and examined to learn of the effect of the time-related deformation on the natural pattern of water flow. The study concluded that the observed deformation varied appreciably from one location to another depending on the following factors: volume of discharge, geometric configuration of meandering sections, nature of scoured soil, and pattern of transported and deposited sediments. Of the fifty studied locations, focus areas will be those that experienced the most severe deformation.

Flood of October 31 to November 3, 2019, East Canada Creek, West Canada Creek, and Sacandaga River Basins

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Between October 31 and November 3, 2019, historic flooding in parts of the Mohawk Valley and southern Adirondack region resulted in one fatality (Masters, 2019), an estimated $33 million in damages (New York State Governor's Office, 2019a), and the declaration of a state of emergency for 13 New York counties (New York State Governor's Office, 2019b). Flooding resulted from high-intensity rainfall within a 24-hour period between October 31 and November 1, 2019 (Figure 1), at the end of an October that had much higher rainfall than normal (Figure 2). In that 24-hour period, rainfall amounts in the most heavily affected parts of the region largely ranged from about 2 to 5 inches, but a maximum rainfall amount of 7.00 inches was recorded in Speculator, NY in Hamilton County (National Weather Service, 2019b). In this location, a rainfall of 7.00 inches in a 24-hour period is estimated to have between a 200- and 500-year recurrence interval or between a 0.5- and 0.2-percent chance of happening or being exceeded in any given year (Northeast Regional Climate Center, 2021).

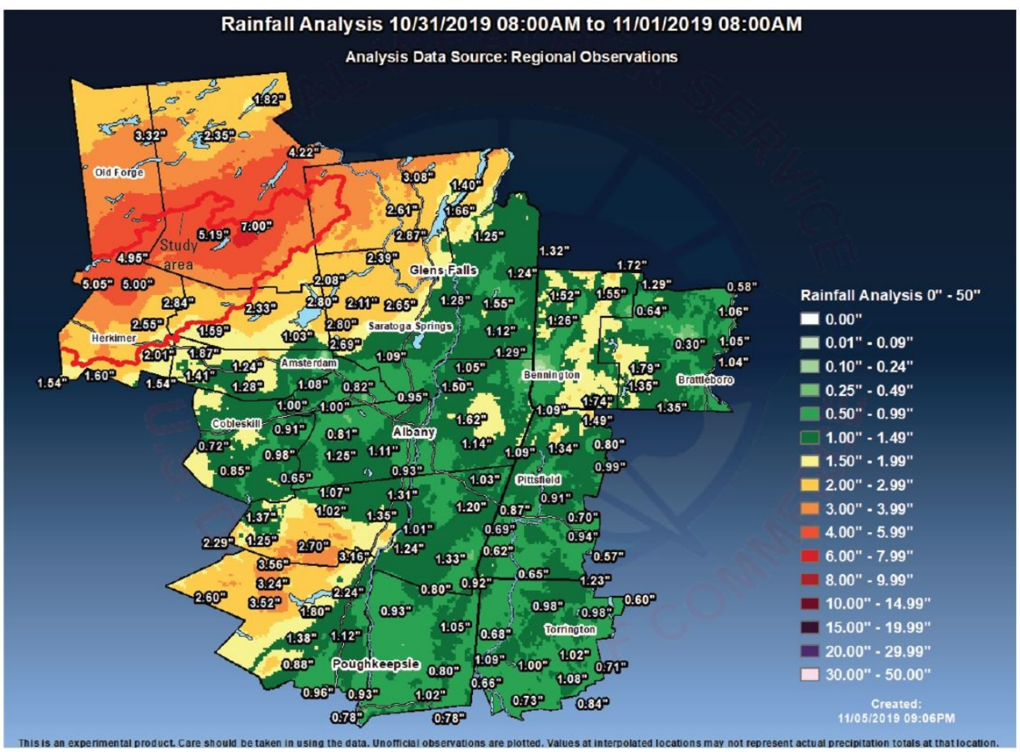

Figure 1: Map showing rainfall totals for the 24-hour period between October 31, 2019, 8:00 a.m eastern standard time and November 1, 2019, 8:00 a.m eastern standard time from precipitation stations in the National Weather Service Albany, New York region (National Weather Service, 2019b; Graziano and others, 2024). Original map from National Weather Service was modified for Graziano and others (2024) by superimposing the boundary (solid red line) for the part of the study area shown on the map.

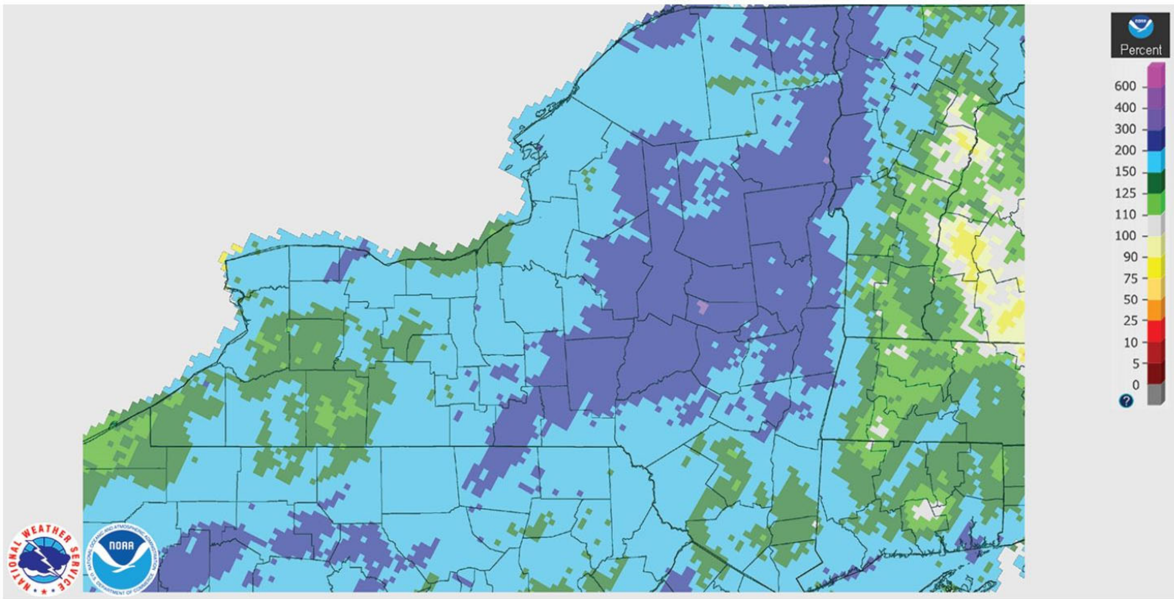

Figure 2: October 2019 monthly percent of normal precipitation for New York State, based on 30-year precipitation normals from 1981 to 2010 (National Weather Service, 2019a; Graziano and others, 2024). Wetter than normal conditions are indicated for all parts of New York State that are shown.

The most severe flooding from October 31 to November 3, 2019, was mainly in the East and West Canada Creek basins, which are within the Mohawk River basin, and the Sacandaga River basin, which is within the upper Hudson River basin (selected parts of each of these basins are within the partial study area boundary shown on Figure 1). Flooding resulted in new peak streamflow records at eight of nine selected U.S. Geological Survey streamgages from the region, including at three streamgages that have been in operation for about 100 years (Table 1). At East Canada Creek at East Creek, NY (01348000), flooding resulted in the second highest peak streamflow in its 71-year period of record. National Weather Service major flood stages were exceeded at the three streamgages in the region where National Weather Service flood stages have been established (Figure 3) and were exceeded at Hinckley Reservoir at Hinckley, NY (01343600) (Figure 4). Hinckley Reservoir has a drainage area of 372 square miles and regulates West Canada Creek streamflow about 31 miles upstream of West Canada Creek at Kast Bridge (01346000) and 3 miles downstream of West Canada Creek near Wilmurt, NY (01343060).

In West Canada Creek, downstream of Hinckley Reservoir, a distinct double peak of streamflow happened during the 2019 flood and was recorded at West Canada Creek at Kast Bridge, NY (01346000) (Figure 3*B*; Figure 5). A similar, but less distinct, double peak was recorded at Mohawk River near Little Falls, NY (01347000) (Figure 3*C*), which is located 14.8 miles downstream of West Canada Creek at Kast Bridge, NY (01346000). The first peak of the double peak was likely caused by inflows to West Canada Creek from unregulated tributaries downstream of Hinckley Reservoir, such as Cincinnati Creek, which drains a relatively large area of 48.5 square miles in the northwest corner of the West Canada Creek watershed. Cincinnati Creek was ungaged at the time, but in response to the flood, the U.S. Geological Survey, in cooperation with the New York State Canal Corporation, installed a gage at Cincinnati Creek at Barneveld, NY (01344795) that has been in operation since November 2022. The second peak of the double peak, which happened about a day after the first peak, likely resulted from regulated streamflow that passed through Hinckley Reservoir. At the other streamgages upstream of Hinckley Reservoir, single peak streamflows were recorded during the flood. More details on the nature of the flood of October 31 to November 3, 2019, including the historic context of the flood, and the results from flood-frequency analysis of six selected streamgages in the Mohawk Valley and southern Adirondack region, are discussed in Graziano and others (2024).

Table 1. Peak stage and streamflow, from the flood of October 31 to November 3, 2019, at selected U.S. Geological Survey streamgages in the Mohawk Valley and southern Adirondack region in central New York (U.S Geological Survey, 2016; Graziano and others, 2024).

U.S Geological Survey station name and station identifier	Drainage area, in square miles	Flood data					National Weather Service flood stage, in feet
		Period of record, through 2020, for annual peak streamflows, in water years	Flood of October 31 to November 3, 2019				
			Rank of annual peak streamflow in record	Date of peak streamflow	Peak stage, in feet	Peak streamflow, in cubic feet per second	
Sacandaga River Basin							
Sacandaga River near Hope, NY; station 01321000	491	1912-2020	1 of 109	11/1/2019	12.94	41,400	7
Mohawk River Basin							
Mohawk River near Utica, NY; station 01342602	553	2015-2020	1 of 6	11/2/2019	19.22	12,800	—
Vly Brook near Morehouseville, NY; station 01342797	3.28	1993-2020	1 of 28	11/1/2019	17.49	969	—
West Canada Creek near Wilmurt, NY; station 01343060	238	2001-2020	1 of 20	11/1/2019	16.73	37,400	—
Black Creek near Gray, NY; station 01343403	60.9	2015-2020	1 of 6	11/1/2019	23.72	14,700 (estimated)	—
West Canada Creek at Kast Bridge, NY; station 01346000	560	1913; 1921-2020	1 of 101	10/31/2019	10.94	27,500	6
Mohawk River near Little Falls, NY; station 01347000	1,342	1901-1902; 1904; 1913; 1928-2020	1 of 97	11/2/2019	19.86	36,900	15
East Canada Creek at East Creek, NY; station 01348000	289	1946-1996; 1998; 2000; 2003-2020	2 of 71	11/1/2019	10.86	30,300	—
Mohawk R above State Highway 30A at Fonda, NY; station 01349527	2,118	2015-2020	1 of 6	11/1/2019	29.42	65,100	—

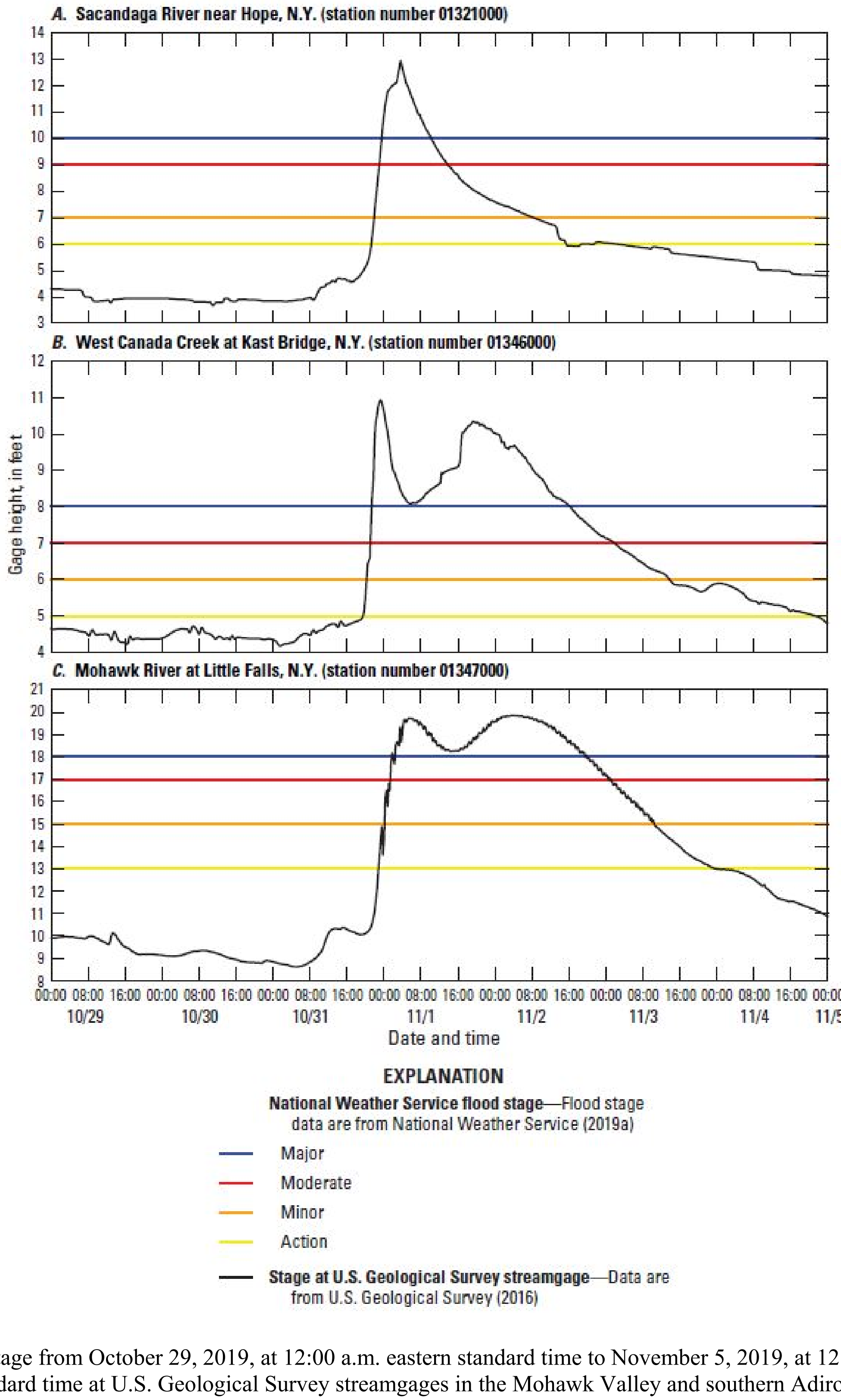

Figure 3. Stage from October 29, 2019, at 12:00 a.m. eastern standard time to November 5, 2019, at 12:00 a.m. eastern standard time at U.S. Geological Survey streamgages in the Mohawk Valley and southern Adirondack region in central New York where the National Weather Service has established flood stages (Graziano and others, 2024). *A*, Sacandaga River near Hope, NY (01321000), *B*, West Canada Creek at Kast Bridge, NY (01346000), and *C*, Mohawk River near Little Falls, NY (01347000).

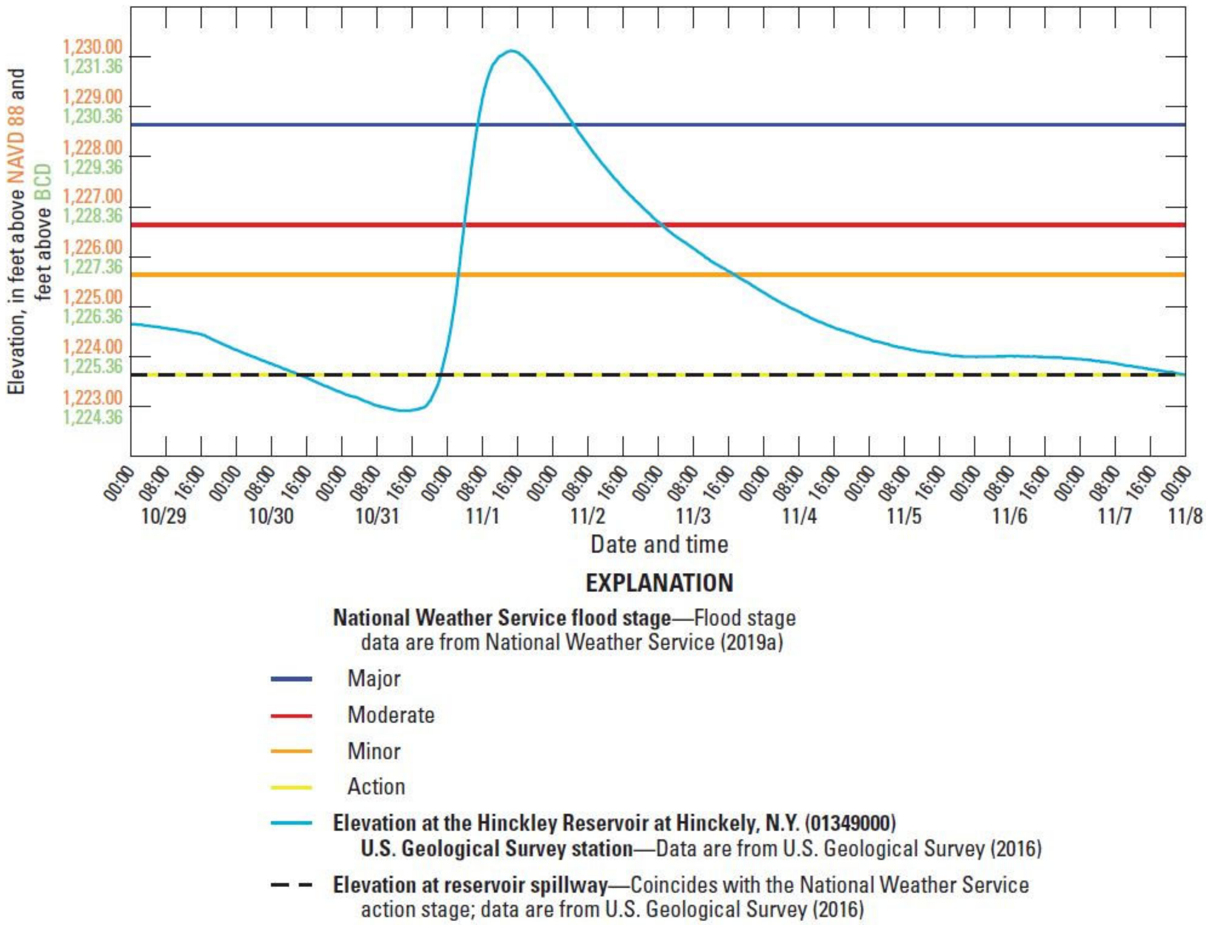

Figure 4. Reservoir elevation at the Hinckley Reservoir at Hinckley, NY (01343900) U.S. Geological Survey station, plotted with the spillway elevation and the National Weather Service flood stages, from October 29, 2019, at 12:00 a.m. eastern standard time to November 8, 2019, at 12:00 a.m. eastern standard time (Graziano and others, 2024). NAVD 88, North American Vertical Datum of 1988; BCD, New York State Barge Canal Datum.

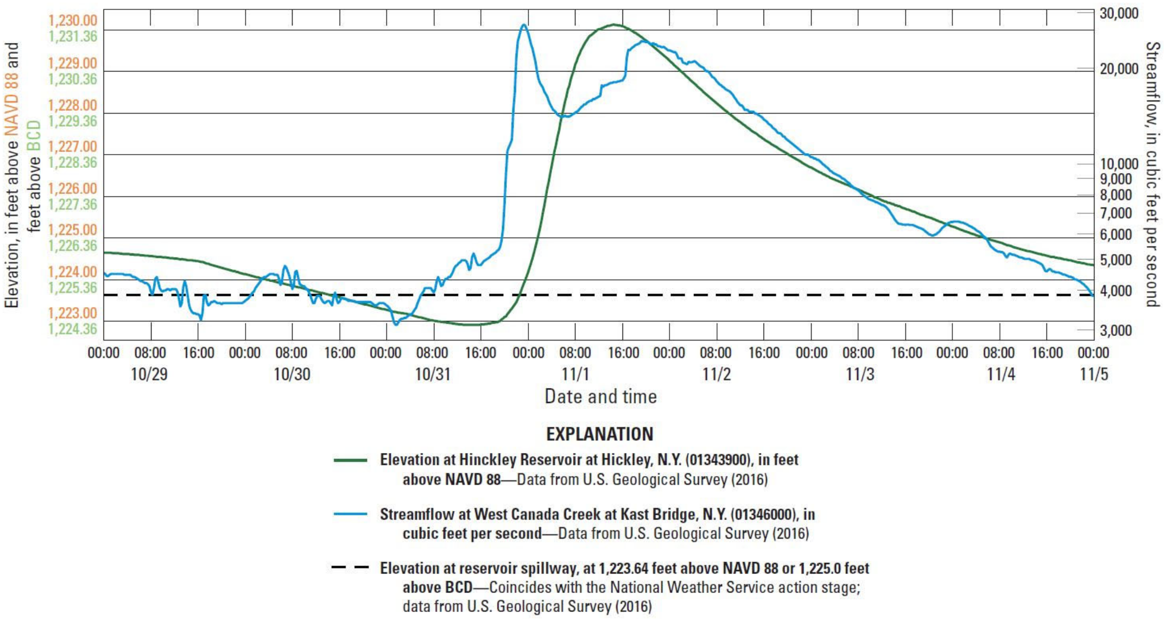

Figure 5. Streamflow at the West Canada Creek at Kast Bridge, NY (01346000) U.S. Geological Survey streamgage and reservoir elevation at the Hinckley Reservoir at Hinckley, NY (01343900) U.S. Geological Survey reservoir elevation station from October 29, 2019, at 12:00 a.m. eastern standard time to November 5, 2019, at 12:00 a.m. eastern standard time (Graziano and others, 2024). NAVD 88, North American Vertical Datum of 1988; BCD, New York State Barge Canal Datum.

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PFAS concentration in whole-body fish tissue over 7 years of monitoring downstream of AFFF spill, Rome, NY

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Introduction
Per- and polyfluoroalkyl substances (PFAS) are an emerging contaminant of which little is known about its movement through the environment over time. PFAs in Aqueous Film Forming Foam (AFFF) has been used for decades on military bases to prevent and fight fires. Bioaccumulation of PFAs has been documented in many different biota. An accidental spill in 2017 discharged an unknown amount of AFFF directly into a Sixmile Creek downstream of the Former Griffiss Air Force Base (FGAFB). This discharge created a foam plume approximately 10' high over the water's surface downstream of the FGAFB. Fish were collected in Sixmile Creek above and below the spill and overtime to document any changes in PFAS concentrations.

A significant decline in whole-body Σ11PFAS concentration was observed over the course of this study ($p<0.05$). Differences were seen between 2018 and both 2020 and 2023 but no difference was seen between 2020 and 2023, suggesting a nonlinear recovery. Significant differences in contaminant concentration between White Sucker and Creek Chub was observed, however no differences were found between Brown trout and White Sucker or Creek Chub ($p<0.05$). Creek Chub accumulated the highest individual whole-body fish concentration of Σ11PFAS, greater than 7500 ppb in one individual from 2018. This study expands our understanding of how different Σ11PFAS are accumulated in an ecologically relevant context and possible natural recovery without remediation.

Handling Figures

Photo 1: AFFF on Sixmile Creek 2017

Photo 2: Electroshocking in 2023.

Table 1. Total detections and detection percentage.

	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnA	PFDoA	PFBS	PFHxS	PFOS	PFOSA
Detections	1	1	6	44	89	81	78	0	107	114	111
Percentage	0	0	0.1	0.4	0.83	0.73	0.7	0	0.94	1	0.97

Table 2. Total non-detect breakdown by species and year.

Species	Year	PFDA	PFDoA	PFUnA	PFHxS	PFOS	PFOSA	Total ND
BT	2018	1	1	1	0	0	0	3
BT	2020	0	0	1	0	0	0	1
BT	2023	8	10	10	0	0	2	30
CC	2018	0	0	0	0	0	0	0
CC	2020	0	0	0	1	0	0	1
CC	2023	0	0	0	0	0	1	1
WS	2018	1	2	3	0	0	0	6
WS	2020	1	7	4	0	0	0	12
WS	2023	9	15	13	5	0	0	42

Table 3. Sample distribution across space, time and species.

2018	Gulf Rd	Rickmeyer Rd	Rte 365
BT	0	4	0
CC	0	6	8
WS	0	6	7
Total	0	16	15

2020	Gulf Rd	Rickmeyer Rd	Rte 365
BT	3	8	5
CC	3	6	7
WS	0	6	6
Total	6	20	18

2023	Gulf Rd	Rickmeyer Rd	Rte 365
BT	8	8	5
CC	8	8	8
WS	8	8	8
Total	24	24	21

ALL	Gulf Rd	Rickmeyer Rd	Rte 365
BT	11	20	10
CC	11	20	23
WS	8	20	21
Total	30	60	54

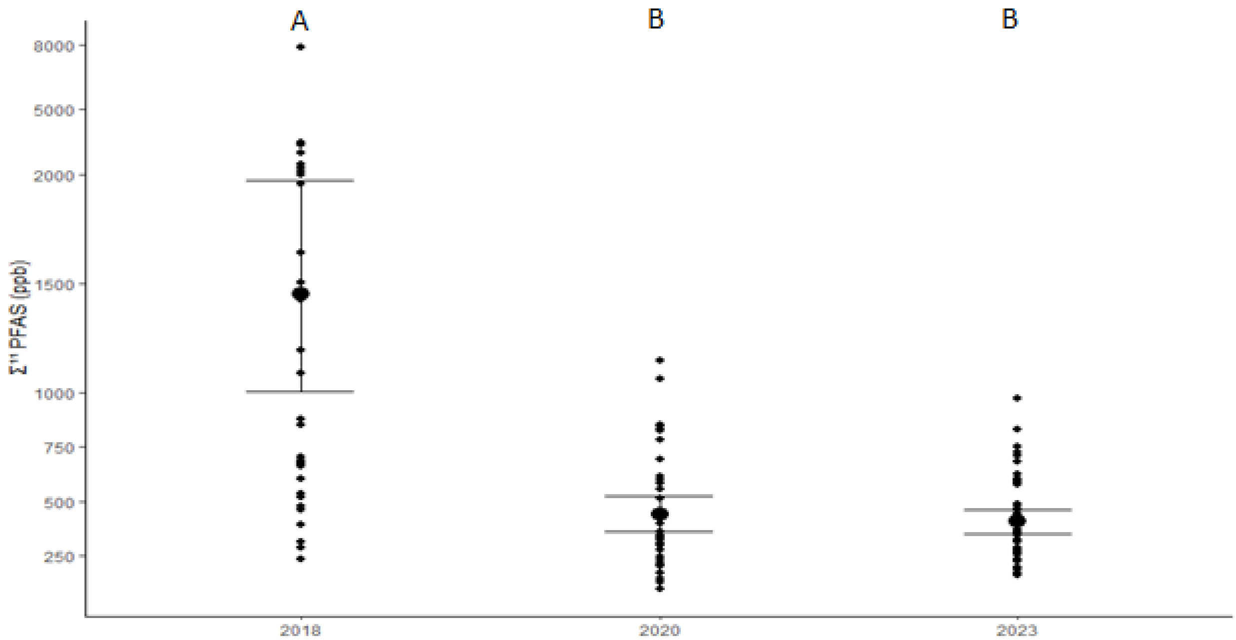

Figure 1. 95% CI of mixed effects model, Σ11PFAS concentration by year from 2018, 2020, and 2023.

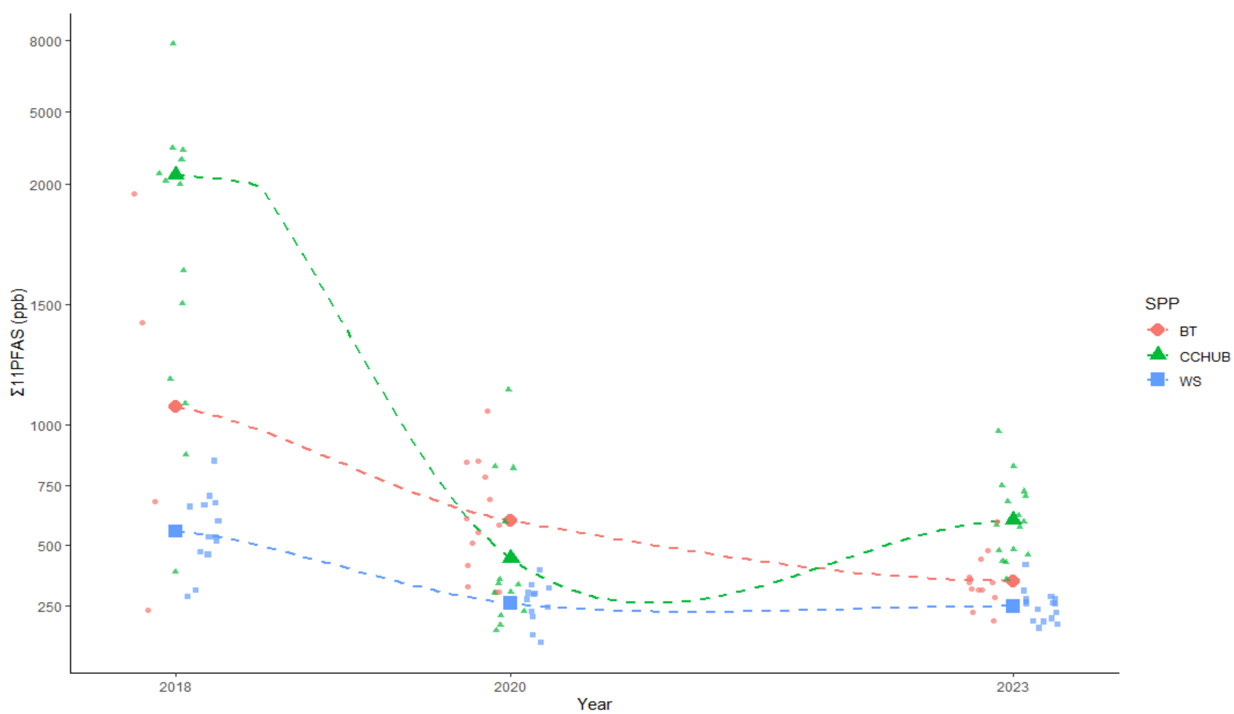

Figure 2. Σ11PFAS concentration by species collected from 2018, 2020, and 2023.

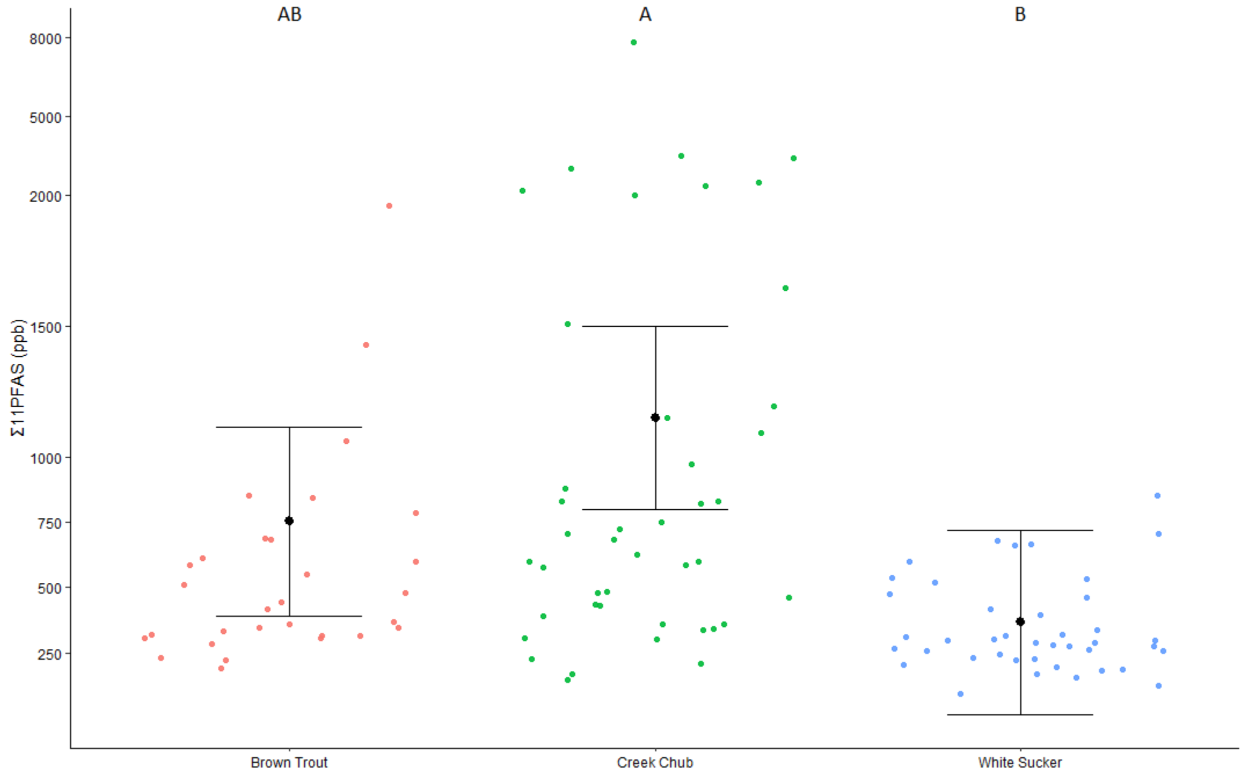

Figure 3. 95% CI of mixed effects model, Σ11PFAS concentration by species from 2018, 2020 and 2023.

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A Day in the Life of the Hudson & Harbor

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Each fall all along the Hudson River from the Adirondacks to the Atlantic Ocean, teachers and education partners team up to bring school groups to the water's edge to collect samples and learn from the river. This unique event is designed to both celebrate the Hudson River and educate participants on the uniqueness of this valuable local resource.

The event began in 2003 with a dozen partners and 300 student participants and has grown to 5000 students and teachers from 100 schools and organizations who sample at 90 sites. Students study the river as a whole system by gathering physical, biological, chemical and sediment data on their spot along the Hudson. Results are shared through educational activities developed using the annual data, an online website, and an interactive database. Students gain experience in field sampling and build their data literacy through their participation. Data, lesson plans, and lots of resources and materials are provided for participants.

Up until now the sampling has been focused mainly on the estuary section of the lower Hudson from Troy to NYC, but we are expanding to include the Mohawk River and Upper Hudson as well. These systems offer unique opportunities to include data from the entire watershed, and to adapt parameters to study non-tidal reaches of the rivers. The event is coordinated by The Hudson River Estuary Program of the New York State Department of Environmental Conservation and the Lamont-Doherty Earth Observatory.

Submerse NY: creative approaches to flood risk communication and outreach through public art

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Submerse NY is a state-wide outreach effort that supports communities in using public art to raise awareness about flood risk and encourage locally-driven solutions. Communities in New York State are increasingly vulnerable to rising sea levels and extreme flooding. Yet, homeowners and the public do not have an adequate understanding of flood risk, which leads to low disaster preparedness, misinformed decisions about the purchase and development of private property and limited public participation in resilience planning. Though there are a variety of maps and digital applications available to visualize flooding risk at various scales, many people appreciate, prefer, or can only access physical indicators in their immediate environment.

Public art - including murals, sculpture, performance, and signage - can be an effective visual tool to help the public understand their position in the landscape and connect it to present and future vulnerability to flooding. To understand the benefits and challenges of this approach, we surveyed and compiled over fifty exemplary flood-focused public art projects in New York State and beyond to identify themes and trends in using art as a tool for environmental communication. Using this repository, we developed a "Menu" that highlights different project characteristics and provides a way for communities to design their own art projects as per their priorities and maximize the effectiveness of their flood-outreach efforts.

Findings from this work were used to carry out pilot community-engagement processes, where participants from Town and Village governments, NGOs and local businesses used the Menu as a tool to envision how to creatively communicate flood risk in their community. In the Mohawk, we are working with partners to engage community members in envisioning risk communication at the Guy Park Manor Education and Resiliency Park.

Garver, J.I., Smith, J.A., and Rodak, C. 2024. Proceedings of the 2024 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 15, 2024, Volume 14, 90 pages.

Microplastic analysis of high-flow and low-flow streams located in Rensselaer County: final results

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Introduction
Microplastic pollution is a growing problem in today's society. Microplastics are plastic particles that are less than 5mm (Arthur 2008). Due to their small size, they collect in bodies of water. Lakes and areas of decreased flow velocity act as microplastic sinks, causing microplastics to build up, and streams serve as microplastic conveyance, moving the microplastics to the next lake or ocean (Peterson 2020). Microplastics have been identified in mass quantities in local rivers. In studies of the Mohawk River in eastern New York and 21 of its tributaries, every sample taken contained microplastics (Smith 2020).

In the Mohawk River study, microplastic particles were pervasive in surface waters of the lower Mohawk River (below Rome), with all 64 trawl samples containing some microplastics, from 3 particles to 521 particles. In some cases, the high abundance of microplastic particles correlated closely to proximity to WWTPs (wastewater treatment plants), but not in all cases (Smith 2017).

Testing for microplastics in Mohawk tributaries found microplastics in every sample taken (Smith 2019). Study sites included the Hans Groot Kill, a small creek that flows through the Union College Campus in Schenectady, NY. The water in the Hans Groot Kill is predominantly sourced from stormwater collected in the General Electric Realty Plot and neighborhoods to the north of it. When the stream was tested at high-flow, the 8-minute sample had an estimated 15,000 particles, compared to the low-flow sample, which had 75 particles in 27 minutes (Smith 2019). The findings of microplastics in the Hans Groot Kill, as well as the later finding of fecal indicator bacteria and human DNA, led the City of Schenectady to begin an investigation into the source of the sewage in the Hans Groot Kill (Willard-Bauer 2020).

The presence of microplastics, if found in abundance, can point to sewage leaking from sanitary pipes into storm water pipes. Microplastic fibers are most commonly found in laundry wastewater, due to plastic fiber breaking off synthetic materials and synthetic detergent. The laundry wastewater, which is part of the sewage stream, can then mix with stormwater when aging pipes crack and leak, or alternatively, mix directly through illegal connections (Willard-Bauer 2020). Another way microplastics can infiltrate the surrounding environment is through landfill runoff and leachates.

While the Mohawk River, the largest tributary to the Hudson River, has been documented to have microplastics that are most likely coming primarily from sewage, the rivers to the east of the Hudson have not been studied. The purpose of this research was to sample the local streams in Rensselaer County for microplastics and analyze the level of microplastics present. High microplastic levels might mean leakage of sewage or landfill runoff, or both.

Hypothesis
The streams sampled were Quakenderry Creek, Mill Creek, and Moordener Kill (Figure 1). Samples were classified by river, flow conditions, and date. The hypothesis was that there will be more microplastics in after-rain high-flow samples and that there will be more microplastics in streams with proximity to landfills or transfer stations. Quackenderry Creek, which is closest to the Dunn Mine and Landfill, was hypothesized to have the most microplastics overall. Mill Creek is also affected by the Dunn Mine and Landfill, so it was hypothesized that it would have similar levels of microplastics to Quackenderry Creek.

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Moordener Kill, the stream farthest from a landfill, was hypothesized not to have many microplastics, though it might have some from the transfer station located next to the river.

Streams - background information

Figure 1: Map of sampling locations, Dunn Mine and Landfill, Schodack Transfer station, and East Greenbush Sewage plant.

Local historians for Rennsealer, East Greenbush, and East Schodack were contacted to explore the history that might have affected each of the three sampled streams (Figure 1).

Quackenderry Creek is located in the City of Rensselaer. It flows through Hollow Park, in Rensselaer, NY, and the park was used to access the sampling location. In the past, the land was used as a rifle range, which was then converted to the park. The sampling location has a small dam located upstream, and is downhill from the Dunn Mine and Landfill. The Dunn Mine started operations as a mine in the 1830s, and was only recently used as a landfill, starting in 2015. Since then, the landfill's close proximity to the local elementary schools have caused concern because the landfill has been seen emitting fumes and smoke multiple times, causing there to be protests against the landfill (Dunn Landfill, 2022).

Mill Creek is located within the City of Rensselaer and the Town of East Greenbush. The stream was accessed within the Town of East Greenbush, on Michael Road. In the past, the creek was used to power multiple mills, which is where the creek gets its name. Recently Mill Creek was featured in the news due to the announcement of a dam removal (Karlin, 2022).

Moordener Kill is located within the Town of East Greenbush and the Town of Schodack. The sampling location was accessed through the East Schodack Town Park, which was created during the 1990s. The Moordener Kill was historically used to power small mills. Around 1958, a dump was started at the location of the existing Schodack Transfer Station. Dumping had been occurring at that location by the farm owner for some years previously. In 1989, the dump was capped because the bottom did not have a liner. Grass was planted over the existing land. As of 1989, the dump became a transfer station with nothing being deposited at the former dump location. Waste was found beyond the original cap and the Town of East Schodack had to buy additional land to extend the cap. The Town Park was developed as a result of this additional land purchase of 56 acres (Hutchinson, 2023). Similar to Mill Creek, this creek is considered a herring and American eel spawning site (Nri-map 2019).

Methods

A 3-meter neuston net with a 335-µm mesh was used to collect samples. It was placed in the section of the stream with the strongest flow. The velocity of the stream was determined using a fishing bobber

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attached to the end of a two-meter-long piece of fishing line. The bobber was placed a meter before where the net would be placed for sampling, so the flow velocity would represent the water flowing into the net. Each sample was collected for 30 minutes, with the exception of the after-rain high-flow sample for Quackenderry Creek, which was collected for 2 minutes and 15 seconds due to the amount of material passing into the net. Samples were washed from the net into a 16-ounce wide-mouth glass mason jar using a backpack sprayer.

Due to the amount of material in the net after the after-rain high-flow sample for Quackenderry Creek, multiple bins of water were used to wash leaves off all material, then the water in the bins was poured back through the net and then washed into multiple mason jars. Samples were drained of water using 10 micron filter paper. The filter paper was screwed onto the jars using the mason jar lids. The jars were set on their sides to dry for multiple months with a large plastic box that was cleaned to prevent any disturbances to the jars. Samples were sieved once dry through a sieve stack of decreasing filter size. The size of the filters were 4750µm, 2000µm, 231µm, and 63µm. Therefore, all microplastics included in this study are larger than 63µm. The collected sample material was manipulated into glass petri dishes by a stainless steel sampling spoon. The spoon was washed in between different samples. The glass petri dishes were used for each filter size and washed and dried before use. Samples were viewed using a stereoscope, and a grid sheet was taped under the petri dish to help with the visual identification and classification of microplastics. An article provided guidance to sort microplastics identified into groups of fragments, foams, pellets/beads, films, and fibers/lines (MERI, 2015).

Contamination is a large concern in microplastic sampling. Due to most materials being made out of plastic, there is almost no way to sample for microplastics without interacting with plastic in some way. Precautions can be made by washing plastic materials thoroughly before coming into contact with samples, but a large problem comes from the fact that the neuston net used to sample for microplastics is made of nylon.

Data and Results

The data are tabulated below in Tables 1, 2, and 3. Table 1 presents stream and sampling data for each of the 10 samples collected. Table 2 presents streamflow and sampled volume calculated for each sampling time. Table 3 presents microplastic counts for each sampling round.

Table 1. All stream measurements taken in the field on the sampling date.

Stream	Sample Type	Latitude	Longitude	Sampling Date	Time (min)	Time (s)	Submerged Depth Left (m)	Submerged Depth Right (m)	Net width (m)	Stream Depth (m)	Stream Width (m)
Mill Creek	Low Flow	42°36'45.5"N	73°41'45.2"W	6/18/22	30	1800	0.05	0.05	0.91	0.1	1.78
Mill Creek	High Flow	42°36'45.5"N	73°41'45.2"W	7/2/22	30	1800	0.06	0.09	0.91	0.17	2.26
Mill Creek	High Flow After Rain	42°36'45.5"N	73°41'45.2"W	9/13/22	30	1800	0.11	0.12	0.91	0.2	2.33
Moordener Kill	Low Flow	42°33'25.2" N	73°39'08.5" W	6/26/22	30	1800	0.08	0.06	0.91	0.12	1.78
Moordener Kill	High Flow	42°33'25.2" N	73°39'08.5" W	7/5/22	30	1800	0.08	0.12	0.91	0.2	1.6
Moordener Kill	High Flow After Rain	42°33'25.2" N	73°39'08.5" W	6/27/22	30	1800	0.12	0.12	0.91	0.21	2.67
Quackenderry Creek	Low Flow	42°39'00.1" N	73°43'52.3" W	6/29/22	30	1800	0.19	0.19	0.91	0.31	1.43
Quackenderry Creek	Low Flow	42°39'00.1" N	73°43'52.3" W	7/12/22	30	1800	0.06	0.19	0.91	0.2	1.39
Quackenderry Creek	High Flow	42°39'00.1" N	73°43'52.3" W	7/28/22	30	1800	0.08	0.05	0.91	0.1	1.44
Quackenderry Creek	High Flow After Rain	42°39'00.1" N	73°43'52.3" W	11/12/22	2.25	135	0.33	0.18	0.91	0.34	3.5

Table 2: All calculations using measurements presented in Table 1.

Stream	Sample Type	Sampling Date	Average Bobber Time (s)	String Length (m)	Flow Velocity (M/s)	Sudmerged Area (m2)	Volume of water (m3)
Mill Creek	Low Flow	6/18/22	3.71	2.00	0.54	0.05	44.19
Mill Creek	High Flow	7/2/22	3.76	2.00	0.53	0.07	65.43
Mill Creek	High Flow After Rain	9/13/22	2.97	2.00	0.67	0.10	126.71
Moordener Kill	Low Flow	6/26/22	4.25	2.00	0.47	0.06	53.94
Moordener Kill	High Flow	7/5/22	3.84	2.00	0.52	0.09	85.42
Moordener Kill	High Flow After Rain	6/27/22	3.61	2.00	0.55	0.11	108.90
Quackenderry Creek	Low Flow	6/29/22	16.48	2.00	0.12	0.17	37.77
Quackenderry Creek	Low Flow	7/12/22	32.71	2.00	0.06	0.11	12.52
Quackenderry Creek	High Flow	7/28/22	26.43	2.00	0.08	0.06	8.06
Quackenderry Creek	High Flow After Rain	11/12/22	2.01	2.00	1.00	0.23	31.25

Table 3: All microplastic counts and calculations made using microplastic counts.

Stream	Sample Type	Sampling Date	Particle Abundance (total # particles)	fragments	foams	pellets/beads	films	fibers/lines	Percent Fibers (%)	Particle Concentration (particles/m3)	Stream load (particles/ sampling period)	Estimated Stream Volume of Water while sampling (m3)	Estimated annual streamflow (# particles/ year)
Mill Creek	Low Flow	6/18/22	7	4	0	0	2	1	14.3%	0.16	27	172.88	479778
Mill Creek	High Flow	7/2/22	6	5	0	0	0	1	16.7%	0.09	34	368.34	591752
Mill Creek	High Flow After Rain	9/13/22	312	1	31	0	1	279	89.4%	2.46	1389	564.22	24340830
Moordener Kill	Low Flow	6/26/22	40	9	0	0	1	30	75.0%	0.74	134	180.86	2349935
Moordener Kill	High Flow	7/5/22	24	4	0	1	0	19	79.2%	0.28	84	300.39	1478611
Moordener Kill	High Flow After Rain	6/27/22	21	5	0	1	2	13	61.9%	0.19	108	559.15	1889128
Quackenderry Creek	Low Flow	6/29/22	14	1	1	0	2	10	71.4%	0.37	36	96.85	628876
Quackenderry Creek	Low Flow	7/12/22	3	0	0	0	0	3	100.0%	0.24	7	30.60	128454
Quackenderry Creek	High Flow	7/28/22	21	0	0	0	1	20	95.2%	2.61	51	19.61	895697
Quackenderry Creek	High Flow After Rain	11/12/22	563	58	45	2	7	451	80.1%	18.02	2887	160.25	674445128

Findings and Discussion

Microplastics were found in all 10 samples (Table 3). In general, microplastic fibers were the most abundant, followed by fragments. Total particle counts range from 3 in the Quackenderry low-flow sample to 563 in the Quackenderry Creek high-flow after-rain sample. Quackenderry Creek 7/12/22 low-flow and Quackenderry Creek high-flow had the highest percent fibers. Quackenderry Creek high-flow after-rain had the highest particle concentration. Mill Creek low-flow and Mill Creek high-flow had the lowest percent fibers at 14.3% and 16.7% respectively. Quackenderry Creek low-flow (7/12/22) and Quackenderry Creek high-flow had the highest percentage of fibers at 100% and 95.2% respectively.

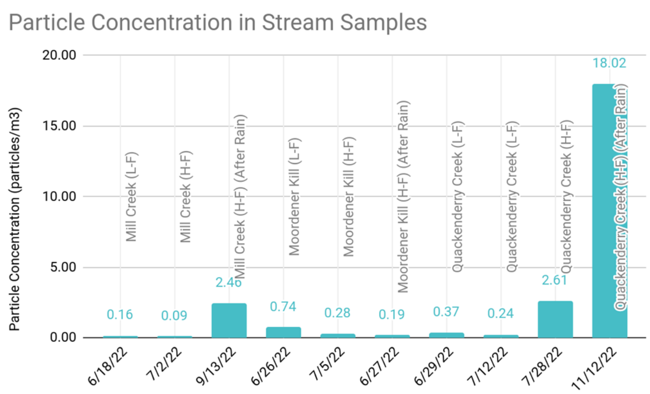

Figure 2: Bar chart comparing the microplastic concentration in all samples.

Mill Creek high-flow had the lowest concentration at 0.09 particles per m^3 (Figure 2). Quackenderry Creek high-flow had the highest particle concentration at 18.02 particles per m^3. This graph shows how both Mill Creek and Quackenderry Creek reflected the hypothesis that there would be more microplastics and higher particle concentration in high-flow samples. Moordener Kill does not support this hypothesis.

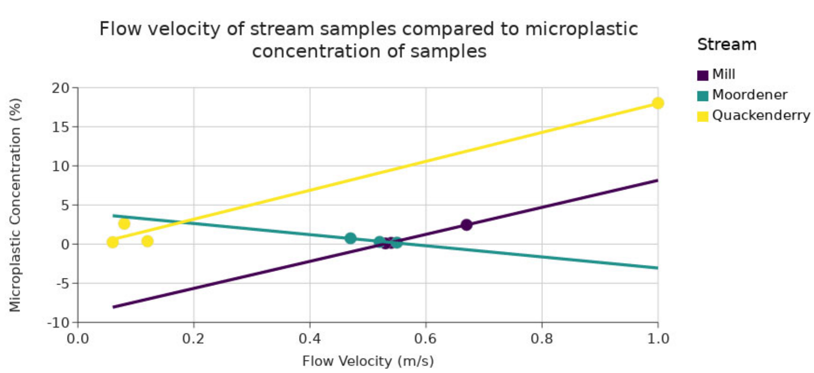

Figure 3: Scatterplot showing the relationship between flow velocity and microplastic concentration.

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Mill Creek has a positive relationship between flow velocity and microplastic concentration, showing that as flow velocity increased, microplastic concentration increased as well (Figure 3). Moordener Kill had the only negative relationship: the regression line shows that as flow velocity increased, microplastic concentration decreased. Quackenderry Creek had a positive relationship, with microplastic concentration increasing as flow velocity increased. When a linear regression was calculated it produced a p-value of 0.05, meaning that there is some confidence that there is a relationship between flow velocity and microplastic concentration. This makes sense, as the faster the water, the more flow velocity and the more possibilities for microplastics to enter the net. This graph supports the hypothesis that there would be more microplastics in after-rain high-flow samples.

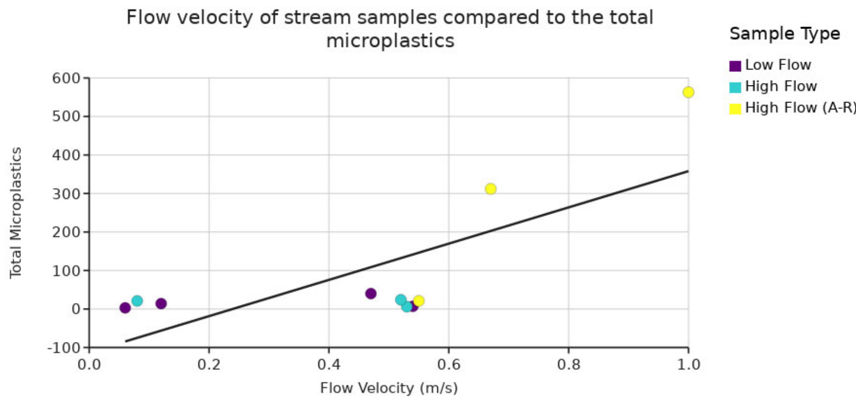

Figure 4: Scatterplot showing the relationship between flow velocity and total microplastics counted.

Figure 4 shows that overall, the relationship between flow velocity and total microplastic count is positive. The high-flow after-rain samples are located on the higher end of the flow velocity, and both the Mill and Quackenderry Creek high-flow after-rain samples are far from the regression line. This means that the low-flow and high-flow samples can be predicted by the regression line while the high-flow after-rain samples are extremely unusual due to their high particle counts. The low-flow and high-flow samples are located closer to the regression line, with two clusters on either side of the regression line. When a linear regression was calculated, a p-value of 0.01 was found, meaning there is a very strong confidence that there is a relationship between flow velocity and total microplastics. This graph also supports the hypothesis that there would be more microplastics in after-rain high-flow samples.

Conclusion

Three creeks in Rensselaer County, New York, were sampled for microplastics under both high-flow, high-flow-after-rain, and low-flow conditions. Microplastic particles were found in all creeks sampled. The highest microplastic counts came from the Quackenderry Creek and Mill Creek high-flow-after-rain samples. Moordener Kill did not support the original hypothesis that high-flow samples will have more particles and higher particle concentrations than low-flow samples. Mill Creek supported the hypothesis only in the high-flow-after-rain sample. Quackenderry Creek supported the hypothesis in both the high-flow and high-flow-after-rain samples. Quackenderry Creek samples had some of the highest percentage of fibers, and the Quackenderry high-flow-after-rain sample had the highest particle concentration.

More analysis needs to be done to see if there is any correlation between location of the sample and location of a local landfill. Mill Creek most likely had the most percent fibers in the high-flow-after-rain sample as it is a rural stream in which microplastics would be sourced from the microplastics in the environment, while Quackenderry Creek's high-flow-after-rain sample had higher amounts of fragments and foams than Mill Creek perhaps because of its close proximity to the Dunn Mine and Landfill. Both Mill and Quackenderry Creek appear to be affected by Dunn Mine and Landfill runoff, while Moordener Kill appears not to be affected by the transfer station and to be relatively low in microplastics.

The calculation of annual microplastics load shows that even a small amount of microplastics can add up to a large amount, from 3 particles in 30 minutes to roughly 128,454 particles in a year. These microplastics can carry invasive species and chemicals such as BPA, which can cause strokes in humans, and PCBs, which can cause general sickness in humans and cancer to small animals (Teuten, 2009). The contributions of the Dunn Mine and Landfill are suggested by the sampling results, with the two streams that run by the landfill, Mill Creek and Quackenderry Creek, having the largest amount of microplastics overall.

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Upstate Flood Mitigation Task Force Report

Kenneth Kemp

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Background

Legislation (S.8204a/A.9177) signed on July 1, 2022 by Governor Hochul reauthorized the Upstate Flood Mitigation Task Force (USFMTF) and established the New York State Canal Corporation Executive Director Brian Statton as the Task Force Chair. The Legislation required the USFMTF to submit a Report by July 1, 2023 describing the impacts of flooding over the last five years; assessing the direct or indirect impacts of New York State Canal System operations on flood mitigation and flood management; and identifying and providing a list of adaptive measures, procedures and associated costs to enhance flood management and mitigation along the New York State Canal System within the Oswego and Mohawk River Basins. The legislation required at least four USFMTF meetings be conducted prior to the report deadline and the USFMTF will meet on an annual basis thereafter.

Introduction

The Task Force consists of nine members, including the Director of the NYSCC, Commissioner of the NYS Department of Transportation (NYSDOT), Commissioner of the NYS Department of Homeland Security and Emergency Services (NYSDHSES), Commissioner of the NYS Department of Environmental Conservation (NYSDEC). Five members (three appointed by the Governor, one appointed by the President Pro Tempore of the Senate, and one appointed by the Speaker of the Assembly) are also part of the Task Force and include:

- William Nechamen, Nechamen Consulting, LLC, Floodplain Management
- Orrin MacMurray, PE, C&S Companies, Civil Engineering
- Theodore Endreny, PE, State University of New York – Environmental Science and Forestry (SUNY ESF) Hydrology
- Peter Nichols, Schoharie County Soil & Water Conservation District, Soil & Water Conservation
- Nagappa Ravindra, PE, Ravi Engineering & Land Surveying, PC, Civil Engineering

The Task Force members created three subcommittees to assist in accomplishing the legislation's ambitious objectives. These subcommittees include:

- Grants and Policies
- Hydrology and Engineering
- Public Engagement and Outreach

The geographic scope of this examination includes areas that are within Flood Mitigation Regions. Flood Mitigation Regions are defined as upstate counties through which the Erie Canal passes in whole or in part and are within the Federal Emergency Management Agency (FEMA) Special Flood Hazard Area (SFHA) or 100-year floodplain, and those areas tributary to the Erie Canal system. The Mohawk River Flood Mitigation Region included the following counties (west to east): Oneida, Herkimer, Montgomery, Schenectady, Saratoga, and Albany.

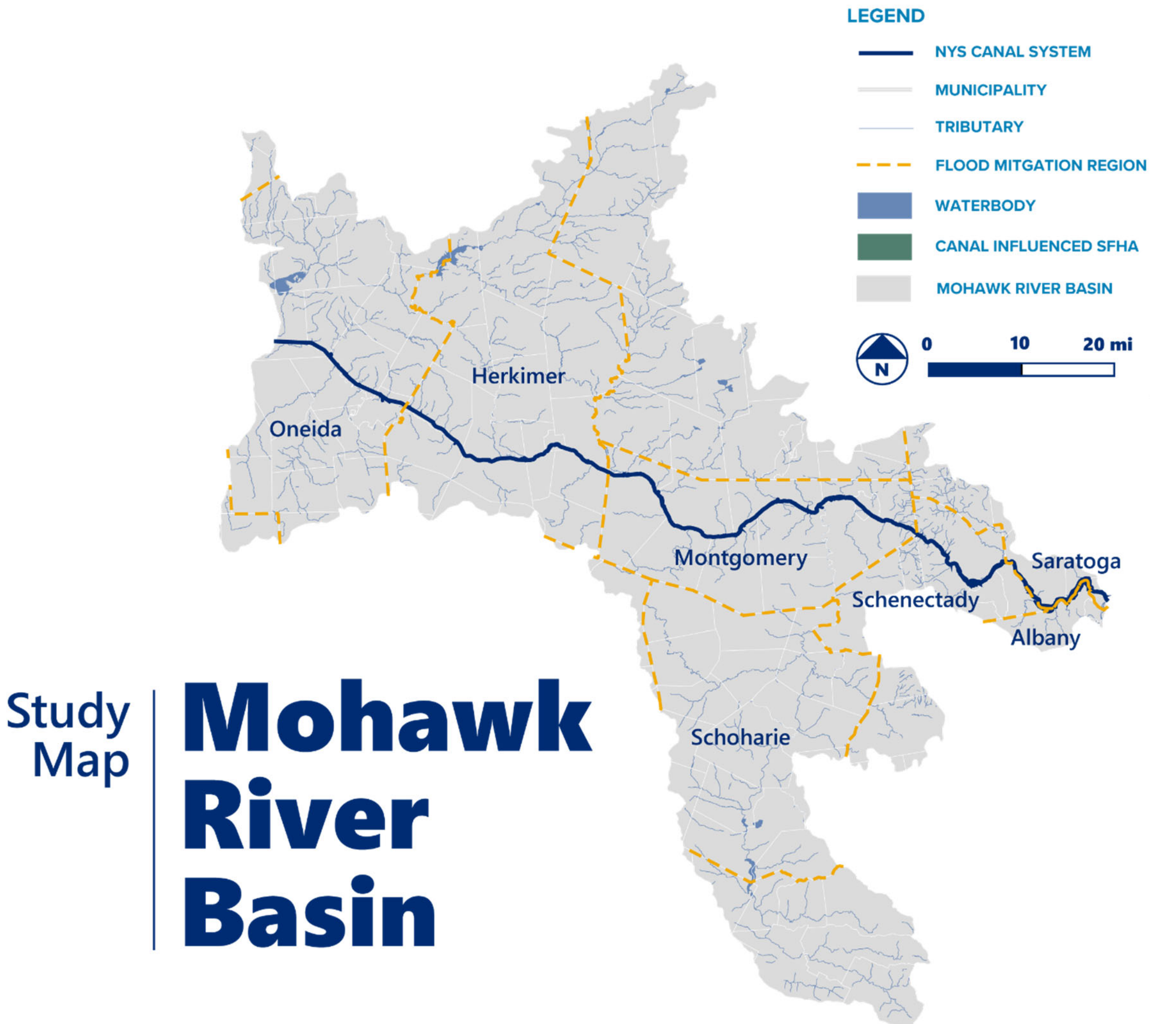

Figure 1. Mohawk River Basin Flood Mitigation Region

The data presented analyzed and presented was sourced from river and meteorological gages, previous studies conducted within the Flood Mitigation Regions, and available damage records from previous flooding events. River gage records were obtained from several sources including the National Weather Service Advanced Hydrologic Prediction Service (AHPS), HydroSphere, United States Geological Survey (USGS) WaterWatch, and New York State (NYS) Mesonet. No new hydrologic or hydraulic analysis was performed as a part of this Report. The effect of climate change on recent flood events was not considered, however, the adaptive measures included considered resiliency and adaptability for the potential effect of future climate change.

As part of this effort, previously completed reports and studies related to the Mohawk and Oswego River Basins were reviewed and summarized. A total of 38 reports were reviewed for the Mohawk River Basin. The report recommended both physical interventions and policy recommendations as adaptive measures, ten of which are applicable to both geographic areas, as well as adaptive measures specific to the Mohawk River Basin. The broad-ranging recommendations for both geographic areas include improving data collection and analysis, improved communication between water managers within the basins, additional public education and outreach, restoration of floodplain, purchase of flood prone structures as well as reduced development within the floodplain, addressing erosion and sedimentation in the main rivers as well as tributaries, and increased state support of programs like the National Flood Insurance Program.

Adaptive measures specific to the Mohawk River Basin include updating FEMA Flood Insurance Rate Maps to reflect recent operational changes, evaluating modernization of the Canal owned moveable dams, continuing efforts to mitigate ice jam formation in the Schenectady area, and studying the potential to modify operations at Delta Reservoir and bifurcated sections of the Canal/Mohawk River to improve flood resiliency.

The USFMTF made every effort to distill the analysis and resulting recommendations into actionable opportunities. It is the USFMTF's opinion that further investigation and implementation of the recommended adaptive measures is overdue. Previous efforts did not advance, and recent flooding events studied demonstrate the severity and significant variability in the location and duration of these events. Every effort must be made to advance the Report's recommendations as soon as possible to better assist and better protect New York residents and infrastructure most vulnerable to flooding.

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Observations from longitudinal monitoring of fecal indicator bacteria (*Enterococci* and *Escherichia coli*) in the Mohawk River Watershed

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Surface water quality is of concern to all citizens who live in the Mohawk River Watershed. This body of water serves as drinking water sources, places of recreation, and wildlife habitat. We are monitoring and observing water quality trends by sampling for fecal indicator bacteria, FIB (*Enterococci* and *E.* coli) along the Mohawk River from Delta Lake to its confluence with the Hudson River. This work is accomplished through six sampling events occurring monthly between May and October, with samples typically collected within a 14-24 h period (9 h shortest; 48 h longest). Samples are analyzed for *Enterococci*, using IDEXX's Enterolert method (EPA Standard Method 9230D). *E.* coli, are measured using the IDEXX Colilert system (EPA Standard Method 9223B). Thus, this work provides a view of water quality through two widely accepted FIB methods. Although *Enterococci* may typically not be harmful, in part due to their existence in the guts of warm-blooded animals, their presence in water samples indicates the likely presence of more harmful pathogens associated with fecal contamination. Contributing bacteria may enter a waterway through combined sewer overflows, sewer system failures, septic system failures, urban surface water run-off (including domestic and wildlife sources), or agricultural run-off. Contamination typically continues to be highest after precipitation events in both tributaries and the main stem. This work extends the data over nine years from 2015-2023. It must be noted that the value of long-term data is the ability to address trends which might not be evident from a single sampling campaign. This presentation will address the inclusion of the 2023 data into the body of work and the trends that were presented at the 2023 Mohawk Watershed Symposium.

Garver, J.I., Smith, J.A., and Rodak, C. 2024. Proceedings of the 2024 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 15, 2024, Volume 14, 90 pages.

Canals and aquatic invasive species: protecting New York's waterways from harmful species

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New York's Wonderful Waters

With over 7,000 lakes and ponds and some 70,000 miles of rivers and streams, New York State is home to exceptional freshwater ecosystems. These waters support a diversity of wildlife, figure prominently within the region's history, and enrich the lives of residents and visitors. They are key for the state's economic development and sense of place. Protecting them benefits all of us.

Among these important freshwater resources is the expansive New York State Canal System (NYSCS). The NYSCS helped usher in an era of economic growth during the Industrial Revolution and was responsible for the livelihoods of some 50,000 New Yorkers at its economic height. While the NYSCS is still utilized for commercial transport, its primary use today is for recreation and tourism. Millions of visitors enjoy boating, fishing, sightseeing, hiking, biking and many other activities on the Canals and adjacent trails each year.[1]

Canals are engineered passageways comprised of built and natural waterways, which over time can become part of the landscape and support habitats for native species. Some of these species are recreationally important, threatened, endangered, and/or invasive. Anglers enjoy leisure fishing for warm waters species, like panfish, throughout the NYSCS and there are sections that support world-class fishing opportunities. In addition to recreationally important fishes, the NYSCS contains species that need careful management and conservation, such as imperiled freshwater mussels, blueback herring, and American eel. Harmful invasive species are also present within the NYSCS due to its connectivity to other waterbodies and introductions directly into the canals by human activity.

Unintended Consequences of Canals

Aquatic Invasive Species and Canals. Aquatic invasive species (AIS) are plants and animals introduced from other ecosystems that multiply and spread rapidly, so much so that they change the way their new habitat functions to the detriment of native species. AIS can damage water quality and harm local economies by interfering with recreational activities like fishing and boating. Once introduced, AIS are difficult to control and often cost local communities millions of dollars to manage the ecological and economic fallout. AIS threaten native species and recreational opportunities in New York's waterways, potentially causing a significant loss of ecosystem services for Canal communities and visitors. Species such as the red swamp crayfish (*Procambarus clarkii)*, whose burrowing activities may destabilize embankments,[2] can threaten the integrity of Canal infrastructure. This damage could require costly repairs to preserve historically important infrastructure and maintain critical operations.

Unintended Consequences of Connected Waterways. The spread of AIS into the NYSCS has serious implications that extend far beyond the canal system itself. The canal system creates a connection between five major watersheds and several large waterbodies, including two Great Lakes (Erie and Ontario), the Finger Lakes, Oneida Lake, Lake Champlain, and the Atlantic Ocean. These connections inadvertently create dispersal pathways for AIS to travel between these naturally separated waterbodies. The Great Lakes currently host about 65 non-native and invasive species that are not yet found in the Hudson or Mohawk Rivers. These rivers are at risk of new AIS introductions from the Great Lakes due to their connection by the Erie Canal. The New York Power Authority, New York State Canal Corporation (NYSCC), and New York State Department of Environmental Conservation (NYSDEC) are working together to address these AIS spread risks while maintaining public access to and through the NYSCS.

Irreversible Impacts. AIS can be introduced to new watersheds in many ways. Species may hitch a ride on boats, be dumped from unwanted household aquariums or bait buckets, and/or spread unassisted through natural population growth. Several AIS are known to have spread from the Great Lakes to other regions of New York by way of the Erie Canal.[3] Here are some examples:

- **Zebra mussel (*Dreissena polymorpha*).** This invasive mussel caused plankton populations to plummet by 70 to 80 percent in the Hudson River, reducing food supply for fish and other wildlife.[4]
- **Faucet snail (*Bithynia tentaculata*).** The faucet snail is a small aquatic snail that infests municipal water systems. It also harbors a variety of parasites that are deadly to migratory waterfowl. At least 60,000 birds across 15 species have been killed by these parasitic assemblages nationwide, with thousands of birds continuing to die each year.[5]
- **Round goby (*Neogobius melanostomus*).** The newest arrival to the Hudson River is the round goby,[6] an aggressive, voracious predator that disrupts fisheries.[7]

Taking Action to Prevent Harmful Species Spread

The spread of round goby highlights the importance of preventing AIS from using the NYSCS to move into new waterways. The NYSCC, NYSDEC, LCBP, and other stakeholders are implementing a comprehensive effort to combat the potential spread of the round goby through the Champlain Canal to Lake Champlain. This strategy is based on the experience of subject matter experts involved in AIS at local, state, and regional levels. Although this strategy focuses on the Champlain Canal as a specific pathway for round goby migration, it details a series of rapid responses that could be used to guide action throughout the NYSCS to deter future AIS introductions.

Rapid Response Plan for The Champlain Canal. The rapid response plan uses surveys conducted by our partners to detect the presence of round goby in the Champlain Canal and proposes adaptive actions to contain round goby using a Trigger Action Response Plan (TARP). The TARP includes a series of escalating actions, such as limiting vessel traffic or temporary lock closures, to contain round goby if it advances within the Champlain Canal.[8] Here are some of the actions the NYSCC and partner agencies are taking to mitigate the spread of round goby in the Champlain Canal:

- **Round Goby Monitoring.** The LCBP, USGS, and NYSDEC are using electrofishing and eDNA surveys to monitor round goby populations in the Hudson River and Champlain Canal.[9]
- **Operational Changes.** The NYSCC is continuing to implement operational modifications to reduce the risk of round goby spreading within the Champlain Canal. These modifications include scheduled lock openings, double draining at locks C1 and C2, and using data on round goby presence to time floodgate operation.[10]
- **Community Education and Outreach.** Preventing the spread of AIS is the most impactful and cost-effective management strategy available. The NYSCC has produced educational materials to alert boaters to the presence of round goby, explain operational changes, and highlight ways the community can help stop the spread of round goby (link to DEC clean, drain, dry).[10]

Champlain Canal Facility Plan. The facility plan is a preliminary design study that describes and evaluates potential technological interventions that could be implemented to mitigate the spread of round goby in the Champlain Canal and into Lake Champlain. The proposed technologies include a bubble curtain and electric deterrent within the Champlain Canal, as well as an inlet screen system to deter round goby from entering the Glens Falls Feeder Canal.[11] These measures may also mitigate the spread of other AIS and will be evaluated based on their efficacy.

Future AIS Planning. While progress has been made by the NYSCC on developing rapid response plans and evaluating deterrent technologies to fight the spread of round goby in the Champlain Canal, additional threats lay on the horizon. For example, invasive carp, a significant threat to native fisheries and the health of boaters and anglers, may soon enter the Great Lakes and spread through the Canal System into the Mohawk and Hudson Rivers. The NYSCC is using lessons learned from work in the Champlain Canal to develop additional strategies that prioritize early detection of new AIS and rapid responses in other NYSCS locations.

Management strategies for the NYSCS will continue to seek balance between preserving recreational opportunities and mitigating AIS impacts. The response to AIS will evolve through ongoing collaboration with our partners on early detection and rapid response plans, deterrent technology planning and implementation, and public education initiatives.

Acknowledgements

The NYSCC is grateful for the contributions of our partners in helping us fight the spread of AIS through the NYSCS and connected watersheds. We acknowledge useful discussions with a small group representing various stakeholders in the Mohawk, Hudson and Champlain watersheds.

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The Schenectady Environmental Education Center: connecting communities, parks, and schools through environmental literacy education and neighborhood-based stewardship activities

John McKeeby

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In 2023 the City of Schenectady, in partnership with the Schoharie River Center, Inc. (SRC), and its partners: the Environmental Clearing House of Schenectady (ECOS), Community Fathers, Inc.(CFI) and the Upper Union Neighborhood Association (UUNA), pledged to work to transform the abandoned "Casino Building" located in the City's Central Park, into a modern environmental education center that will serve as learning hub for advancing environmental literacy in the City through school and community based environmental education, environmental stewardship activities, citizen science research, digital media education, and workforce development programs. The Schenectady Environmental Education Center, (SEEC) will be operated by the SRC as lead organization, responsible for the program development, implementation and day-to-day operations of SEEC in Central Park. We collaborate with our partner organizations (ECOS,CFI, UUNA), the City Parks Department, City Schools, and other individuals and CBO's to develop city-wide programming offered through SEEC.

Together, we envision a renovated facility that will be a community resource where area youth and others will have the opportunity to enjoy and learn about their local environment, and what can be done to protect it. Our goal is that the building renovations will produce a sustainable, carbon net zero facility that will produce all the energy needed to operate the Environmental Education Center. The Environmental Education Center will be open daily, year round and become a hub for a range of community based programming provided by the SRC, our partners (CFI, ECOS, UUNA) and others interested in promoting a more healthy, sustainable and equitable City.

Garver, J.I., Smith, J.A., and Rodak, C. 2024. Proceedings of the 2024 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 15, 2024, Volume 14, 90 pages.

While planning and fund raising is underway for the building's renovation with a completion date in late 2024 - 2025. The Environmental Education programming that will be based at the Center is already taking shape. Since 2006, the SRC's Environmental Study Team youth development program (EST), has worked with over 1000 youth from many Communities within the Schoharie and Mohawk River watershed, including Schenectady. Engaging them in locally based watershed education, water quality monitoring skills development, field research opportunities, and recreational stewardship activities. Through EST, youth (ages 12 – 18) get outside, have fun, and learn to apply science and research skills to better understand the local ecology and learn about their community. Youth build their competencies while at the same working to improve local conditions (water quality) within their communities (including the City of Schenectady).

In 2018, the SRC and Community Fathers' Inc. initiated a partnership to develop and implement an Urban Ecology EST program for youth living in the City of Schenectady. A focus of this EST program has been to fill the gap in our communities' environmental literacy quotient, and increase the public's knowledge about emergent environmental issues impacting the City. Youth work in teams, outdoors with trained adults to learn skills to identify and document environmental conditions, as well as gain knowledge on ways to avoid or remediate environmental threats in their urban environment. Climate change, invasive species, bio-diversity, air and water pollution concerns, plastic pollution, environmental justice, and sustainability skills and strategies are all topic areas explored in the program.

In October 2023 the SRC partnered with the Schenectady School District to provide environmental literacy education / skills training, and stewardship activities to district students attending their 21st Century After-school program. Working 3 days a week in both the High School (grades 9 – 12) and Central Park Middle School (6 – 8), the program provides youth with experientially based environmental education, sustainable building design / construction activities , digital media skills learning, and outdoor based recreational activities (hiking. Cycling, cross-country skiing, etc.). These skills provide a foundational knowledge for youth as they look toward their future life, graduation and career plans. For these students, who are interested in out-of-school learning experiences, the Urban Ecology EST programs are there year-round during the summer and weekends. They continue to provide them with high quality, community based youth development and career skills programming and community service activities. During times when students are less programmed and parents are seeking high quality, and safe activities for their children and families.

Utilizing Central Park and all of Schenectady's 30 neighborhood public parks, preserves and green spaces for these activities makes tremendous sense and is an efficient and sustainable strategy for successful community based environmental literacy education and youth development activities at many levels. For many youth in Schenectady, their neighborhood parks serve as their community "back yard" where they can safely enjoy the outdoors (away from traffic) and learn about their city's urban ecology and natural history. Several of Schenectady's parks provide access to local streams, ponds, and the Mohawk River, as well as mature urban forests, and a variety of specialized habitats: riparian areas, pine Bush forests, open meadows. City parks also provide biking, walking / cross country skiing trails, boat launches and docks, and important historical and cultural learning features.

The parks provide a publically available living laboratory from where to research and monitor environmental conditions across the city, learn the values of stewardship, and positive community engagement.

Engaging community through art: an ecological field class on the Mohawk River

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Introduction

Undergraduate field courses foster experiential learning by immersing students in hands-on activities, observations, and discussions within a field setting. The transformative impacts of these field experiences on mental health, sense of identity, and appreciation for nature mirror the effects often associated with the practice of art-making. To better understand this relationship in the context of the Mohawk River, we are participating in a course, titled Art and Science of the Mohawk River, offered through Cornell Ecological Arts in the Department of Natural Resources and the Environment. Like other Cornell EcoArts courses, the goal of this course is to engage students with local artists, scientists, indigenous people, and other community members to create well-informed environmental artwork that has a significant impact. Throughout this course, we will travel to various locations in the watershed, including Schoharie River Center, NY Mills Middle School, and Cohoes Falls. At these sites, we will reflect upon and interpret the geological, geographical, environmental, and people's history of the Mohawk River Watershed. At the end of the course, we will design and fabricate group art projects that highlight aspects of the field experience and align with the goals of the Mohawk River Action Agenda. These interdisciplinary art projects will be publicly exhibited in local venues. Combined with relevant lectures, readings, and presentations, we aim to deepen our appreciation for the Mohawk River's embattled history, diverse people, and essential ecosystem.

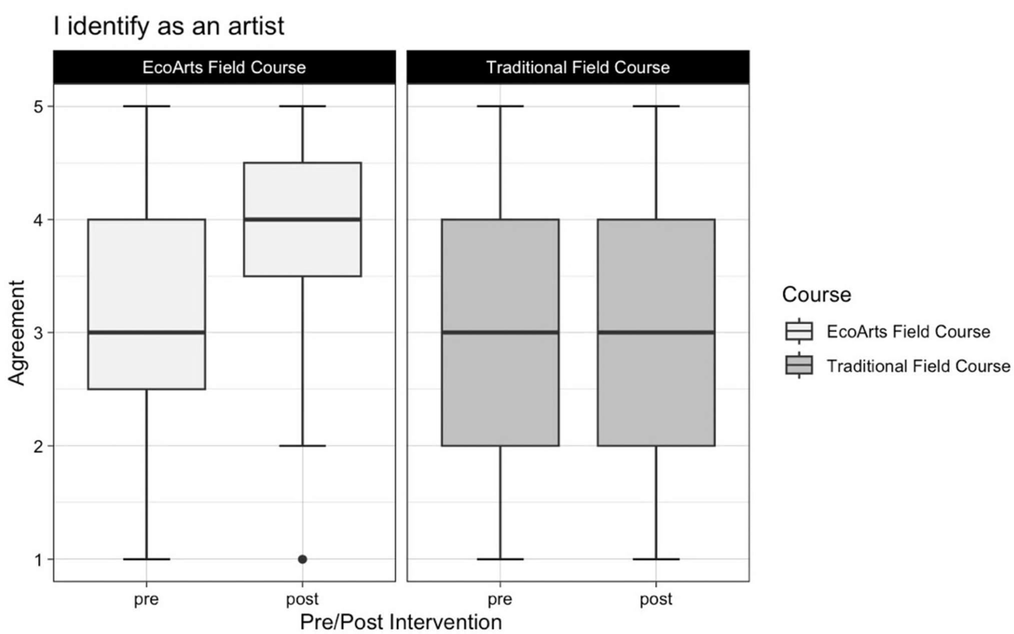

Figure 1. Box plot of Likert-type survey data comparing an EcoArts field course to a traditional field course (control) pre- and post- intervention.

Garver, J.I., Smith, J.A., and Rodak, C. 2024. Proceedings of the 2024 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 15, 2024, Volume 14, 90 pages.

Figure 2. Students from the Art and Science of the Mohawk River course reflect on the ways rivers inspire us and provide for us, alongside visiting artist Linda Weintraub.

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Survey of recreational boating in the Mohawk Watershed

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"The victim was not wearing a life jacket when found unresponsive in the water."

A 2022 accidental drowning while recreating on the Mohawk River highlights the need for education and awareness of boating safety. Using NYS Department of Motor Vehicles boat and boat dealer registration data combined with open source identification of boat launches and marinas, the poster seeks to identify areas where boater education resources may be directed.

Addressing aquatic invasive species movement through the Champlain Canal: partnership efforts working toward solutions

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Lake Champlain Basin Program and New England Interstate Water Pollution Control Commission, Grand Isle, VT

Lake Champlain and Aquatic Invasive Species Spread Prevention

Lake Champlain is an invaluable economic resource for residents and visitors in the region. Watershed stakeholders from New York, Vermont, and Quebec have been working together for decades to protect its water quality, fishery, native species, habitats, environmental services, and recreational opportunities. Lake Champlain is home to 80 species of fish, including sport fish and that attract fishing tournaments of all sizes.

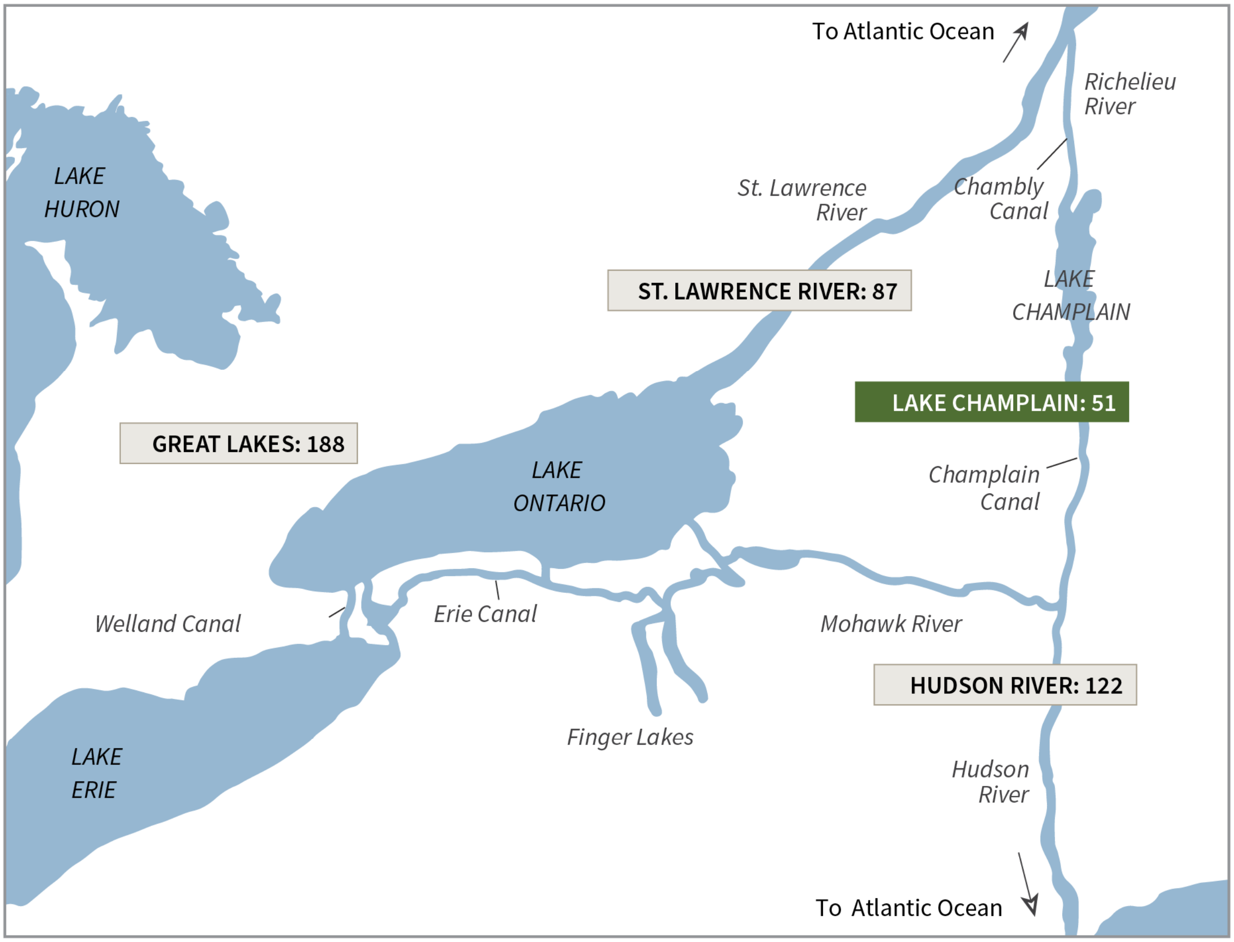
Lake Champlain also is home to 51 known aquatic nonnative and invasive species (AIS). The federal definition of aquatic invasive species, as defined by Executive Order 13112, is non-native (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic harm, environmental harm, or harm to human health. New York State's legal definition of invasive species is consistent with the federal definition. Detrimental impacts of these species impact fishing and swimming experiences in the lake and disrupt the aquatic community food web. Once AIS are introduced to Lake Champlain, there are few management techniques that can be implemented to successfully control them. Containment and spread prevention through education and outreach to promote best management practices that prevent species movement from one body of water to another is critical. Lake Champlain continues to be a source lake for AIS that can spread to other inland bodies of water in the watershed. Inland lake monitoring results show that 80% of the lakes in Vermont and 75% of the lakes in the Adirondacks are free of AIS. The best way to protect these lakes is to prevent AIS introduction.

Partners in New York, Vermont, and Quebec have worked together to address overland transport of AIS on watercraft, trailers, and other recreational equipment, baitfish introduction, aquarium release, created regulations of listed species to address sale and trade or organisms, and canal systems. However, canals remain an open pathway of inter-basin transfer for aquatic invasive species introduction and spread. Lake Champlain is connected by manmade canals to a number of surrounding bodies of water with a greater number of AIS present which includes the St. Lawrence Seaway (87), Great Lakes (188), and the Hudson River (122). Research has shown that the greatest number of known invasive species introductions have occurred through the Champlain Canal.

Recent research and monitoring in New York State in the Hudson River, Erie Canal, and Champlain Canal, within Lake Champlain and its tributaries, and Quebec in the Richelieu River and Chambly Canal exemplifies the ever-present threats of new invasions of AIS, such as the round goby and grass carp, which threaten Lake Champlain.

Partnerships and Authorities support AIS spread prevention in the Champlain Canal

Lake Champlain partner organizations have been working to address the spread of aquatic invasive species through the Champlain Canal for a number of decades. Lake Champlain Sea Grant, University of Vermont, and Vermont Department of Environmental Conservation evaluated the feasibility of Champlain Canal aquatic nuisance species barrier options in 2005. The Lake Champlain Basin Program reignited partner meetings with the New York State Canal Corporation in 2006 to identify common goals for aquatic invasive species spread prevention.



NOTE: Data current as of January 2021. All waterways contain some overlap of species.
DATA SOURCES: UVM, LCBP, Lake Champlain Sea Grant, Great Lakes Environmental Research Laboratory, Lafontaine and Costan 2002, Strayer 2012, Egan 2017, and GLANSIS 2020.

Lake Champlain Basin Program
sol.lcbp.org

Figure 1. Non-native species threats to the Lake Champlain Basin from connected waterways.

Federal authorization supports addressing aquatic invasive species transport through the Champlain Canal. The 2007 Water Resources Development Act Section 5146 identifies the need for a barrier feasibility study to prevent AIS movement through the Champlain Canal. Senator Leahy secured resources from the Great Lakes Fishery Commission to initiate that study with the US Army Corps of Engineers through the WRDA 2000 Section 542 Lake Champlain Basin Watershed Assistance Program. The study had support from the New York State Canal Corporation and the national Aquatic Nuisance Species Task Force. The first phase of the study is complete which evaluated different methods and alternatives that would be most effective at preventing the inter-basin transfer of AIS between the Champlain and Hudson watersheds: https://www.nan.usace.army.mil/Portals/37/Champlain%20Canal%20AIS%20Barrier%20Study%20Phase%20I%20-%20Final%20Report.pdf.

The second phase of the study will optimize an all-taxa solution and with matching support from New York State Department of Environmental Conservation and Lake Champlain Basin Program/New England Interstate Water Pollution Control Commission, also under the Section 542 Program.

Interim Aquatic Invasive Species Spread Prevention

The Lake Champlain Basin Program support an Aquatic Invasive Species Rapid Response Task Force made up of experts from New York, Vermont, and Quebec. Recent threats of round goby advancements towards Lake Champlain have triggered early detection monitoring using eDNA, trawling and electrofishing. Monitoring results are reviewed regularly to inform management actions that can be taken to prevent round goby spread. New York State Department of Environmental Conservation and NYPA/Canals has created a Champlain Canal facilities plan that identified interim solutions to help prevent the spread of aquatic invasive fish through the Champlain Canal. Partners will continue to pursue solutions to achieve the greatest amount of risk reduction in aquatic invasive species until an all-taxa barrier may be implemented on the Champlain Canal.

Acknowledgements

The Lake Champlain Basin Program would like to thank partners working to support spread prevention efforts for all taxa through the Champlain Canal including New York State Department of Environmental Conservation, New York State Power Authority/New York State Canal Corporation, U.S. Fish and Wildlife Service, U.S Army Corps of Engineers, Vermont Agency of Natural Resources, and Quebec Ministry of Environment.

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Problems, progress, and prognoses on the North Chuctanunda Creek and urban trail through Amsterdam

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Mission -"To develop, enrich and preserve the North Chuctanunda Ecosystem"

Introduction

The North Chuctanunda Creek, called "The Chuck", is a medium fourth-order stream determined by the Strahler Method. The North Chuctanunda Creek rises just below the Adirondack Blue Line in Saratoga County near Barkersville. This is about twelve miles north of Amsterdam. The Chuck flows south crossing NY Route 29 and is dammed to form privately-owned 550 acre Galway Lake after passing through Lake Butterfield. The Chuck then passes quickly through Fulton County near West Galway and then into Montgomery County passing through Hagaman and Amsterdam to the Mohawk River. Healy Kill, Bunn Creek, Caneys Brook, Mosher Brook and others are tributaries. The Friends of North Chuctanunda Incorporated, sometimes called the Friends of the Chuck, is a community group organized to develop, enrich, and preserve the North Chuctanunda Creek ecosystem to benefit and educate the public.

The Chuck plunges through the City of Amsterdam where it empties into the Mohawk River. Its water power energized the American Industrial Revolution in Amsterdam - called the Carpet City. The North Chuctanunda Trail is about 4 miles long from the north tip of the City at Shuttleworth Park to the Mohawk Valley Gateway Overlook Pedestrian Bridge. The Creek and Trail through Amsterdam are punctuated by many jewels: 12 waterfalls or dams, 20 bridges, and six parks. The six parks are Riverlink Park, James T. Bergen Veterans Memorial Park, Kirk Douglas Park, Flat Rock Park, Veterans Park, and Shuttleworth Park. The trail shows the history of the American Industrial Revolution and in some places provides a serene urban greenspace. This trail provides natural beauty in a critical environmental justice area. Geology, ecology, biology and history are displayed in the real and on trail sign boards.

The City of Amsterdam, the City Tourism, Marketing, and Recreation Dept., Montgomery County, the Montgomery Co. Soil and Water Conservation District, Historic Amsterdam League, NYS DOT, Walter Elwood Museum, SUNY Cobleskill, Schoharie River Center, Riverkeeper, NYS DEC, Preservation League of New York, Town of Amsterdam, Friends of Shuttleworth Park, Montgomery Co. Water Quality Committee, Historic Amsterdam League, Erie Canalway National Heritage Corridor, and others have worked alongside the Friends of the North Chuctanunda to improve the trail and stream. We hope to expand the list.

The North Chuctanunda Trail and the Friends of the Chuck have experienced problems and progress. Prognoses, which are our wishes for the future, are also presented here.

Problems

- Pollution continues to be found in the North Chuctanunda. The 2017 Mohawk Watershed Symposium featured a cover picture of the mouth of the North Chuctanunda Creek entering the Mohawk River next to the MVGO pedestrian bridge. The irony of the new bridge structure connecting the community to the river and the failure of infrastructure that created millions of gallons of sewage to leak in the Chuctanunda was pointed out. We believe the major leak has been repaired but we have

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other pollution problems. SUNY Cobleskill's Dr. Barbara Brabetz, Dr. Neil Law, and students have found very high levels of bacteria in the North Chuctanunda Creek, probably coming from septic systems in the Town of Amsterdam. They have been working with Riverkeeper and researchers from SUNY Poly to sample bacteria at many locations in the Mohawk and tributaries for many years. SUNY Cobleskill and the City of Amsterdam have done further testing and the problem persists. The Town of Amsterdam has received a grant to study solutions for this pollution problem but has not yet received a report. The cost of building sewers on the Midline Road section of the town has worried officials.

- At times we have been disappointed that officials do not take the creek seriously and have made mistakes in the past. They have disregarded the Chuck and perhaps not followed the City Master Plan. A piece of land across from Flat Rock Park has been mistakenly sold in a tax auction. In 2016 November tax sale 3.4 acres were purchased for $100. This land parcel has some of the most scenic views of the creek. Also, in 2015 City of Amsterdam granted the property on Lyon and Forest Avenue to AIDA. They attached a perpetual easement for the trail. In 2019, AIDA sold the property above the Powerhouse to Sticker Mule with no clause of easement. We feel the City plans indicate this creekside property should be reserved for the North Chuctanunda Trail. We hope the right of way can be used here.
- Litter is a chronic problem in some sites on the trail. A recent study found 17% of people litter and 83% dispose of litter properly. Litter begets litter and if we pick it up we improve the quality of life. Some people think it is not their property so they litter. We pick up litter.
- There is not enough direct access to the creek along the trail. Access for fishing and other activities is limited. More creek access needs to be provided. Parts of the creek are channelized and some parts have steep banks. Private land blocks stream access in some places. More places for fishing and direct access are needed. Kayakers use the creek on the few days that conditions are correct. Even kayakers deserve access.

Progress

- In 2023, The Montgomery County Planning Department was awarded a grant to develop a model trail section for 550 feet along the bank of the creek at Elwood Museum along a section of Church Street in Amsterdam. Another 50 feet to Willow Street may be taken over by the Friends of North Chuctanunda Incorporated. Montgomery County and Elwood Museum along with the Friends of the North Chuctanunda are still in the planning stages for this model trail. SUNY Cobleskill Professor Timothy Marten and student Owen Anderson are helping with planning. Also the City of Amsterdam, with DRI funds, in 2023, constructed a beautiful new trail section along the creek behind the post office and library.
- In 2023 the City Local Waterfront Revitalization Plan was revised to include the area on both sides of the North Chuctanunda Creek in the entire city from the Mohawk River to the north tip of the City at Shuttleworth Park (LWRP section 4 p 62) . In 2003 the City Local Waterfront Revitalization was first proposed. In 2004 the Greenway overlay was added as appendix I.
- Another Clean Up Day has been scheduled on Earth Day this year on April 20,2024 by the Purtell Agency. Many cleanups have taken place in the past. The Montgomery County Water Quality Committee has also had many on the creek. Small group cleanups have received help from City of Amsterdam Tourism, Marketing and Recreation Director, Rob Spagnola when problems have arisen on the trail.
- 2020 Flat Rock Park was constructed on Forest Avenue at the most beautiful waterfall on the North Chuctanunda. This is the site of Smealie and Voorhees (Papermill) Dam and Waterfall.
- In 2021, the Friends of the North Chuctanunda sponsored a meeting to discuss the high bacteria levels found by SUNY Cobleskill. The mayor of Amsterdam, city engineer, the supervisor of the Town of Amsterdam, the Montgomery County administrator, the head of the Montgomery County Health Department, Village of Hagaman deputy mayor, representatives of Paul Tonko, Angelo Santabarbra,

Senator Hinchey, DEC Region 4, Riverkeeper, and many others were present. Dr. Barbara Brabetz of SUNY Cobleskill presented the data she has found showing high levels of bacteria. Andrea Conine and Derek Thorsland from NYSDEC spoke. Open discussion took place.

- Many walks have been held in all parts of the North Chuctanunda Trail highlighting the history, geology and biology of the trail. The hikes were well attended by the public. Several are planned for this year.
- Special activities about the trail have been held and been well attended. This year National Trails day June 1, 2023. All Things Outdoors Forum is scheduled for the Clock Tower Building. Public talks are also scheduled.
- The City of Amsterdam with Rob Spagnola has constructed a quarter mile loop of trail at the end of Hewitt Street to great views of rock outcrops along the North Chuctanunda at Shuttleworth Park. Previously, the City and Rob constructed the beautiful walking Trail along the Creek behind the ballfield in Shuttleworth Park. These are part of the trail.
- The NYS DOT has been negotiating the development of a trail section on property along the creek on Route 67 in the City across from the City Hall. Landscape Architect Christina Graveling and the local DOT office have been working on the project with the Friends of North Chuctanunda.
- 2017 Erie Canalway National Heritage Corridor (ECNHC) awarded a grant for signage along the creek. The Recreation Department completes it with assistance from HAL.
- The City of Amsterdam adopted a North Chuctanunda Trail Marker. It reads "CHUCTANUNDA CREEK TRAIL FOLLOW THE CHUCK ". It pictures mills that represent the Industrial Revolution History. It also has a waterfall that represents the 12 waterfalls that punctuate the creek. The trail marker has trees and plants that represent the ecosystem that is being preserved along the creek.
- Since 2004 The City of Amsterdam Comprehensive Plan created a City greenway system that would protect and enhance natural riparian corridors and create active and passive recreation opportunities. It created a Greenway Corridor Overlay Zone to preserve, evaluate and protect specific areas, such as trails, overlooks, parks, and nature sanctuaries.

Prognoses (our forecasts for the future)

- More signage and marking of the trail for wayfinding and education will occur.
- Working with DOT the area on the creek across from City Hall will become a model trail section.
- Working with Sticker Mule, the lot between DOT land and Schuler Street will become a model trail along the North Chuctanunda.
- Working with Sticker Mule between the Powerhouse and Lyon Street the wood-decked bridge and area of former Mohasco headquarters will be officially incorporated into a section of trail.
- Powerhouse development as proposed in the Preservation League Study will be carried out with grant money.
- Friends of Shuttleworth Park development of the trail section behind Chad Majewski's on Lyon Street. It might be good for a DEC fishing access site.
- A development of a trail section by Tuman's Restaurant on Forest Avenue through Creekview Street and Creek Side Avenue to Clizbe Avenue near the MTS Lakeside Residence will take place.
- A trail through the woods from Shuttleworth Park on Crescent Avenue to Harrower's Dam on the east side of the North Chuctanunda will be marked.
- The trail downtown will be marked to go behind the Horigan Building to the area behind the Bank Building to view the Chuck under the building and then go on to the James T. Bergen Veterans Memorial Park.
- Fishing access site(s) along the North Chuctanunda in Amsterdam will be created after Scott Wells of the DEC Region 4 Bureau of Fisheries in Stamford, NY, offers some advice and assistance. The Five Corners, the paper mill below Flat Rock Park and the area on Lyon Street at Sticker Mule and at former Dave's Landscaping are suggested sites.

- Make a park at the Five Corners now that the old stores are removed. A fishing access site will be included.
- A walkway is constructed on the train trestle from Willow Street to Fourth Avenue to view the Kelloggs and Miller Dam and Waterfall after a planning grant obtained by Alex Kuttesch of Montgomery County.
- A walkway is constructed on old trestle abutments that still exist from the five corners to the parking lot near Belmont Place and the former Elks Club across from the Paper Mill on Forest Avenue after a study grant obtained by Alex Kuttesch of Montgomery County.
- A Cattle Pass Park is developed at the old trolley cattle pass near Crescent Avenue below William B. Tecler Elementary School. A section of the trail is eventually made over the cattle pass. A nature trail is made from the elementary school to the Creek and Harrower's Dam.
- Regular walks and maintenance and cleanup days are established on the first Saturday of the month.
- Arbor Day Friday April 26, 2024 is celebrated by planting trees
- A master plan for the Northern Chuctanunda Creek is completed by Montgomery County Soil and Water with Joe Slezak and John Vanderwerker.

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"The Brook" by Alfred Lord Tennyson
... I chatter, chatter, as I flow
To join the brimming river,
For men may come and men may go,
But I go on for ever…

Rapid, long-range movement and establishment of Round Goby in the Hudson River, NY, confirmed through traditional fish sampling, eDNA, and otolith microchemistry

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Introduction

Round Goby (*Neogobius melanostomus*) has been described as one of the fastest spreading non-native aquatic species facilitated by its reproductive success, adaptability to different environmental conditions, and aggressive behavior. In New York, Round Goby has been steadily expanding from the Great Lakes to eastern New York largely via the New York State Canal System and was first documented in the Mohawk River watershed in 2014. In 2021, Round Goby were detected in the tidal Hudson River during annual beach seine monitoring conducted by the New York State Department of Environmental Conservation (NYSDEC). Initially captures occurred in the Albany region, and by mid-summer Round Goby were found as far south as Poughkeepsie with several gravid females among the individuals collected.

Methods

Annual beach seining occurs from late June through early November in six regions (Albany, Coxsackie, Poughkeepsie, Newburgh, Haverstraw, Tappan Zee) throughout the Hudson River to monitor the relative abundance of young of year Striped Bass and alosine species. In 2022, Round Goby eDNA monitoring was conducted from the Troy Dam to Tappan Zee to better understand the spatial distribution of goby one-year post-introduction. Sampling occurred at select beach seine locations in addition to six tributaries and regions not sampled by beach seine (e.g. Catskill, Kingston, etc.). In 2023, monitoring was informed by eDNA detections and beach seine captures during 2022; based on these, eDNA was monitored only in tributaries and at mainstem sites from Newburgh south to the George Washington Bridge. Otoliths were extracted from six Round Goby collected from the Hudson River to characterize individual provenance and coarse in-river movement. Elemental signatures from the otoliths were determined through laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) and compared to chemical profiles of the Hudson and Mohawk rivers.

Results and Conclusions

From 2021 to 2023, 166 Round Goby have been collected during annual beach seine monitoring (Figure 1). The highest number of individuals was collected in 2021 (n = 112), whereas catch was lower in 2022 (n = 12) and 2023 (n = 42). The size of individuals has ranged from 20 to 87 mm total length. Seven additional larger Round Goby, ranging from 80 to 130 mm were collected in 2022 at the Roseton Generating Station north of Newburgh, marking the southernmost physical collection to date. Gravid females have been continuously captured since 2021.

In 2022, Round Goby eDNA was intermittently detected at beach seine locations and other river regions

Garver, J.I., Smith, J.A., and Rodak, C. 2024. Proceedings of the 2024 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 15, 2024, Volume 14, 90 pages.

between the Troy Dam and Newburgh as well as Catskill and Esopus creeks (Figure 2). These detections corresponded to locations where Round Goby had been or were captured at the time of eDNA sampling, yet also demonstrated the widespread presence of Round Goby in other regions of the river. eDNA sampling during 2023 indicated Round Goby presence in Hannacroix and Rondout creeks and in Newburgh. In both years, no Round Goby eDNA was detected in brackish water south of Newburgh.

Elemental signatures from Round Goby otoliths collected from Albany, Poughkeepsie, and Newburgh suggested varying natal origin and in-river movement. Elemental ratios from one individual collected in Albany indicated potential birth in Oneida Lake with subsequent movement along the Mohawk River. An individual caught in Poughkeepsie had low Sr:Ca at the otolith core suggestive of birth above the Troy Dam before moving to the Hudson River, whereas an individual collected in Newburgh had elemental ratios that indicated Hudson River birth and potential movement to slightly brackish water.

Based on the results from beach seine monitoring, eDNA monitoring, and otolith microchemistry, Round Goby exhibited rapid, long range (~140 km) movement from a source population on the Erie Canal and quickly established throughout the upper 2/3 of the tidal Hudson River. However, no positive eDNA samples nor physical collection of Round Goby have occurred south of Newburgh suggesting a potential avoidance of brackish water. Microchemistry results and the size and maturity of individuals captured also suggested a reproductively mature population established in the Hudson River during the year of their initial detection and that reproduction is continuing to occur. This study demonstrates the feasibility of eDNA techniques and otolith microchemistry for monitoring a cryptic species in low abundance within a large river system and describing population origins of a rapidly spreading species.

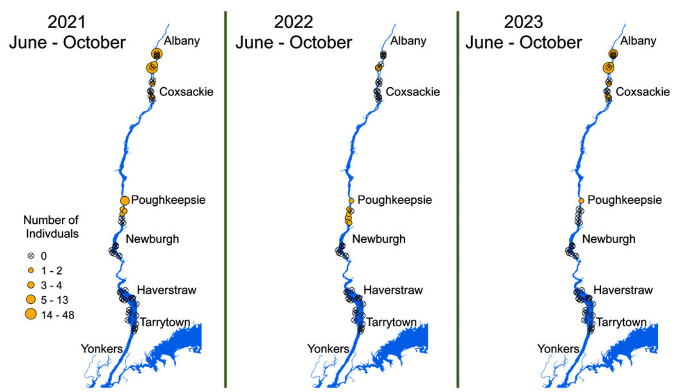

Figure 1. Location and number of Round Goby collected during annual beach seine monitoring (2021-2023) in the Hudson River.

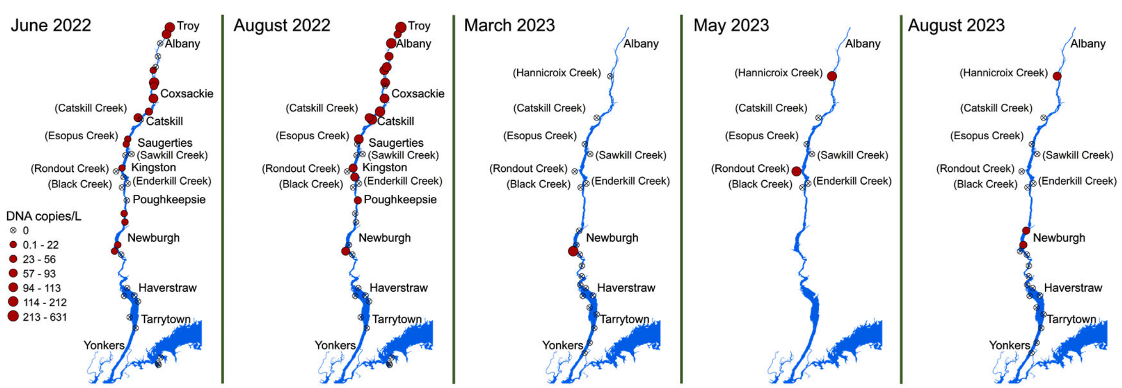

Figure 2. Location and number of Round Goby DNA copies per liter detected during eDNA monitoring (2022-2023) in the Hudson River.

Water quality of the Kromme Kill and Collins Lake system, Scotia and Glenville NY: septic failure and salinization

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Regional salinization and septic failure have resulted in enormous challenges for the water quality in the Mohawk River watershed, including the Scotia-Glenville area that sits on part of the designated protection zone for the Great Flats Aquifer. The Mohawk River provides important ecosystem services, including the direct and indirect supply of municipal drinking water, but many urban and suburban tributaries, like the Kromme Kill watershed, are impaired and understudied. The Kromme Kill is a small system flowing into and over top of the permeable and productive Great Flats Aquifer (GFA) and the drainage includes the southern part of the town of Glenville and the village of Scotia. The wellfield for the Village of Scotia draws from the GFA in the study area. The Collins Lake system also sits on the GFA and is in the same setting.

Sewage and salt are two of the main concerns for pollution in the aquifer. This study shows that the Kromme Kill and therefore part of the Great Flats Aquifer are compromised by both sewage and salt. The creeks of this system are of particular interest because they have high potential for interaction with the aquifer. By learning about the stream chemistry of the Kromme Kill, we can also learn about the Great Flats Aquifer and interactions between surface water and groundwater.

Regional salinization is a major concern for surface water impairment and the harm that chloride does to aquatic ecosystems in our streams, rivers, and lakes (Kaushal et al., 2022; Hintz et al., 2022a). NY State has tried to address this issue in the recently released Adirondack Salt Reduction Task Force assessment. An important question that emerges from this report is the concentration of chloride in surface waters that causes ecological harm. Hintz and others suggest that the thresholds for chronic impairment of 230 mg/l (US EPA) and 120 mg/l (Canadian Council of Ministers of the Environment) are too high, and that negative effects on zooplankton occur at lower concentrations (40-90 mg/l) (Hintz et al., 2022b). The Adirondack Salt Reduction Task Force report suggests that changes in aquatic ecosystems occur at chloride concentrations between 5-90 mg/l (ADK Salt Task Force, 2023). The task force appears to favor the Consolidated Assessment and Listing Methodology of the NY State DEC for chloride impairment and that the standard should be ~43 mg/l for flowing waters (rivers and streams) and ~31 mg/l for lakes and ponds (ADK Salt Task Force, 2023).

Methods

To test water quality of the Kromme Kill and the Collins Lake system, samples were taken from accessible sites that were distributed to capture stream water quality in multiple streams that are on and around the permeable aquifer. Samples for key sites were collected consecutively for five weeks in September and October 2023. A YSI multiparameter probe was used for measuring water quality parameters at each site. For fecal indicator bacteria (FIB), standard testing for salt-tolerant *Enterococcus* was done using IDEXX *Enterolert*. Samples were collected in WhirlPak bags, diluted (90:10), and incubated for 24 hr at 41°C and read to determine the concentration given in maximum probable number per 100 ml (MPN/100 ml). Ion concentrations were measured from a subset of samples at Union College using the Dionex Ion Chromatograph (ICS-2100, anions and DX-500, cations). Of all the ions studied, chloride (Cl^-), nitrate (NO_3^{2-}), phosphate (PO_4^{3-}), and sodium (Na+) are of particular interest. Samples were taken during times of high and low flow (precipitation versus no precipitation) to get a better

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understanding of stream chemistry and contamination at base flow. Other sampling, with lower frequency, was conducted on the Mohawk, Plotter Kill, and the urban Hans Groot Kill, and these results are shown in the figures for context. Precipitation data were collected using a Vantage Pro2 Plus weather station at Union College.

Results and Discussion

Horstman Creek and the main branch of the Kromme Kill have high levels of both chloride and the fecal indicator bacteria *Enterococcus*. The Collins Lake system (Collins Lake Beach, Collins Outlet, and Collins Creek) all have remarkably stable water chemistry with high chloride concentrations, and relatively low *Enterococcus* values. Here we consider FIB and chloride separately.

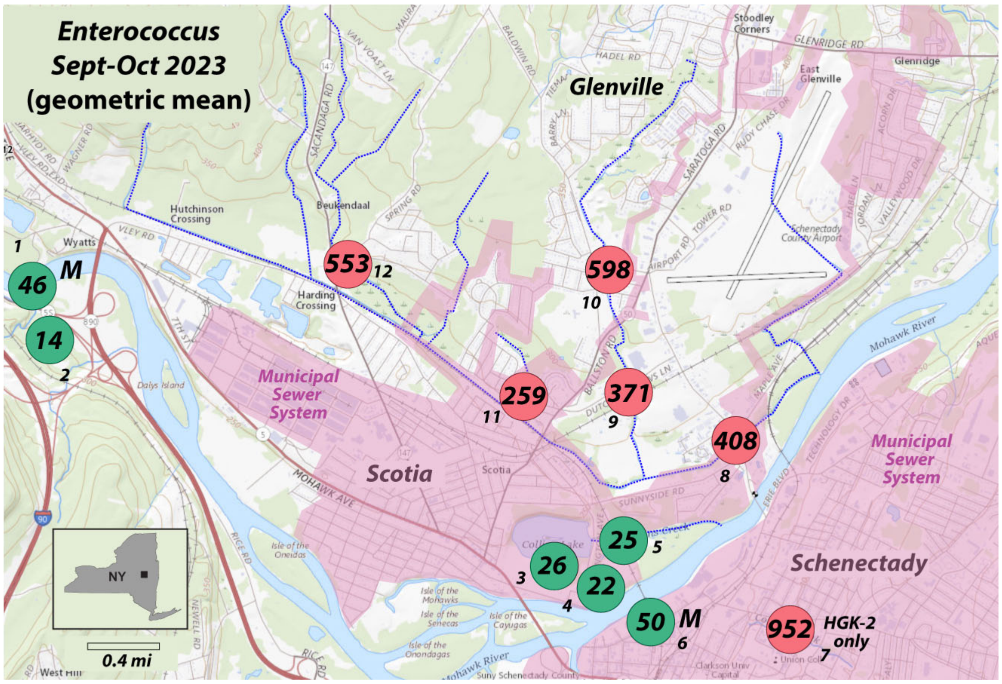

Figure 1. All FIB Pathogen analyses were done in September and October 2023, and this map shows the geometric mean of samples from each location. Those in red are impaired and exceed EPA criteria. The regularity of testing varied between sites, but most were weekly. Locations: 1) Mohawk River, Kiwanis Park, n=3; 2) Plotter kill, Old Erie canal, n=3; 3) Collins Lake Beach, n= 6; 4) Collins Lake, outlet area, n=5; 5) Collins Ck, Washington Ave, n=6, weekly; 6) Mohawk River, Stockade, n=3; 7) Hans Groot Kill, Jackson's Garden, n=24; 8) Kromme Kill, Freeman's Bridge Road, n=5, weekly; 9) Horstman's Ck, Dutch, n=6, weekly; 10) Horstman's Ck, Horstman Dr, n=6, weekly; 11) Unnamed trib, Bancker, n=6, weekly; 12) Unnamed trib, Spring Rd, n=2. Geometric means are for regular sampling and exclude an extremely high flow event on 7 October 2023.

FIB. *Enterococcus* is a good indicator of sewage, but it may have a number of different sources, and in this area, poor water quality is linked to aging infrastructure and increased precipitation (Garver and Smith, 2023). Our FIB data indicate impairment, especially in those areas not served by municipal sewage, but by septic systems. Horstman, Dutch, and Freeman's Bridge were the most impaired with geometric means of 598 MPN /100 ml, 371 MPN /100 ml, and 408 MPN /100 ml respectively (Figure 1). These sample sites are well above the EPA water quality criteria for FIB for *Enterococcus* (i.e. a geometric mean value of <30 cfu/100 ml for weekly testing, and single sample threshold of 60 cfu/100 ml). Samples from the heavy rainfall event on October 7th, which were saturated (>24k MPN /100 ml), were not included in the geometric mean calculations because that sample set was not part of the regular weekly sampling. None of these sites with elevated FIB are in areas with municipal sewage lines, and houses bordering these sites are served by individual septic tanks. Based on the location of sites in this study, our hypothesis is that old, leaky septic systems are driving impairment. Recent work in the adjacent Indian Kill of Glenville shows similar water quality challenges due to aging septic systems (Goodman, 2023).

Collins Lake water quality is quite good in comparison. The geometric means of *Enterococcus* are between 22 and 26 MPN /100 ml, and thus are significantly lower than the other study sites, and below the EPA water quality criteria for FIB (Figure 1). The low FIB in the Collins Lake system is good news because the lake is a recreational hub, and there has long been concern with water quality (Newman et al., 2011). In addition, it has been a focus of study due to the high number of transient migratory birds (Tobiessen and Wheat, 2000).

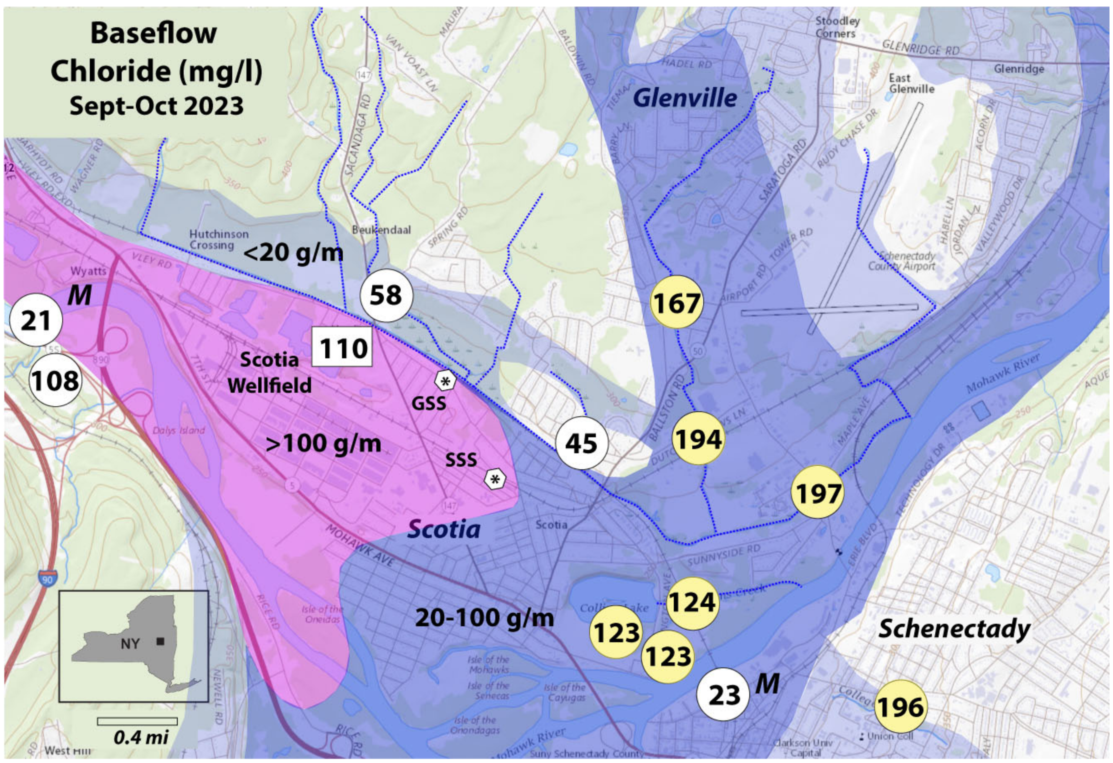

Figure 2. Mean chloride values for sample sites calculated for only dry intervals (rainfall <0.02”/48 hr). Elevated chloride shown in yellow based on an impairment threshold of 120 mg/l. Purple/blue shading reflects Quaternary surface geology, and flow rates based on mapping simplified from Winslow et al., 1965. Chloride is shown as reported by the Village of Scotia (2023) and is identical to measurements we made in October 2023. Salt storage of Glenville (GSS) and Scotia (SSS) are shown.

Chloride. Chloride (Cl^-) is a good indicator of road salt impairment, and municipal water supplies have been harmed in this area (Garver and others, 2023). Horstman, Dutch, and Freeman’s Bridge have mean low-flow Cl^- values of 167 mg/l, 194 mg/l, and 197 mg/l respectively (Figure 2). The Collins Lake system has remarkably consistent Cl^- values and the means range from 123 to 124 mg/l for the three Collins sites in this study interval (high and low flow). These values appear to be the highest reported Cl^- the lake has ever seen. Historically, Cl^- concentrations have been much lower: ~53 mg/l in 1984 and ~95 mg/l in 2011 (Newman et al., 2011). Thus Cl^- in Collins Lake appears to have increased 2.3 times (~130% increase) in the past 40 years. These numbers are four times higher than the ~31 mg/l recommended level for lakes reviewed by the Adirondack Salt Reduction Task Force.

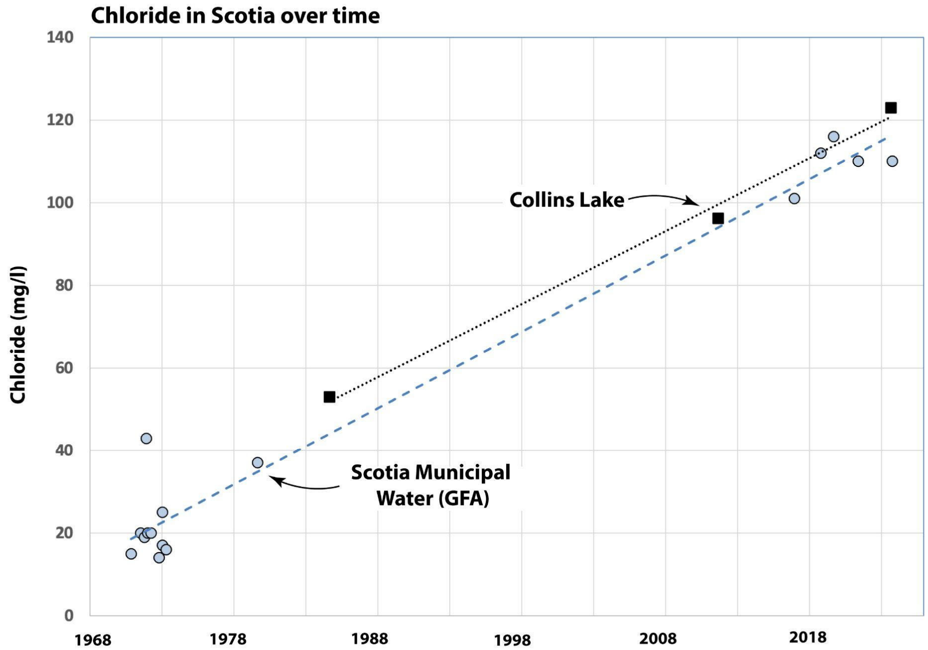

Figure 3. Change in chloride in Collins Lake and Scotia municipal water over time. Scotia municipal water data from: 1) Allen and Waller, 1981 (all pre-1980), 2) Annual water quality reports, Village of Scotia, 3) this study (2023). Collins Lake data averaged from: 1) Newman et al., 2011 (NYS DEC LCI - 2011 and also 1983), and 2) this study (2023).

Conclusions

Surface water impairment is an important issue in the area that is the primary recharge for the Great Flats Aquifer used for municipal drinking water. The Scotia wellfield (Figure 2) draws from the most permeable part of the GFA, which means surface impairment can become aquifer-wide. The issue of high FIB and nutrient concentrations likely means large-scale potential for contamination of the aquifer. Nutrients such as phosphate and nitrate can cause algal blooms in the receiving water including the Mohawk, and challenge downstream municipal drinking water. Septic systems are likely the source of these high pathogen numbers in Glenville. The town of Glenville should work to evaluate septic systems and consider extending municipal sewage lines.

Salt in surface waters indicates a larger issue with the aquifer and interfacing water bodies in the area. Chloride content is high in the Kromme Kill and Collins Lake with the majority of sites having means that exceed chronic impairment. Chloride kills, and is harmful to aquatic ecosystems and these very high non-winter chloride values in Collins Lake are a warning that its ecological health may be suffering. Collins Lake is fed by springs at the bottom of the lake, so it has direct interaction with the aquifer (Tobiessen and Wheat, 2000). With this in mind, chloride in Collins Lake has increased remarkably in the past 40 years, so the aquifer is likely to be similarly impaired. The aquifer having these extreme concentrations of salt is concerning for ecosystem health, human health, and the health of infrastructure in the area. A dramatic increase in chloride has also occurred in the municipal water for the Village of Scotia, which draws from wells nearby in the GFA. Historical data show a significant increase in chloride over time (Figure 3). The increase in chloride in municipal water may be linked to leaching of pipes and elevated lead (Pb) levels in the village (Garver et al., 2023). Solutions include reduced salt usage in the winters, moving salt storage that is on the aquifer, and continued monitoring of the aquifer and streams.

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Drinking water quality and source water protection: challenges in a changing climate

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Introduction

The Hudson and Mohawk Rivers each provide drinking water to more than 100,000 people. The Mohawk River's Great Flats Aquifer provides drinking water to 150,000 more. Within the Mohawk and Hudson River watershed, groundwater supplies residents via public and private wells. Impacts to drinking water sources (both surface and groundwater supplies) are varied and depend on current and historical land use within a given watershed. Industrial pollution, pollution from agriculture, urban run-off and wastewater effluent all contribute a variety of organic and inorganic macro and microcontaminants to the Mohawk and Hudson River watershed. As climate change progresses, contaminant load, the creation of secondary byproducts of pollution, and threats to infrastructure will increase.

Global Heating

As global air temperatures rise, water temperature will increase in both tributaries and the main stems of the Hudson and Mohawk Rivers. Temperature increases will impact the concentration and distribution of a variety of contaminants. Harmful algal blooms (HABs) and eutrophicationare likely to become more common as temperature increases spur algal growth. Increases in soiltemperature will also increase nitrogen and phosphorous mineralization resulting in more nitrogen and phosphorous being released from soils further supporting algal growth. HABs occurred in more lakes and reservoirs across New York in 2016–2019 compared with 2012– 2014[1]. Organic matter associated with the cyanobacterial biomass can also serve as a disinfection byproduct production (DBP) precursor, leading to increased likelihood of DBP formation when more cyanobacteria are present. DBPs will also increase as the rate of the chemical reaction which turns natural organic matter or anthropogenic chemicals into regulated and unregulated disinfection byproducts (respectively) increases. Natural organic matter concentration increases as a function of temperature will further contribute to this problem.

Increased temperature will also lead to changes in water demand. As less precipitation is stored as snow during warmer winter months, higher stream flows are expected during winter and spring. This phenomenon has been observed across NY state.[2] Precipitation falling during colder months is more likely to contribute to high stream flows as the ground is more likely to besaturated than during warmer months when evapotranspiration depletes stored water.

Hydrological modeling for NY state predicts a likely increase in annual discharge as well as a shift in timing of peak flows from spring to winter.[3,4] This is likely to increase turbidity during winter and spring, as well as the likelihood of combined sewer overflows, contributing to additional sewage-related contaminants entering the watershed. Turbidity can also increase surface water temperature, further exacerbating algal growth and increasing the likelihood of HABs. Hydrological climate models have predicted an increase of 12%- 20% an average wintertime streamflow of Esopus Creek, with turbidity increasing by 11%-17% by 2046–2065.[5,6]

Increases in solar radiation are also likely to impact photosensitive compounds. This may bebeneficial in some cases and harmful in others. For example, nitrogenous DBPs such as N- nitrosamines, which are generally more toxic than regulated carbonaceous DBPs, are highly photosensitive and susceptible to sunlight photolysis.[7] Increases in solar radiation will likelyincrease photolytic destruction of these compounds.

Drought and Deluge Cycles

Higher temperatures could lead to more extreme drought and deluge cycles. More frequent short-term droughts can be expected in NY state during late summer due to greater evaporative demand in summer and variations in the timing of annual precipitation.[8] During times of drought, increased groundwater withdrawals for agricultural irrigation are expected leading to potential water shortages in communities reliant on groundwater. Streamflow will decline to a greater extent during future droughts due to higher predicted temperatures increasing evapotranspiration rates. As streamflow declines during periods of drought, the Hudson River salt front can extend further north. During the 2002 and 2007 drought periods, the Hudson Riversalt front reached Poughkeepsie.[9,10] Reservoir systems may be susceptible to drought conditions and water shortages could impact systems with lower storage-to-demand ratios. Systems that relyon river flows may have less water availability as well, and the reductions in flow have the capacity to concentrate pollutants.

More extreme precipitation events are also expected, which will likely lead to an increase in CSOs and release of a variety of contaminants found in wastewater. Pharmaceuticals, personal care products, microbes and other trace organics will threaten drinking water supplies reliant on surface water. Agricultural run-off will also likely increase, due to increasing precipitation, leading to the addition of a variety of nutrients, biocides, steroids, hormones and antibiotics to surface waters. HABs are likely to be exacerbated due to the additional nutrients in the water matrix and higher temperatures. Nitrogen addition from run-off can also result in the formation of nitrogenated DBPs and natural organic matter increases will lead to the formation of carbonaceous DBPs. Lastly, urban run-off will also increase during periods of high precipitationfurthering road salt, heavy metal, PAHs and hydrocarbon pollution in river systems. Furthermore, an increase in wet/dry cycle extremes reduces the ability of soils to bind traceorganics and metals resulting in the increased release of these contaminants into the water matrix.

Infrastructure Problems

Rising temperature, more extreme drought and deluge cycles and sea level rise will all impact water quality directly and worsen it in many cases. Infrastructure used to treat drinking water and wastewater will also be impacted by climate change consequences and create a variety of secondary effects that impact drinking water safety and sustainability. Large influxes of pollution during storm events will require both wastewater and drinking water treatment plants toupgrade their facilities to be able to maintain similar removal efficiencies. Treatment chemicals such as coagulants may need to be added in larger amounts and membranes may foul more easilyin systems where they are utilized. DBPs are likely to form in higher abundance due to an increase in DBP precursors and higher temperatures and biofilms are more likely to form in distribution systems due to higher temperatures. Biofilms are a potential source of pathogens and promote corrosion of pipes. This could lead to increases in lead in water systems with that contain lead piping materials. Additional disinfectant may need to be added to combat their growth, further promoting the formation of DBPs.

High temperatures, flooding and power outages associated with storm events will also pose problems for water treatment plants. Many processes used during water treatment are reliant oncertain temperature ranges to achieve their objectives and extreme heat events may impact theirefficiency and operation. Sea level rise and an increase in the frequency or intensity of storms will increase the risk of flooding, which can directly damage infrastructure. Power outages can also damage equipment and take processes offline resulting in the inability to provide treated water.

Conclusion

Increases in global temperature, increased drought and deluge events and sea level rise will all impact the quality of drinking water sources, including those in the Hudson River and MohawkRiver watersheds. A higher amount of contamination is expected to enter waterways and infrastructure is vulnerable to a variety of problems associated with environmental conditions and storm events. Investments in infrastructure and best management practices that can reducethe pollutant load and combat secondary pollution formation is required to assure that drinkingwater sources remain safe as climate change progresses.

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What's in the water? Critical statistics from sewage release reports and your "Right to Know"

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Introduction

Water quality, resilience, and recreation are strong themes within the 2021-2026 Goals of the Mohawk River Basin Action Agenda (NYSDEC, 2021). However, there is widespread evidence of fecal contamination in the Mohawk watershed as measured by fecal indicator bacteria *Enterococci* and *E.coli* (Garver et al., 2019, Lininger et al 2022, Brooks et al. 2020). There are many potential sources of these bacteria resulting in uncertainty to the source of fecal contamination (e.g. sewage, livestock, etc.). In the region of Utica and Rome NY, microbial source tracking was deployed to identify the potential source of contamination. For many locations, the study revealed what was already known or suspected: in areas where combined sewer systems are present, there was a clear contribution of contamination from human sources (i.e., sewage) (Rodak and Endres, 2020). However, sewage releases occur through other events such as failing infrastructure, which may or may not be observed. Therefore, there is value in understanding the occurrence, duration, and severity of all sewage releases when attempting to provide context surrounding water quality data such as FIB and the overall performance of our wastewater systems.

New York State began requiring the reporting of sewage releases in 2013. In 2016, Vedachalam et al published an analysis of the data between 2013-2014, which normalized sewage release occurrence by population and found correlations with type of municipality, density and age of the treatment plant. Since then, the standardization of the data collected has improved, however the accessibility of this information to the public remains poor. Vedachalam et al (2016) ends their abstract with the following: “Proper implementation of the law would place information in the hands of the people and protect public health”. Collecting this information and making it public is a great first step to place the data in “the hands of the people.” However, the value of this large excel spreadsheet to the average individual and the quest to “protect public health” is less clear. Simple questions remain elusive to the average individual, such as “How many sewage releases occurred in Utica, NY in 2023?”. Therefore, this work explores the feasibility of performance metrics in the evaluation and communication of sewage releases through their application in Oneida County and the City of Utica.

Methods

The sewage release discharge report database was downloaded from the NYSDEC website on May 30 2023. The data was reduced in size to include only relevant information for Oneida County and the City of Utica. It was further cleaned to remove duplicate entries. Data from 2017-2022 demonstrated high consistency in reported information, and was therefore used as the timeframe for the study.

Basic frequency and statistics were calculated on the sewage releases for each month and year. In addition, histograms of duration and volume were generated to explore underlying distribution of the data. The performance metrics proposed are reliability, resilience, and vulnerability, three metrics which have been used in other water resource applications (Hashimoto et al 1982, Fowler et al 2003, Asefa et al 2014). Defined in the context of sewage release events reliability is the probability of no sewage release which captures the frequency of release events (or lack thereof). Resilience is the probability of the wastewater system recovering from a state of failure, which represents a measure of the duration of

Garver, J.I., Smith, J.A., and Rodak, C. 2024. Proceedings of the 2024 Mohawk Watershed Symposium, Union College, Schenectady, NY, March 15, 2024, Volume 14, 90 pages.

sewage release events. For this work, we look at resilience on a 24hr scale; i.e., after 24hrs has the system recovered or is the sewage release still active. Finally, vulnerability looks at the severity of the event, here defined as the average volume of sewage released.

Results and Discussion

The sewage release database contains a significant amount of data which can be viewed from many different perspectives depending on interest. Table 1 is a general overview of the occurrence of sewage releases and the application of the RRV performance metrics from 2017-2022 in Oneida County. During the 6-year period there were 273 reported sewer releases on 175 different days. The average duration of a release was just over 17hrs. The reliability was 92% meaning releases occurred on 8% of the days during the time period of interest and 79% of those releases were less than 24hrs (resilience). The average release volume, described by the vulnerability metric, was 3.15 million gallons.

Table 1. A general overview of the occurrence of sewage releases and the application of the RRV performance metrics from 2017-2022 in Oneida County.

Table 1: 2017-2022 Analysis Summary	
# Of releases	273
# Of unique days with releases	175
Average duration (Hours)	17.12
Reliability	92%
24hr-Resilience	79%
Vulnerability (MG)	3.15

The time scale used for this analysis was 24hrs. Defining a time scale is necessary when determining the resilience of the system. It may be that a different time scale is of interest when describing the recovery of the system. Figure 1 shows the resilience of the wastewater system as a function of duration. For example, the 8hr-resilience is approximately 50%, which means half of the sewage releases had a duration less than 8hrs (i.e., the system had "recovered" within 8 hrs).

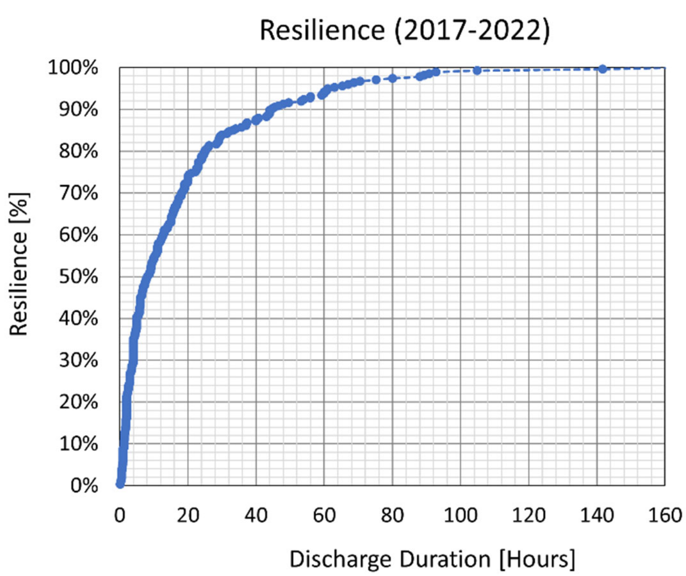

Figure 1. Resilience as a function of duration

The Vulnerability metric represents the arithmetic average volume of sewage releases but the underlying distribution of releases is not necessarily normal. In addition, we may be interested in the volumes at the extremes. Figure 2 shows a histogram of sewage release volume along with a cumulative percent. As mentioned, this data comes from two different sources: Oneida County and the City of Utica. The bimodal data are generated by the estimates from the two different data sources. The data from Oneida County typically varies from report to report and generates a generally unimodal distribution. The City of Utica used a constant flow estimate of 10 gallons per minute until July 8, 2021. After that day the estimates in the sewage release reports were increased to 5985 gallons per minute based on average 2020 annual overflow quantity and duration data according to the reports. The first peak in the histogram is predominantly comprised of the earlier 10 gallons per minute estimates from the City of Utica, which is significantly less than 5985 gallons per minute. This "artifact" reinforcing the need for accurate data in the analysis and suggests that methods to measure sewage releases where possible should be implemented.

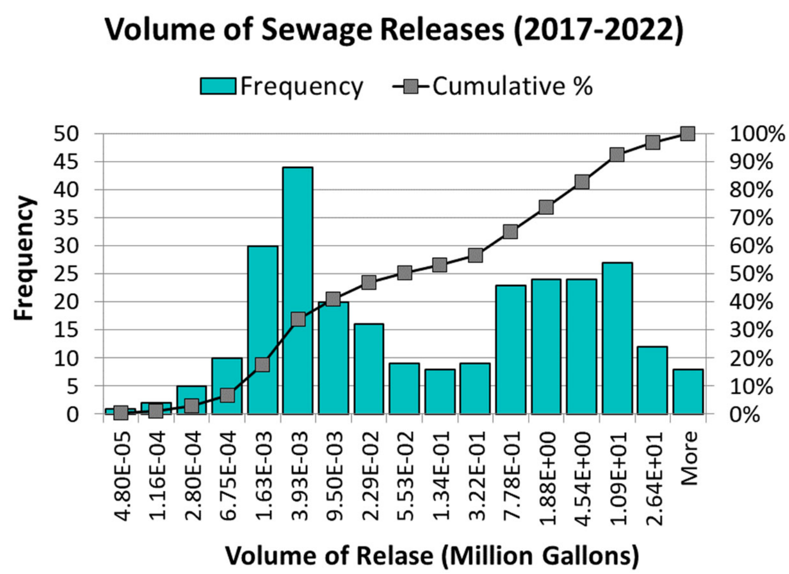

Figure 2. Histogram and cumulative frequency of the volume of sewage releases.

Conclusions

The performance metrics of reliability, resilience, and vulnerability were applied to sewage release data in Oneida County and the City of Utica to explore the applicability and effectiveness of the metrics as a method of communicating relevant sewage release statistics. The metrics provide information on the frequency, duration, and severity of releases and represent one potential method for evaluating this large data set with the goal of providing important information about sewage release events to the public. During the 6yr period of interest, sewage releases occurred in this region on 8% of the days. In the event of a release, 79% of the releases were no longer active 24hrs later and the average release size was 3.15 million gallons. Additional analysis (not shown here) also demonstrated seasonal and to a lesser extent yearly variability in the number of release events that occurred and the RRV performance metrics. Despite shortfalls in data quality and quantity, particularly in the earlier years of the sewage release reports, the evaluation of general statistics and application of RRV to describe sewage releases demonstrates potential as a method to communicate relevant trends in sewage release occurrences. Next steps include the analysis of sewage release reports via general statistics and RRV across New York State and the creation of a map of values in GIS.

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Watershed-scale organizing in the Hudson River Watershed: lessons learned and opportunities

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Why watersheds?

Watersheds are the geographic unit best-suited to understanding conditions and managing our waters. A watershed is the area of land from which water drains into a river, stream, or other waterbody. Water flows off the land into a waterbody by way of rivers and streams and underground through groundwater aquifers. A watershed defines the boundaries of a system of hydrologically connected people, places, and things; the activities at every point in a watershed impact all points downstream and are impacted by activities at all points upstream (Meierdiercks et al. 2024). As watersheds are largely defined by topography, they often cut across municipal boundaries, resulting in a geographic unit for management that is different from political jurisdictions.

The Hudson River watershed, from Lake Tear of the Clouds in the Adirondacks to New York City, covers 13,400 square miles. A mighty river in its own right, the Mohawk River is the Hudson River's largest tributary. It flows 140 miles through Rome, Utica, Schenectady, and other river cities to its confluence with the Hudson River at Waterford. While each river and stream has its own unique set of conditions and challenges, it is also connected to the health of the larger watershed. To improve the Mohawk River, the Hudson River, and their ecosystems, we have to take a watershed approach.

The role of the Hudson River Watershed Alliance and the Watershed Needs Assessment Project

The Hudson River Watershed Alliance unites and empowers communities to protect our shared waters. We support community-based watershed groups, help municipalities work together on water issues, and serve as a collective voice across the region. The Hudson River Watershed Alliance hosts educational and capacity-building programs and provides technical and strategic assistance on watershed work, including fostering new initiatives and helping sustain groups as they meet new challenges.

To inform this work, the Hudson River Watershed Alliance conducted a needs assessment from 2019-2021 to better understand the needs of watershed groups in the Hudson River watershed. Through semi-structured interviews and focus groups, we spoke with 56 Hudson River watershed group leaders and regional partners about watershed group challenges, barriers, needs, strengths, and accomplishments. We used this information to write (1) the *Watershed Needs Assessment Report* (Vail 2022a), a report-out of the information that we heard from interview and focus group participants; (2) the *Watershed Needs Assessment Appendix* (Vail 2022b) to share direct quotations from participants, organized by theme; and (3) the *Work on Watersheds* report (Vail 2020) to highlight watershed group success stories and accomplishments.

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Watershed Needs Assessment findings: watershed-scale organizing and watershed groups roles
Watershed groups are community-based groups working to protect local waterbodies using a watershed framework and scale. Watershed groups can take a variety of forms and roles. In general, these groups convene stakeholders around common water issues, share information, coordinate projects, educate residents, and promote stewardship of their watersheds through projects like tree plantings and stream cleanups. Many groups monitor water quality to understand conditions, partner on research with academic institutions, and help to write and implement watershed management plans. Watershed groups and their partners consistently mentioned flooding, pollution, development, climate change, and emerging contaminants as major watershed issues they are tackling (Vail 2022a, b).

Some watershed groups are entirely volunteer-run, while others are intermunicipal councils. Even those that operate as 501(c)(3) non-profit organizations manage small budgets and work closely with volunteers. Some are led by agencies or organizations that devote staff to coordinate groups. Whatever the form, collaboration is key. Many projects have been successful through partnerships with municipalities, county agencies, Soil and Water Conservation Districts, Cornell Cooperative Extension offices, community organizations, and regional non-profits like Hudson River Sloop Clearwater, Scenic Hudson, and Riverkeeper.

Watershed groups fill an important niche as a voice for their river or stream. They have boots on the ground, waders in the water, and considerable local knowledge. They partner with experts to provide strong scientific foundations and strengthen coalitions. Watershed work is complex and relies on numerous stakeholders to be successful, including municipalities, counties, academic institutions, agencies, regional nonprofits, community groups, private-sector firms, and other partners. While some issues may be better suited for municipalities to lead, such as local land use or managing infrastructure, watershed groups still play an important role. They can help municipalities prioritize watershed management, advocate for solutions, and work together across political boundaries.

Key findings of the *Watershed Needs Assessment* suggest that watershed group strengths include capable and willing volunteers and leaders, commitment to a shared vision for their watershed, the ability to engage community members in meaningful ways, and strong technical and project implementation skills (Vail 2022a, b). Watershed groups build relationships, share knowledge, and develop strong organizations to support effective watershed planning and implementation. The *Work on Watersheds* report (Vail 2020) shares success stories from 32 watershed groups across the Hudson River Watershed, highlighting the diverse roles and achievements of watershed groups. Yet, we found that while technical resources, participation, and funding are important for watershed groups, capacity-building is the most critical need for successful and sustainable groups (Finewood et al. n.d.). Capacity-building for watershed groups has subsequently become a central element of the programming and technical assistance the Hudson River Watershed Alliance provides to groups in the region (Read 2022).

Identifying problems and solutions through watershed characterization and planning
The Hudson River Watershed Alliance builds capacity for watershed groups and their work through pilot projects and case studies that tackle challenging problems, such as watershed planning and management. Within the *Watershed Needs Assessment*, watershed groups articulated the need for watershed management plans to guide their work. They expressed the goals of having a sustainable organization; being a reliable resource for decision-makers; and developing, completing, and implementing watershed management plans (Vail 2022a, b). Types of plans to support watershed work may include strategic plans to guide organizational development, work plans to prioritize shorter-term projects, and watershed plans to identify strategic actions by a variety of stakeholders across the watershed scale.

To help address this need, over the past two years, the Hudson River Watershed Alliance has been working on pilot watershed characterization projects for the Punch Brook-Roeliff Jansen Kill and Sparkill Creek watersheds. Based on our experience in these two distinct watersheds, we can develop guidance and share lessons learned to support other watershed groups in completing similar projects.

Characterizing watersheds using maps and syntheses of available data is an important first step in understanding watersheds and providing the foundation for planning and management efforts. The watershed characterization process compiles existing information to understand current watershed conditions, using narrative, maps, and other tools to tell the watershed's story. This step is crucial for identifying and scoping watershed problems and developing effective management solutions. Within the planning framework, it is essential to understand current conditions, set goals for future conditions, and understand what actions are most strategic to get from here to there. The watershed characterization process helps identify any gaps is existing information and helps ensure that we are collecting the right information and asking the right questions to set baselines. Because watershed management problems are challenging and multi-faceted, jumping straight into management solutions without fully understanding conditions on the ground can produce projects that are ineffective and unsustainable, or may lead to unintended harm.

Compiling geographic information systems (GIS) data and generating GIS maps are important steps of the watershed characterization process. While there are many free and accessible mapping resources available to community groups, these groups may not have the computing resources, time, or capacity to learn or work with the software. GIS mapping by academic partners can be a particularly effective tool for supporting community planning, education, and activism efforts (Lively et al. n.d.). Academic-community partnerships have the potential to provide a mechanism for creating high-quality and customized maps (Meierdiercks et al., 2024) at a scale necessary to meet the watershed management needs in the region. Providing these mapping resources to nonprofit and community groups can be an important way to build capacity for the watershed planning process. But the mapping process must be thoughtful, inclusive, and deliberate so the resulting watershed maps and images not only contain accurate data, but can also be used as tools to connect people to their watersheds (Meierdiercks et al. 2024). Watershed maps and other images must be representative and customized to effectively depict and communicate local issues (Meierdiercks et al., 2024).

Different watershed issues may emerge at different geographic and temporal scales. For example, watershed priorities within a small tributary may be different that those impacting the larger main-stem river; however, all issues are connected to the broader watershed ecosystem. A smaller watershed focus may be best-suited to having more local involvement, while larger watersheds may include broader expertise to tackle more challenging problems. Watershed groups are also facing the challenge of planning for legacy, current-day, and future issues. Scenario planning, creative visioning sessions, and other tools may be valuable to explore what different futures may hold, and what we can do to plan ahead for unknown conditions. This type of planning can support resilience to changes, including leadership transitions, emerging issues of concern, etc.

Watershed groups need to consider their scale and scope in order to have an impact. This relates to the size of their focus watershed, as well as the roles they play. Almost every watershed problem is too complex for a small watershed group to solve alone. The watershed characterization and planning process brings together people from across municipal boundaries to document current watershed conditions, define future goals, and prioritize specific, strategic, implementable actions to improve their watershed's health. This process relies on creating partnerships with and collecting information from a wide range of stakeholders. Watershed groups play important roles in supporting connections both within and between communities.

Throughout the Hudson River Watershed Alliance's work on the *Watershed Needs Assessment* and Watershed Characterization Pilot Projects, it is clear that watershed groups have unique and specialized knowledge of local watershed issues and are doing excellent work to advocate for their waters and their communities. However, watershed groups need more capacity to do this work so that it is impactful, strategic, and sustainable. While funding and technical resources are important, they must be provided in ways and at time and spatial scales that support ongoing efforts. While watershed planning can highlight local knowledge and identify watershed problems at multiple scales, it must be done in ways that center community needs. Watershed characterization has the potential to help build this capacity when it is done with and for watershed communities.

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DNA barcoding for the detection of invasive species in the Hudson River: a molecular approach for ecosystem monitoring

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Invasive species pose a significant threat to the biodiversity and ecological balance of aquatic ecosystems, necessitating advanced monitoring techniques for their timely detection and management. The Hudson River faces an escalating threat[1] from specific invasive species, including round goby (*Neogobius melanostomus*)[2], water chestnuts (*Trapa natans*)[3], hydrilla (*Hydrilla verticillata*), didymo (*Didymosphenia geminata*), zebra mussels (*Dreissena polymorpha*), and grass carp (*Ctenophayngodon Idella*). This study explores the application of DNA Barcoding as a molecular tool for the precise identification of invasive species within the Hudson River. Utilizing DNA sequences from specific genetic markers, such as mitochondrial cytochrome C oxidase I (COI) gene, we aim to develop a comprehensive reference database specific to the Hudson River ecosystem. This database will facilitate the identification of invasive species based on their unique genetic signatures.

The research involves collecting water samples from different locations along the Hudson River and extracting DNA from the collected biological material, followed by polymerase chain reaction (PCR) amplification of the COI gene. Subsequent DNA sequencing and bioinformatics analysis will enable the comparison of obtained genetic sequences with established databases to identify the invasive species present in the samples.

The application of eDNA will provide an efficient and non-intrusive method of invasive species detection in addition to providing valuable insights into the diversity and dynamics of the Hudson River ecosystem. By combining ecological surveys with DNA barcoding, we aim to develop a robust monitoring system that aids in the early detection, management, and mitigation of the impact of invasive species. This will contribute to the preservation and sustainability of the Hudson River ecosystem by facilitating proactive measures.

References

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