Conference Agenda

Last Updated: May 20, 2022

2022 Lake Champlain Research Conference

May 23-24, 2022

Hilton Burlington Lake Champlain

60 Battery Street Burlington, VT 05401

https://www.lcbp.org/about-us/how-we-work/meetings/lake-champlain-research-conference-2022/

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Agenda at a Glance

Day 1: Monday 5/23/2022

8:00am – 5pm: **Registration** ***North Prefunction***

8:00am – 8:45am: **Breakfast Buffet** ***Green Mountain Ballroom***

9:00am – 10:30am: **Welcoming Remarks & Keynote Address** ***Adirondack AB Theatre***

Welcoming Remarks

Keynote Address: **The Clean Water Act: Steering 50 Years of Environmental Improvement in the Lake Champlain Basin** – MaryJo Feuerbach, EPA Region 1

10:30am – 11:00am: **Break & Networking**

11:00am – 12:15pm: **Concurrent Session #1**

Track 1A	Track 1B	Track 1C	Track 1D
Watershed Education	**Wetlands**	**Aquatic Invasive Species**	**Streams, Rivers, and Floodplains Pt 1**
Adirondack AB Theatre	*Montpelier BC Classroom*	*Adirondack C Classroom*	*Adirondack D Classroom*

12:15pm – 1:15pm: **Lunch Buffet** ***Green Mountain Ballroom***

1:15pm – 2:30pm: **Concurrent Session #2**

Track 2A	Track 2B	Track 2C	Track 2D
Community Engagement for Water Quality	**Agriculture**	**Lake Species and Habitats**	**Streams, Rivers, and Floodplains Pt 2**
Adirondack AB Theatre	*Montpelier BC Classroom*	*Adirondack C Classroom*	*Adirondack D Classroom*

2:30pm-2:45pm: **Break & Networking**

2:45pm – 4:00pm: **Concurrent Session #3**

Track 3A	Track 3B	Track 3C	Track 3D
"Lake Champlain Unfiltered"	**Community Action**	**Phytoplankton and Data Collection**	**Municipal/Developed Lands Infrastructure**
Adirondack AB Theatre	*Montpelier BC Classroom*	*Adirondack C Classroom*	*Adirondack D Classroom*

4:00pm – 5:00pm: **Poster Session & Conference Reception** ***Green Mountain Ballroom***

4:45pm – 6:15pm: **Film Screenings & Conference Reception, continued** ***Adirondack AB Theatre***

- ***Connected, A Journey Through the Champlain Adirondack Biosphere Network (CABN)*** *~8 minutes*
- ***No Other Lake (Lake Champlain Film)*** *~40 minutes*
- Film screenings will be followed by a Q&A Panel

Day 2: Tuesday 5/24/2022

8:00am – 1pm: **Registration** ***North Prefunction***

8:30 – 9:30am: **Breakfast Buffet** ***Green Mountain Ballroom***

9:30am – 10:30am: **Day 2 Keynote Addresses** ***Adirondack AB Theatre***

- **Round Goby Threat to Lake Champlain and the Champlain Canal**
  Shawn Good, Vermont Fish and Wildlife Department
  Meg Modley Gilbertson, LCBP
- **The Gunboat Spitfire: Local History, National Significance**
  Susan Evans McClure and Chris Sabick, Lake Champlain Maritime Museum

10:30am – 11:00am: **Break & Networking**

11:00am – 12:15pm: **Concurrent Session #4**

Track 4A	Track 4B	Track 4C	Track 4D
Diversity, Equity, Inclusion and Public Access *Adirondack AB Theatre*	**Road Salt: A Contaminant of Emerging Concern** *Montpelier BC Classroom*	**Cyanobacteria** *Adirondack C Classroom*	**Functioning Floodplain Initiative Pt 1** *Adirondack D Classroom*

12:15pm – 1:15pm: **Lunch Buffet** ***Green Mountain Ballroom***

1:15pm – 2:30pm: **Concurrent Session #5**

Track 5A	Track 5B		Track 5D
Cultural Heritage in the Lake Champlain Basin *Adirondack AB Theatre*	**Lake Champlain Federal Partners Climate Change Initiative** *Montpelier BC Classroom*		**Functioning Floodplain Initiative Pt 2** *Adirondack D Classroom*

Agenda in Full

Day 1: Monday 5/23/2022

8:00am – 4:30pm: **Registration** ***North Prefunction***

9:00am – 10:30am: **Welcoming Remarks & Keynote Address** ***Adirondack AB Theatre***

Welcoming Remarks and Land Acknowledgement

- *Julie Moore, Secretary, Vermont Agency of Natural Resources*
- *Breck Bowden, Director of Water Resources and Lake Studies Center, Lake Champlain Sea Grant*
- *Timothy Mihuc, Executive Director, Lake Champlain Research Consortium*
- *Tom Berry, Office of Senator Patrick Leahy*
- *Haley Pero, Office of Senator Bernie Sanders*
- *Rebecca Ellis, Office of Congressman Peter Welch*
- *Ahren von Schnell, Office of Congresswoman Elise M. Stefanik*
- *Eric Howe, Director, Lake Champlain Basin Program*

Keynote Address: **The Clean Water Act: Steering 50 Years of Environmental Improvement in the Lake Champlain Basin** – MaryJo Feuerbach, EPA Region 1

10:30am – 11:00am: **Break & Networking**

11:00am – 12:15pm: **Concurrent Session #1**

Track 1A: Watershed Education ***Adirondack AB Theatre***

Moderator: **Caroline Blake McKelvey**

- The Giant Lake Champlain Map Project
  - *Elizabeth Lee, Lake Champlain Maritime Museum.*
- Watersheds as a Framework for Learning
  - *Ashley Eaton, Lake Champlain Sea Grant*
- Lewis Creek Association Ahead of the Storm Watershed Education Program
  - *Jessica Louisos, SLR International Corporation. Additional Authors: Kate Kelly, Lewis Creek Association*
- Using Community Science to Empower the Public to Observe, Monitor, and Manage Invasive Species in the Adirondacks
  - *Brian Greene, Adirondack Park Invasive Plant Program. Additional Authors: Rebecca Bernacki, Tammara Van Ryn, Zachary Simek*

Track 1B: Wetlands ***Montpelier BC Classroom***

Moderator: **Zapata Courage**

- Citizen Scientists and Vermont's Wetlands
  - *Tina Heath, VT Agency of Natural Resources Wetlands Program. Additional Authors: Charlie Hohn*
- Wetland Restoration Monitoring in Vermont
  - *Tina Heath, VT Agency of Natural Resources Wetlands Program. Additional Authors: Charlie Hohn*
- Phosphorus Cycling in Restored Riparian Wetlands in Vermont
  - *Eric Roy, University of Vermont. Additional Authors: Adrian Wiegman, Kristen Underwood, Breck Bowden*
- Semi- automated Wetlands Mapping in the Otter Creek Watershed of Vermont and Implications for Monitoring and Conservation
  - *Laura LaPierre, Vermont DEC. Additional Authors: B. Freyer, C. Hohn., B. Ketterling, L. Keszey, A. Kreiger, S. MacFaden, J. O'Neil-Dunne, and A. Royar*

Track 1C: Aquatic Invasive Species ***Adirondack C Classroom***

Moderator: **Erin Vennie-Vollrath**

- Modelling the Impact of Alewife Invasion on the Food Webs of Lake Champlain

- *Justin Lesser, University of Vermont. Additional Authors: Rosalie Bruel, Jason Stockwell, Ellen Marsden*
- Using eDNA to Monitor Invasive Species and Factors Influencing Detection Probability
  - *Jake Riley, Stantec Consulting*
- Pathways of Invasion: Recreational Boater Activity, Aquatic Invasive Species Distribution, and Landscape Level Connectivity to Inform Management and Prevention in New York State
  - *Michale Glennon, Paul Smith's College Adirondack Watershed Institute. Additional Authors: Dan Kelting*
- Analyzing Watercraft Inspection Steward Survey Data to Inform Aquatic Invasive Species Management, Monitoring, and Prevention Efforts in New York State
  - *Mitchell O'Neill and John Marino, New York Natural Heritage Program.*

Track 1D: Streams, Rivers, and Floodplains Part 1 — *Adirondack D Classroom*

Moderator: **Rebecca Diehl**

- The past, present, and future of Lake Champlain: Using long-term monitoring data to determine tributary nutrient loads and guide management
  - *Matthew C. H. Vaughan, Lake Champlain Basin Program*
- Increased Winter Thaws in Northern Climates: An Emerging Threat to Lake Champlain Basin Water Quality?
  - *Andrew Schroth, University of Vermont. Additional Authors: Carol Adair, Kathleen Lewis, Saul Blocher, Aimee Classen, Keith Mussleman, Meghan Taylor, Sonya Vogel, Julia Perdrial, Dustin Kincaid, Erin Seybold*
- Assessing the Impact of Private Roads on Aquatic Habitat Connectivity in the Missisquoi Basin
  - *Luke Briccetti, SUNY Plattsburgh Graduate Student. Additional Authors: Dr. Tim Mihuc, Dr. Kimberly Coleman*
- Monitoring Japanese Knotweed Using Drone Imagery
  - *Simon Pearish, Norwich University. Additional Authors: Harry Simotwo, Galen Ryan, Cynthia Fortin, Ronald Lessard*

12:15pm – 1:15pm: **Lunch Buffet** — ***Green Mountain Ballroom***

1:15pm – 2:30pm: **Concurrent Session #2**

Track 2A: Community Engagement for Water Quality — *Adirondack AB Theatre*

Moderator: **Chris Navitsky**

- Forest Landowner Understanding of Water Quality Protection Practices: Case Study in the Lake Champlain Basin
  - *Elizabeth Doran, Civil & Environmental Engineering, University of Vermont. Additional Authors: Kimberly Coleman*
- Incentives and Barriers to Adoption of Green Stormwater Infrastructure by Vermont Municipalities and Residents
  - *Stephanie Hurley, University of Vermont. Additional Authors: Sarah Coleman, Holly Greenleaf*
- Resilient Right-of-Ways: A Collaborative and Integrated Approach to Advance Trees, Forests, and Other Green Stormwater Infrastructure Practices in Vermont's Roadside Environments
  - *Karl Honkonen, USDA Forest Service and Elise Schadler, VT Forests, Parks & Recreation. Additional Authors: Joanne Garton*
- Targeted Stormwater and Shoreline Erosion Assessments on the Lake Champlain Shoreline in Georgia, VT
  - *Kerrie Garvey, Watershed Consulting Associates, LLC. Additional Authors: Andres Torizzo*

Track 2B: Agriculture — *Montpelier BC Classroom*

Moderator: **Joshua Faulkner**

- Re-conceptualizing the Soil and Water Assessment Tool to Predict Subsurface Water Flow Through Macroporous Soils
  - *Aubert R. Michaud, Organisme de bassin versant Baie Missisquoi. Additional Authors: David Poon, Joann K. Whalen*
- Phosphorus Losses in Surface and Tile Drainage from Northern New York Corn Fields
  - *Laura Klaiber, Miner Institute. Additional Authors: Stephen Kramer, Mark Haney*
- Dimensioning and Locating Experimental Riparian Buffers Using Distributed Hydrological Modeling
  - *Guillaume Morin, Institut national de la recherche scientifique. Additional Authors: Cedrick Guedessou, Silvio Gumiere, Étienne Foulon and Alain N. Rousseau*
- Monitoring the Environmental Status of an Integrated Watershed Management Project Using a Suite of Indices

- *Etienne Foulon, Institut national de la recherche scientifique, Centre eau terre et environnement. Additional Authors: Mohamed Laabouli, Alain N. Rousseau*

Track 2C: Lake Species and Habitats — *Adirondack C Classroom*

Moderator: **Tim Mihuc**

- A Preliminary List of Mayflies (Ephemeroptera), Stoneflies (Plecoptera) and Caddisflies (Trichoptera) from Lake Champlain with Discussion of Unique Habitats and Species of Conservation Concern
  - *Luke Myers, Lake Champlain Research Institute, SUNY Plattsburgh. Additional Authors: Timothy Mihuc*
- Tracking Stocked and Naturally-produced Lake Trout Demonstrates Differences in Seasonal Habitat Selection
  - *Matthew Futia, University of Vermont. Additional Authors: Aaron Fisk, Ellen Marsden*
- Use of Genetic Tools to Assess Stocking Performance and Wild Recruitment in a Recovering Lake Trout Population
  - *Benjamin Marcy-Quay, University of Vermont. Additional Authors: Ellen Marsden*
- Assessing and Improving Landlocked Atlantic Salmon Restoration in Lake Champlain with Parentage Based Tagging
  - *Kurt Heim, U.S. Fish and Wildlife Service. Additional Authors: William Ardren*

Track 2D: Streams, Rivers, and Floodplains Part 2 — *Adirondack D Classroom*

Moderator: **Alain Rousseau**

- Development of a Flood Forecasting System for Lake Champlain
  - *Daniel Titze, Cooperative Institute for Great Lakes Research, University of Michigan. Additional Authors: Dmitry Beletsky, James Kessler, Lacey A. Mason, Eric Anderson, Lauren Fry, Laura Read, William Saunders, Philip Chu, Jesse Feyen, Deborah Lee*
- Quantifying the Flow Buffering Capacity of Wetlands Using the Strahler Order – The Case Study of the Lake Champlain Basin
  - *Simon Lachapelle, Institut National de la Recherche Scientifique - Centre Eau Terre Environnement (INRS-ETE). Additional Authors: Stéphane Savary, Alain N. Rousseau*
- First Instance Inundated Area Mapping Using a Zero-Dimensional Model over Small Watersheds
  - *Camila Alejandra Gordon, Institut National de la Recherche Scientifique. Additional Authors: Zainab El Batti, Etienne Foulon, Alain N. Rousseau*
- Toward Establishing Vegetated Buffers in an Agricultural Landscape: a Planning Process
  - *Laurence Turmel-Courchesne, Université Laval. Additional Authors: Chaisse Leal, Laurie; Bourgeois, Bérenger; Morin, Guillaume; V. Guedessou Cedrick; J. Gumiere, Silvio; N. Rousseau, Alain; Poulin, Monique*

2:30pm-2:45pm: **Break & Networking**

2:45pm – 4:00pm: **Concurrent Session #3**

Track 3A: "Lake Champlain Unfiltered" — *Adirondack AB Theatre*

Moderator: **LCBP Staff**

- Late career and newly retired environmental professionals share their experiences and guidance with students and early career professionals. Featuring a fantastic panel of experts:
  - Vicki Drew, retired USDA Natural Resources Conservation Service (NRCS) State Conservationist
  - Donna Parrish, retired, U.S. Geological Survey, Vermont Cooperative Fish and Wildlife Research Unit
  - Eric Perkins, retired US Environmental Protection Agency (EPA) water quality specialist
  - Bob Stegemann, retired NYS Department of Environmental Conservation (DEC) Region 5 Director

Track 3B: Community Action — *Montpelier BC Classroom*

Moderator: **Aude Lochet**

- An Innovative Collective Project to Improve the Water Quality of an Agricultural Watershed
  - *Etienne Foulon, Institut national de la recherche scientifique, Centre eau terre et environnement. Additional Authors: Alain N. Rousseau, Karine Dauphin, André Pion*
- Barriers and opportunities related to the implementation of agri-environmental programs in Quebec (Canada)
  - *Faby Anne G Mimeault, Université du Québec en Outaouais. Additional Authors: Jérôme Dupras, Alejandra Zaga Mendez, Jean-François Bissonnette, Mikaël Scattolin*

- Understanding Knowledge and Stewardship Actions of the Public Across the Lake Champlain Basin to Inform Future Outreach
  - *Kris Stepenuck, University of Vermont. Additional Authors: Jane Kolodinsky, Michael Moser, Lori Fisher*
- Investigating Interventions to Increase Environmental Literacy among K-12 Teachers and BIPOC Students
  - *Jillian Kara, SUNY Plattsburgh. Additional Authors: Dr. Kimberly J Coleman*

Track 3C: Phytoplankton and Data Collection — *Adirondack C Classroom*

Moderator: **Ana M. Morales-Williams**

- Changes in Lake Champlain Phytoplankton Community Composition and Distribution From 1970 to 2020
  - *Kayleen Snyder, Lake Champlain Research Institute. Additional authors: Timothy Mihuc*
- Algal Growth in Lake George, NY as an Indicator of Water Quality Impacts from Land Use – Analysis from 2020 and initial results from 2021
  - *Brea Arvidson, Lake George Association. Additional authors: Chris Navitsky*
- Developing low-cost cyanobacteria, algae, turbidity, and temperature sensor systems for water quality monitoring of Lake Champlain waterfront areas
  - *Clayton Williams, Saint Michael's College. Additional authors: Tian Xia; Jessica Sheridan; Wenzhe Chen; Ana M. Morales-Williams*
- A Shiny app for the interactive display of near real-time data from the Upper Saranac Lake Environmental Monitoring Platform
  - *Brendan Wiltse, Paul Smith's College Adirondack Watershed Institute*

Track 3D: Municipal/Developed Lands Infrastructure — *Adirondack D Classroom*

Moderator: **Jill Sarazen**

- Subsurface horizontal-flow gravel wetlands in Vermont – permitting, performance, and chloride concerns
  - *Andres Torizzo, Watershed Consulting Associates. Additional authors: Eric Roy, Donna M. Rizzo, Nisha Nadkarni*
- Subsurface horizontal-flow gravel wetlands in Vermont – material selection impacts on performance
  - *Eric Roy, University of Vermont. Additional authors: Marcos Kubow, Andres Torrizo, and Donna M. Rizzo*
- Nitrate Reduction from Woodchip Bioreactor Technology at a Small Community Treatment Plant
  - *Chris Navitsky, Lake George Waterkeeper. Additional authors: Jim Sutherland, PhD; Kathy Suozzo, P.E.*

4:00pm – 5:00pm: **Poster Session & Conference Reception** — ***Green Mountain Ballroom***

During the conference reception, non-alcoholic drinks and snacks will be provided and for those wishing to have an alcoholic beverage there will be a bar that accepts credit/debit card payments.

Posters:

- Bird and pollinator friendly farming practices co-benefit clean water, healthy soils, and climate solutions in the Lake Champlain Basin
  - *Cassandra Wolfanger, Audubon Vermont and Lake Champlain Sea Grant*
- Statistical meta-analysis of agricultural BMPs and BMP group performance
  - *Brendan Lombard, Undergraduate Researcher. Additional Authors: Dr. Elizabeth Doran*
- Temporal effect of green manure use on soil microbial community in field cropping systems
  - *Thiago Gumiere, Université Laval. Additional Authors: Carl Lalonde-Haman, Jhemson Brédy, Silvio J. Gumiere, Caroline Halde, Cedrick V. Guedessou, Etienne Foulon, Alain N. Rousseau*
- Characterization of Viral and Bacterial Dynamics in Lake Champlain Cyanobacterial Harmful Algal Blooms
  - *Briana Gifty and Johson Atanga, Middlebury College. Additional Authors: Erin Eggleston*
- Wool and Water: Environmental Education through Participatory Fiber Arts
  - *Michale Glennon, Paul Smith's College Adirondack Watershed Institute*
- Baseline Phosphorus Monitoring in Preparation for a Watershed Action Plan for Lake St. Catherine
  - *Andrew Vermilyea, Castleton University. Additional Authors: Chris Ciccarelli*
- Consequences of Winter Thaw and High-Flow Events on Nutrient Loading into the Lake Champlain Basin

- *Sonya Vogel, University of Vermont. Additional Authors: Carol Adair, Meghan Taylor, Andrew Schroth*
- Using a variety of diet tracers can help managers stay one step ahead of the next big invasion
  - *Ariana Chiapella, University of Vermont. Additional Authors: Jason Stockwell, Martin Kainz, Ellen Marsden*
- Artistic Interpretations on How Pollution Impacts the Lake Champlain Watershed
  - *Jill Serrano Michalsky, BluSeed Studios*
- Our Scrumptious Lake: Phyto-tastic!
  - *Sandy Murphy, Independent Literacy Consultant and Tutor.*
- Paleolimnological data synthesis to assess and predict long-term ecological change in Vermont inland lakes
  - *Ismar Biberovic, University of Vermont. Additional Authors: Ana Morales-Williams*
- Assessing Internal Phosphorus Loading in Lake Carmi in Response to Whole Lake Aeration
  - *Ashton Kirol, University of Vermont. Additional Authors: Andrew Schroth*
- Invasive Predatory Cladocerans Alter Lake Champlain Zooplankton Community
  - *Zachary Cutter, Lake Champlain Research Institute. Additional Authors: Tim Mihuc, Luke Myers*
- Predictive Modeling of Road-salt Related Chloride Pollution within Aquatic Systems of the Adirondack Park and Associated Watersheds
  - *Jesse Rock, Brendan Wiltse*
- Long Term, High Frequency Measurements of Environmental Soil Parameters Illustrate the Relationship Between Soil CO2 Emissions and Winter Warming Conditions and Variable Snowpack in Lake Champlain Riparian Zones
  - *Meghan Taylor, University of Vermont. Additional Authors: Carol E. Adair; Andrew Schroth; Dustin Kincaid*

4:45pm – 6:15pm: **Film Screenings & Conference Reception, continued** ***Adirondack AB Theatre***

During the conference reception, non-alcoholic drinks and snacks will be provided and for those wishing to have an alcoholic beverage there will be a bar that accepts credit/debit card payments. The film screenings will be followed by a Q&A Panel Discussion.

Films:

- ***Connected, A Journey Through the Champlain Adirondack Biosphere Network (CABN)*** *(~ 8 minutes)*
  - *This film celebrates the partners working to build a more sustainable future for communities across the Champlain Basin and the Adirondack Mountains. It was directed by Lia Nydes and produced in partnership with the National Park Service and the Center for Environmental Filmmaking, American University.*
- ***NO OTHER LAKE (Lake Champlain Film)*** *(~40 minutes)*
  - *Motivated by a desire to better understand his home watershed, Jordan Rowell embarks on a two-week kayaking trip along the 120-mile length of Lake Champlain, stopping along the way to talk to a wide range of characters about the future of their shared basin. Set 50 years after the passage of the Clean Water Act, NO OTHER LAKE is both a celebration of the unique beauty of Lake Champlain and a confrontation with its greatest challenges. This adventure-conservation documentary strives to inspire people to better connect with the natural world around them, see issues from a different point of view, and get involved with stewardship efforts happening close to home.*

Day 2: Tuesday 5/24/2022

9:30am – 10:30am: **Day 2 Keynote Addresses** ***Adirondack AB Theatre***

- **Round Goby Threat to Lake Champlain and the Champlain Canal** – Shawn Good, Vermont Fish and Wildlife Department and Meg Modley Gilbertson, LCBP
- **The Gunboat Spitfire: Local History, National Significance –** Susan Evans McClure and Chris Sabick, Lake Champlain Maritime Museum

10:30am – 11:00am: **Break & Networking**

11:00am – 12:15pm: **Concurrent Session #4**

Track 4A: Diversity, Equity, Inclusion, Public Access ***Adirondack AB Theatre***

Presentation by Dr. Maria Mercedes Avila, Assistant Professor of Pediatrics, Adjunct Assistant Professor of Nursing, the University of Vermont and Chair of Vermont Department of Health's Health Disparities and Cultural Competence Committee

Track 4B: Road Salt: A Contaminant of Emerging Concern ***Montpelier BC Classroom***

Moderator: **Eric Moody**

- Understanding winter maintenance practices of basin communities
  - *Kris Stepenuck, UVM. Additional Authors: Ruth Smtih and Kristina Hartzell*
- An Environmental Monitoring Program to Evaluate the New York State Department of Transportation Road Salt Reduction Pilot Program in the Lake George Drainage Basin
  - *Jim Sutherland, Lake George Association. Additional Authors: Chris Navitsky, Brea Arvidson*
- Regional pollution of groundwater by road salt in the Adirondack Park
  - *Dan Kelting, Paul Smith's College Adirondack Watershed Institute. Additional Authors: Corey Laxson and Elizabeth Yerger*
- Multi-decadal monitoring reveals salinization impacts of road de-icing salt application in the Lake Champlain watershed
  - *Will Sutor, University of Vermont. Additional Authors: Matthew C. H. Vaughan, Ana M. Morales-Williams, Brendan Wiltse*

Track 4C: Cyanobacteria ***Adirondack C Classroom***

Moderator: **Peter Isles**

- Deciphering the diversity and role of bacteriophage in Lake Champlain
  - *Nana Ankrah, SUNY Plattsburgh. Additional Authors: Luke Myers, Ashley Barkley*
- Linking Comprehensive Monitoring with a 3D Coupled Hydrodynamic-Aquatic Ecosystem Model to Evaluate Alternatives for Controlling Internal Phosphorus Loading in Missisquoi Bay, Lake Champlain
  - *Andrew Schroth, UVM. Additional Authors: Ashton Kirol, Meghan Arpino, Clelia Marti, Ken Wagner, Dave Braun*
- Artificial aeration alters Cyanobacteria functional diversity and stability but not dominance in Lake Carmi, VT
  - *Ana M. Morales-Williams, University of Vermont Rubenstein School of Environment and Natural Resources. Additional Authors: Maria Alfaro, Jeremy Howland, Ashton Kirol, Austin Wilkes, and Andrew Schroth*
- Effects of Disturbance on Phytoplankton Communities in Two Eutrophic Bays of Lake Champlain
  - *Katelynn Warner, University of Vermont. Additional Authors: Andrew Schroth, Ana M. Morales-Williams*

Track 4D Functioning Floodplain Initiative Part 1 ***Adirondack D Classroom***

Moderator: **Roy Schiff**

- Developing tools to restore floodplain function in Vermont's Lake Champlain Basin – Overview of the Vermont Functioning Floodplain Initiative

- *Gretchen Alexander, Vermont DEC. Additional Authors: Roy Schiff, SLR International; Evan Fitzgerald, Fitzgerald Environmental; Kristen Underwood, University of Vermont; Mike Kline, Fluvial Matters; Jody Stryker, Stone Environmental*

- Integrating Stream Geomorphic Data to Improve Floodplain Mapping Using a Probabilistic Low-Complexity Hydraulic Model
  - *Kristen Underwood, University of Vermont. Additional Authors: Stephanie Drago, Jeremy E. Matt, Rebecca M. Diehl*
- Evidence-based prioritization of restoration for phosphorus retention in floodplains and wetlands of the Lake Champlain Basin
  - *Rebecca Diehl, University of Vermont. Additional Authors: Kristen Underwood, Stephanie Drago, Don Ross, Beverley Wemple*
- Predicting Stream Power from a Low Complexity Hydraulic Model
  - *Jeremy Matt, University of Vermont. Additional Authors: Rebecca M. Diehl, Kristen L. Underwood, Elizabeth M.B. Doran, Ali Javed, Stephanie Drago, Rachel M. Seigel, Donna M. Rizzo*

12:15pm – 1:15pm: **Lunch Buffet** ***Green Mountain Ballroom***

1:15pm – 2:30pm: **Concurrent Session #5**

Track 5A: Cultural Heritage in the Lake Champlain Basin ***Adirondack AB Theatre***

Moderator: **Katie Darr**

- 'Our Best Endeavors:' Temperance, Prohibition, and Smuggling in Champlain Valley
  - *Susan McClure, Lake Champlain Maritime Museum*
- War and Enslavement in the Champlain Valley
  - *Matthew Keagle, Fort Ticonderoga*

Track 5B: Lake Champlain Federal Partners Climate Change Initiative ***Montpelier BC Classroom***

The Lake Champlain Federal Partners Workgroup invites conference attendees to join this meeting space to learn, ask questions, and share feedback about current Basin-wide climate change initiatives.

Track 5D: Functioning Floodplain Initiative Part 2 ***Adirondack D Classroom***

Moderator: **Roy Schiff**

- A method to classify headwater reaches for stream and floodplain project crediting under the Lake Champlain phosphorus TMDL
  - *Scott Lawson, University of Vermont. Additional Authors: Kristen L. Underwood, Stephanie Drago, Gretchen Alexander, Roy Schiff, Mike Kline*
- Expanding the Vermont Functioning Floodplain Initiative (FFI) to include Instream and Floodplain Habitat Protection and Restoration Potential
  - *Elizabeth Doran, Civil & Environmental Engineering, University of Vermont. Additional Authors: Roy Schiff, Mike Kline, Kristen Underwood, Rebecca Diehl*
- The Vermont Functioning Floodplain Initiative: Crediting River Corridor Projects for Total Phosphorus Attenuation for the Lake Champlain TMDL
  - *Roy Schiff, SLR International. Additional Authors: Mike Kline, Fluvial Matters; Evelyn Boardman, Fitzgerald Environmental; Evan Fitzgerald, Fitzgerald Environmental, LLC*
- The FFI Web Application – Translating Research Outcomes into Project Planning, Implementation, and Tracking of River and Floodplain Reconnection
  - *Jody Stryker, Stone Environmental. Additional Authors: Barbara Patterson, Nick Floersch, Gretchen Alexander, Roy Schiff, Evan Fitzgerald, Evelyn Boardman, Kristen Underwood, Mike Kline*

Abstracts

11:00am – 12:15pm: **Concurrent Session #1**

Track 1A: Watershed Education ***Adirondack AB Theatre***

1A-1:The Giant Lake Champlain Map Project

Elizabeth Lee, Lake Champlain Maritime Museum.

In 2020, Lake Champlain Maritime Museum launched a new school and community learning resource, the Giant Lake Champlain Map, with the support and partnership of the Lake Champlain Basin Program. The Giant Map is an accurate and detailed 35' x 27' map of the Lake Champlain Watershed for teachers and learners of all ages to use in schools and other educational sites. The Giant Map was designed to increase stewardship of the Lake Champlain watershed by increasing understanding of how individuals are connected to the lake and how individual and community choices influence the lake's health. Using cross-curricular activities at multiple grade levels, the Giant Map "wows" students and opens up tremendous possibilities for new spatial thinking skills. Students visualize destinations and then go from place to place at a huge scale. Lessons on the map can truly explore any aspect of the Lake Champlain Basin: history, water quality, geography, science, music, math, literature, and more. The Museum's Education Director Elizabeth Lee will share how the map was created, the importance of the partnership with Lake Champlain Basin Program, and the response from teachers and the community to this amazing teaching resource. She will share examples of student interaction and of teacher training on the map, as well as the impacts the program is having on students, and plans to expand the program's reach in the future.

1A-2:Watersheds as a Framework for Learning

Ashley Eaton, Lake Champlain Sea Grant

Since 2002, Lake Champlain Sea Grant has partnered with University of Vermont (UVM) Extension to bring the Watershed Alliance education program to elementary, middle, and high school students in the Lake Champlain basin. Students receive hands-on watershed education in their own classrooms, in the classroom at UVM's Rubenstein Ecosystem Science Laboratory, on Lake Champlain aboard the UVM research vessel, as well as in basin tributaries. Watersheds can provide a framework for learning and offer a powerful systems-based approach for engaging students in explorations of place. Waterways are complex systems designed by nature over geologic time scales and offer many entry points for students to experience the natural world. Directly engaging students in the natural world sets the stage for inquiry. Educators can skillfully guide reflection and assist in forming connections between different aspects of the natural system in students' minds. Join this session to explore examples of entry points as well as an ecological approach to using watersheds as frameworks for learning. This session will share the impact of using a watershed-focused approach by presenting information collected through program evaluations, including participant quotations, to share programmatic outcomes from the Lake Champlain Sea Grant and University of Vermont Extension's Watershed Alliance program.

1A-3: Lewis Creek Association Ahead of the Storm Watershed Education Program

Jessica Louisos, SLR International Corporation. Additional Authors: Kate Kelly, Lewis Creek Association

Ahead of the Storm (AOTS) takes a multi-prong approach to improve water quality and flood resiliency in the LaPlatte River watershed and Lake Champlain direct drainages. Education, inspiration, watershed planning, and direct implementation are coupled into one program. The Lewis Creek Association (LCA), in partnership with grant programs, and water resource engineers provided technical guidance and design services to 15 demonstration projects that show how improvements can be made on the ground and actively create improvements to water quality and flood resiliency. These demonstration sites are described in lay-friendly materials and are a part of a community self-guided tour available at local libraries. Projects represent residential, rural town road, agriculture, town parks, library, senior center, town garage, and church land areas. Optimal Conservation Practices (OCPs) are used to establish stormwater treatment necessary to protect ecosystem functions where feasible and cost effective. In many cases, the design approach goes above and beyond state permitting requirements that are often not adequate to maintain high water quality at local sites given climate change. Recommended practices naturalize the hydrology of a site, enhance flood resiliency, and protect water quality in the receiving waters. OCPs do a better job than traditional stormwater treatment practices in slowing down runoff, spreading out runoff, and promoting infiltration. The AOTS project has a strong educational component to inspire others in the watershed to adopt OCPs and voluntarily install similar retrofits. LCA has educated community members and teachers on how to perform site assessments and create designs themselves, and to teach local students about stormwater and the Ahead of the Storm program. Watershed stewards and water resource engineers partnered with teachers in multiple schools to put together a watershed and stormwater education program. The curriculum was taught to volunteers and teachers, and piloted in multiple classrooms from elementary to high school in the Champlain Valley. Multiple community forum events called Water Matters were used to extend watershed and

stormwater learning to the community. We will give an overview of the curriculum, report on successful application to a variety of education settings, and provide information on integration into school stormwater projects.

1A-4: Using Community Science to Empower the Public to Observe, Monitor, and Manage Invasive Species in the Adirondacks

Brian Greene, Adirondack Park Invasive Plant Program. Additional Authors: Rebecca Bernacki, Tammara Van Ryn, Zachary Simek

Professional staff that manage large areas know that they do that have the time, resources, or ability to monitor all areas or collect the critical data they need for all projects. By engaging and empowering the public through community or citizen science projects staff can efficiently increase the region's capacity to adaptively manage resources. The Adirondack Park Invasive Plant Program (APIPP) hosted by the Nature Conservancy is one of New York's eight Partnerships in Regional Invasive Species Management (PRISM). APIPP collaborates with partners across the Adirondacks to manage the negative impacts of invasive species across more than 6.5 million acres and 10,000 lakes. Since 2002 APIPP has used community science projects to collect data on invasive species across the region. Projects work in both aquatic and terrestrial ecosystems to collect observation data, track management progress, and empower communities to act. We will share examples from our Lake Protectors and Forest Pest Hunters that provide early detection information about the distribution and abundance of invasive plants and invertebrates. Two other programs, Lake Management Tracker and Knotweed Coordinators, were designed so community scientists could collect data on management projects and use that information in an adaptive framework to inform future actions. We have found that this is an effective way to collect invasive species data and build an informed cohort of community scientists that are empowered to steward their local resources.

Track 1B: Wetlands *Montpelier BC Classroom*

1B-1: Citizen Scientists and Vermont's Wetlands

Tina Heath, VT Agency of Natural Resources Wetlands Program. Additional Authors: Charlie Hohn

There are several ways the public can help document and map the state of Vermont's wetlands. The DEC Wetlands Program has developed the Vermont Rapid Assessment Method (VRAM) to quickly assess condition and function of wetlands throughout the state. This assessment can be conducted on any wetland and is assessable to the layperson. There's an even easier way to help as well- By adding an observation of a plant or animal in a wetland to the iNaturalist app and uploading it to the "Vermont Wetland Mapping Project", citizen scientists can alert the Wetlands Program to the presence and status of the wetland, which can be used to update wetland mapping. This discussion will go over the components of the VRAM and why it's so useful in determining wetland condition and function, the iNaturalist wetland mapping project, and how the public can engage and collect valuable information about wetlands in Vermont.

1B-2: Wetland Restoration Monitoring in Vermont

Tina Heath, VT Agency of Natural Resources Wetlands Program. Additional Authors: Charlie Hohn

Wetland and floodplain restoration are among some of the most important tools for improving water quality in Lake Champlain and meeting its TMDL goals. In addition to removing phosphorous from floodwaters wetlands provide many other functions including flood control, wildlife habitat, and carbon sequestration. For this reason wetland restoration projects have recently increased in the Champlain basin. However, there has not been a simple and consistent tool for monitoring restoration success at the many sites in the state. The Vermont Wetlands Program has developed an assessment method called the Restoration Indicators of Success Index and is simple to complete, can be conducted by experts and citizen scientists alike, and is validated by a long history of more in-depth wetland assessments conducted over the last 15 years. This presentation will provide an overview of wetland restoration in Vermont and its necessity in protecting Lake Champlain's water quality, the Wetlands Program's restoration monitoring project, and what we're learning so far about wetland restoration success.

1B-3: Phosphorus Cycling in Restored Riparian Wetlands in Vermont

Eric Roy, University of Vermont. Additional Authors: Adrian Wiegman, Kristen Underwood, Breck Bowden

The contribution of riparian wetland restoration to meeting phosphorus (P) load reductions in agricultural watersheds is uncertain. Wetlands are effective at trapping sediment and associated P during flood events. However, many potential restoration sites overlay former agricultural soils that can contain legacy P and hydrologic changes associated with restoration can potentially mobilize legacy soil P as soluble reactive P (SRP),

offsetting some of the P retained via sediment deposition. Understanding of the general magnitude of SRP release versus retention of sediment-bound P during flooding remains very limited, as do the spatial and temporal dimensions of SRP release. We are using a multi-scale approach to address these knowledge gaps as part of a broader research project focused on P dynamics in restored riparian wetlands in the Vermont portion of the Lake Champlain Basin. To date, we have conducted laboratory experiments using intact cores from 20 sites, from which we observed SRP release rates that span two orders of magnitude, with corresponding mean equilibrium SRP concentrations ranging from 0.02 to 2 mg P/L. Results indicate that soil characteristics and land use metrics are both important. We have also conducted complementary field monitoring of P dynamics at 3 sites and are using model simulations to determine net P retention rates when considering multiple P fluxes. Our goal is to inform site selection and design for riparian wetland restoration projects in Vermont so that desired P retention benefits are achieved.

1B-4: Semi- automated Wetlands Mapping in the Otter Creek Watershed of Vermont and Implications for Monitoring and Conservation

Laura LaPierre, Vermont DEC. Additional Authors: B. Freyer, C. Hohn., B. Ketterling, L. Keszey, A. Kreiger, S. MacFaden, J. O'Neil-Dunne, and A. Royar

For more than 40 years, the National Wetlands Inventory (NWI) has provided a comprehensive, national-scale database for wetlands in United States, serving as an essential benchmark in monitoring, regulation, and conservation. However, its time-tested methods of manual image interpretation tend to be laborious, meaning that state-specific NWI layers are updated infrequently and can be decades out-of-date. Newer remote-sensing technologies promise to expedite wetlands mapping, making it possible to update and expand NWI on a regular basis, but they have not yet been fully integrated with existing mapping efforts. To gauge the utility of these newer methods, we first performed automated wetlands mapping in the Otter Creek Watershed of Vermont, using LiDAR and orthoimagery, and then reviewed and edited the draft output to improve its accuracy and appearance (e.g., remove false positives). We also attributed mapped features following the Cowardin wetlands classification. The immediate goal was to produce an NWI-compliant database that would replace the existing version for the Otter Creek and provide the Vermont Department of Environmental Conservation (VT DEC) and other stakeholders with a contemporary inventory of the region's wetlands. The ultimate goal was to demonstrate the efficiency of our hybrid mapping approach and its value to a regular, frequent revision schedule. These improvements will enable VT DEC to monitor the effects of climate change and other stresses on Vermont's wetlands and to develop better strategies for preserving their essential anthropogenic (e.g., water quality, flood control) and ecological benefits (e.g., biological diversity).

Track 1C: Aquatic Invasive Species ***Adirondack C Classroom***

1C-1:Modelling the Impact of Alewife Invasion on the Food Webs of Lake Champlain

Justin Lesser, University of Vermont. Additional Authors: Rosalie Bruel, Jason, Stockwell, Ellen Marsden

Over the past 200 years, the food web of Lake Champlain has been substantially impacted by invasions, stocking programs, and species extirpations and re-establishments. In particular, the historic invasion of the Lake by alewives had the potential to significantly reorganize the distribution of biomass throughout trophic levels by expanding the prey base, thus increasing the amount of primary production available to support predator populations. Here, we seek to understand this historic change by using data from the past 30+ years collected by state and federal agencies and universities to construct biomass models of the "coldwater" food web of Lake Champlain. Using Ecopath, we assess the distribution of biomass throughout the "pre-alewife invasion" food web and use Ecosim to assess the impact of the invasion over time. We find that the pre-alewife food web was extremely predator-heavy, and thus must have featured extensive connections to food webs in other Lake areas, and/or lower-than-estimated predator population sizes; alewives may have increased the ability of predators to acquire food and therefore eventually led to the establishment of wild lake trout. This model can be used to assess the dynamics of the Lake Champlain food web in response to a host of other variables and predict its response to potential future lake trout management strategies.

1C-2: Using eDNA to Monitor Invasive Species and Factors Influencing Detection Probability

Jake Riley, Stantec Consulting

Sampling for environmental DNA (eDNA) has proven to be a reliable, sensitive, and cost-effective method for detecting a diverse suite of aquatic species in lentic and lotic systems. We have successfully used eDNA to confirm the presence of rare and threatened fish and salamanders but have also successfully field-tested assays to detect invasive aquatic vegetation and invasive mollusks in rivers, ponds and lakes, including Lake Champlain. eDNA is a powerful and sensitive sampling technology with the ability to detect a single landlock salmon (Salmo salar) in a stream for only 17 hours and 5 Northern Leatherside chub (Lepidomeda copei) 1,000 meters downstream (with a detection probability of 85% 400 meters downstream) in our caged studies, and therefore could also be a valuable tool in providing early detection for monitoring the spread of invasive species. In a 2019 pilot study on behalf of the Lake Champlain Basin Program, we sampled three sites in northern Lake Champlain and two sites in the Richelieu River for the presence of invasive quagga mussels (Dreissena rostriformis bugensis), which were reported to be present in the river north of the lake. There was no detection of quagga mussels, but extracted eDNA from each of the five sites had positive detections of zebra mussel (Dreissena polymorpha) in six out of six technical replicates, proving the vertical profile sampling methodology was successful for detecting invasive mollusks in a large lake and river systems. In Massachusetts, eDNA has also been successful at detecting multiple strains of invasive hydrilla and zebra mussels but results from two years of sampling has indicated that proximity to established populations and sample size are important factors for increasing detection probabilities. eDNA sampling has been incorporated into Stantec's fisheries and aquatic monitoring projects to augment conventional survey approaches to address research questions, however, based on our lessons learned from various case studies there are a myriad of important biotic and abiotic factors affecting detection probabilities to consider in a sampling design that will be discussed.

1C-3: Pathways of Invasion: Recreational Boater Activity, Aquatic Invasive Species Distribution, and Landscape Level Connectivity to Inform Management and Prevention in New York State

Michale Glennon, Paul Smith's College Adirondack Watershed Institute. Additional Authors: Dan Kelting

Aquatic resources are vital to the economy and ecology of the Adirondack Park and require significant investments of time and resources for detection, management, and prevention of aquatic invasive species (AIS). Since 1989, the Adirondack Watershed Institute has worked to protect water quality in northern New York state via water quality monitoring, aquatic invasive species monitoring and management, environmental science and data analysis, and broad public outreach and education. AWI's Stewardship Program is the primary vehicle for spread prevention, achieved through education, outreach, and direct engagement with recreational boaters, thought to represent the primary means by which aquatic invasive species are dispersed and spread among waterways. Longstanding investment in the region has resulted in a wealth of long-term and broad-scale data that can be used to better understand the factors that influence both the ability of invasive species to reach new areas and those which influence the likelihood of their successful establishment. We have found that a number of factors influence the levels of recreational boating activity (i.e., propagule pressure) among lakes including lake size, access features, and connections to other waterways. We have also found that some of these same factors influence the likelihood of establishment (i.e., invasibility) of AIS including Eurasian watermilfoil. A combined analysis of these two axes of invasion risk has allowed us to identify the connections and most likely pathways of spread between established AIS populations and uninvaded waterways in the Adirondacks and Northern New York and to prioritize spread prevention efforts in the region.

1C-4: Analyzing Watercraft Inspection Steward Survey Data to Inform Aquatic Invasive Species Management, Monitoring, and Prevention Efforts in New York State

Mitchell O'Neil and John Marinol, New York Natural Heritage Program.

Watercraft Inspection Steward Programs (WISPs) are an essential component of aquatic invasive species (AIS) prevention, given the role of recreational boating in the spread of AIS. Not only do these programs facilitate the interception of aquatic invasive hitchhikers on watercraft, but they increase public awareness of invasive species impacts and spread prevention measures such as "Clean, Drain, Dry". The value of WISPs is increased when data collection by stewards is standardized across waterbodies and programs. This facilitates analyses to prioritize launches and waterbodies, identify opportunities for AIS early detection, and assess the success of the program in educating the public and intercepting AIS. In the WISP coordinated by the New York State Department of Environmental Conservation, stewards across NYS are employed by a variety of organizations but report to a standard Survey123 form managed by the New York Natural Heritage Program (NYNHP). The database is reviewed

in-season by individual programs and NYNHP staff to monitor steward's findings, resulting in a robust multi-year statewide dataset. NYNHP has leveraged this dataset in several analyses aimed at providing useful information to natural resource managers, including: 1. The Hits Analysis, which compares species intercepted during receiving watercraft surveys with the species confirmed to be present at the same waterbody in iMapInvasives (the centralized invasive species database for New York), highlighting potential gaps in distribution data as well as species that may be new to the waterbody. 2. Spider Diagrams, which use the "Previous Waterbody" reported during a launching watercraft survey to infer pathways from waterbody to waterbody and highlight the likeliest pathways of AIS spread. 3. Assessing change over time in the willingness of watercraft users to verbally commit to taking reasonable AIS spread prevention measures 4. Prioritization analyses that use the WISP data to model boat traffic across the state, and identify the waterbodies at the highest risk of AIS introductions, for prioritizing management and steward placement. In this talk we will discuss the practical and research applications of a robust dataset collected by NYS watercraft inspections stewards across the state over multiple years.

Track 1D: Streams, Rivers, and Floodplains Part 1 ***Adirondack D Classroom***

1D-1: The past, present, and future of Lake Champlain: Using long-term monitoring data to determine tributary nutrient loads and guide management

Matthew C. H. Vaughan, Lake Champlain Basin Program

Lake Champlain has experienced pressure from several anthropogenic stressors, including excessive nutrient loading from developed lands and agricultural activities. As a result, Lake Champlain is the subject of several water quality restoration goals, including two Total Maximum Daily Load regulations for phosphorus. Determining the amount of water and nutrients delivered each year by major tributaries is critical for effective lake management toward these restoration goals and requires substantial investment. Further, tracking water quality improvements or deterioration and communicating analytical results for many different stakeholder groups is nontrivial. Here, I use Lake Champlain Long-term Monitoring Program data and a flow-normalization modeling technique to examine annual tributary concentrations, loads, and long-term trends for key water quality parameters: total phosphorus, dissolved phosphorus, and total nitrogen. In addition, I use new methods developed by the US Geological Survey to allow for more nuanced understanding of flow regime changes and attribution of water quality trends. In this talk, I will discuss approaches for communicating these results and associated uncertainty with policy makers, lake managers, and the lay public. This work lies at the intersection of natural resource management, optimized resource allocation, environmental monitoring, uncertainty, science communication, and environmental policy for Lake Champlain.

1D-2: Increased Winter Thaws in Northern Climates: An Emerging Threat to Lake Champlain Basin Water Quality?

Andrew Schroth, University of Vermont. Additional Authors: Carol Adair, Kathleen Lewis, Saul Blocher, Aimee Classen, Keith Mussleman, Meghan Taylor, Sonya Vogel, Julia Perdrial, Dustin Kincaid, Erin Seybold, Sonya Vogel

A pronounced impact of Anthropocene climate change has been an increased occurrence of winter thaws and nonfrozen precipitation in the winter season across much of the central and northern U.S. While the detrimental impact of midwinter high flow events due to flooding is well-documented, an understanding of their impact on water quality is less developed. Much of this is due to minimal to nonexistent water quality monitoring during winter in cold climate like Vermont's, efforts that are often hampered by ice cover and dangerous conditions. Here, we highlight the increasing importance and threat posed by these events across much of the continental U.S. based on geospatial data that was used to identify hot spots consistently exposed to winter rain on snow events and bearing labile terrestrial nutrient pools. We then examine a case study in one hot spot, the Lake Champlain Basin, where we monitored the physical and biogeochemical impact of a large winter thaw event across instrumented soil-stream-receiving water continua. Monitoring sites span soils of montane and agricultural watersheds typical of the region through their respective stream networks and into two shallow eutrophic bays of Lake Champlain. We describe the physical and chemical manifestation of the event as meltwater-derived runoff transits these continua into receiving waters, and how this compares to comparable high flow events that occur in the growing season. Findings suggest that these events can have substantial impacts on annual nutrient budgets

and receiving water quality, but event impact is variable depending on landcover/use, elevation and physical attributes of the receiving water system. We propose that water quality researchers and policy makers should increasingly consider such events as a component of water quality monitoring programs and policy given the emergent, widespread and poorly understood threat such events could pose to U.S. water quality.

1D-3: Assessing the Impact of Private Roads on Aquatic Habitat Connectivity in the Missisquoi Basin

Luke Briccetti, SUNY Plattsburgh Graduate Student. Additional Authors: Dr. Tim Mihuc, Dr. Kimberly Coleman

The Lake Champlain Basin is 66% forested, with around 80% of that land held in private ownership. Therefore, there is a need for understanding how the impact of private forest road management in the basin is impacting stream systems. This presentation will frame the need for research that assesses the impact of private road crossings on habitat connectivity, specifically in the context of Brook Trout habitat. More specifically, this presentation will give an overview of key areas that will be explored, including: identifying and mapping private crossings in both Vermont and New York; performing a large-scale survey mailing to assess the attitudes and perspectives of riparian forest landowners toward the management of road crossings; conducting field aquatic organism passage (AOP) assessments of private barriers at the subwatershed scale; and assessing the biological impact of impassable private barriers in selected stream reaches. The presentation will conclude with next steps for exploring these topics.

1D-4: Monitoring Japanese Knotweed Using Drone Imagery

Simon Pearish, Norwich University. Additional Authors: Harry Simotwo, Galen Ryan, Cynthia Fortin, Ronald Lessard

Fallopia Japonica (commonly known as Japanese knotweed) is an invasive geophyte that thrives along riparian buffers. It has adverse effects on biodiversity, the structural integrity of riverbanks, and other physical and biological processes of the riparian habitat. Here we present a novel approach to monitoring Japanese knotweed using images taken by unmanned aerial vehicles (aka drones). The current focus of the project combines aerial imagery with surveys conducted on the ground to train computer algorithms to recognize the light wavelength signature of Japanese knotweed. This multi-disciplinary project is a collaboration between faculty from several academic disciplines at Norwich University, undergraduate researchers, and middle school students and educators. It was made possible by LCBP Education and Outreach Grant funding awarded to the Dog River Conservancy, a branch of the Center for Global Resilience and Security at Norwich University.

1:15pm – 2:30pm: **Concurrent Session #2**

Track 2A: Community Engagement for Water Quality ***Adirondack AB Theatre***

2A-1: Forest Landowner Understanding of Water Quality Protection Practices: Case Study in the Lake Champlain Basin

Elizabeth Doran, Civil & Environmental Engineering, University of Vermont. Additional Authors: Kimberly Coleman

Water quality impairment in Lake Champlain requires that land owners and managers throughout the basin take appropriate mitigative action on their land, including forest land owners. The Lake Champlain Basin is approximately 66 percent forested with roughly 80 percent of that land in private ownership. Forested lands are more common in headwater locations that are spatially removed from the lake. This study therefore seeks to understand the level of concern for lake water quality and the engagement of forest landowners in the management practices occurring on their land that might mitigate impairment in downstream water bodies. The study collected 19 landowner interviews during the summer of 2019 and fall of 2020 using a semi-structured interview approach. The interviews were coded and analyzed using NVivo software. Findings suggest that landowners interviewed are not generally aware that while sedimentation from forest management activities is undesirable, coarse woody debris is a beneficial byproduct that can enhance soil and water and habitat. These findings suggest a clear need for landowner education activities that clearly address the difference between these two potential forest management impacts and what forest landowners can do to manage their harvesting activities in ways that benefit forest health without compromising downstream water quality.

2A-2: Incentives and Barriers to Adoption of Green Stormwater Infrastructure by Vermont Municipalities and Residents

Stephanie Hurley, University of Vermont. Additional Authors: Sarah Coleman, Holly Greenleaf

Green stormwater infrastructure (GSI) aims to mitigate water storage and pollution challenges in the built environment by mimicking natural systems. GSI designs use engineered soils and perennial vegetation to collect, store, and filter runoff from parking lots, roads, rooftops and other impermeable surfaces within developed watersheds. This presentation will describe the state of understanding of and application of GSI strategies among Vermont cities, towns, and private residents. Based on two recent surveys conducted with municipal officials and Vermont residents, findings will be presented regarding intentions to adopt GSI, barriers to adoption, and capacity to maintain GSI systems. Along with ecological factors, social and policy related concerns will be discussed in the context of households, neighborhoods, and watersheds, as well as across an urban to rural gradient within Vermont.

2A-3: Resilient Right-of-Ways: A Collaborative and Integrated Approach to Advance Trees, Forests, and Other Green Stormwater Infrastructure Practices in Vermont's Roadside Environments

Karl Honkonen, USDA Forest Service, Elise Schadler and Joanne Garton, Vermont Department of Forest Parks and Recreation.

This project developed a collaborative and integrated approach to advance Green Stormwater Infrastructure (GSI) in roadside environments, targeted at communities in the Lake Champlain basin that have the greatest need to manage stormwater runoff from developed urban centers and rural back roads. A a four-phase approach was utilized: 1) Identify high-priority communities for targeted technical and financial assistance to encourage and incentivize implementation of GSI practices; 2) Update state recognized best practice resources by VT Agency of Transportation: Landscape Guide for VT Roadways, to include innovative GSI practices for urban roadside environments and Better Back Roads Manual, to include innovative GSI practices for rural roadside environments; 3) Help 20 high-priority municipalities assess their urban forest and develop GSI plans; and 4) Deliver training for targeted municipalities to understand and sustain their GSI over time.

2A-4: Targeted Stormwater and Shoreline Erosion Assessments on the Lake Champlain Shoreline in Georgia, VT

Kerrie Garvey, Watershed Consulting Associates, LLC. Additional Authors: Andres Torizzo

Uncontrolled stormwater runoff coupled with dense development along the Lake Champlain shoreline in Georgia, Vermont has resulted in sediment and associated nutrient transport to the Lake. Erosive flows have the potential to threaten property and sensitive infrastructure, reduce nearshore habitat quality, and increase cyanobacteria blooms, an issue of acute concern. The goals of this study, developed by the Friends of Northern Lake Champlain (FNLC) and funded by the Lake Champlain Basin Program, were to provide a base of accurate mapping data, identify specific problem areas, and develop three conceptual engineering designs to address identified issues. This study was completed by Watershed Consulting Associates, LLC.

To locate pollution hot spots, multiple spatial datasets were overlaid and scored to classify the near shore area (0-250ft from the shoreline) into "Water Quality Risk Zones", which were used to target field assessments. The risk zones were then revised based on field collected information. The area was classified into High Risk (99 acres), Moderate Risk (15 acres), and Low Risk (117 acres) zones. Field assessments were completed in October 2020. In total, 34 shoreline assessments were completed via kayak and drone-captured photos for difficult to access areas, 25 terrestrial best management practice (BMP) assessments were completed, and 44 areas for buffer creation or enhancement were identified. Conceptual (30%) designs were completed for three of the identified projects. The assessed shoreline segments and BMP locations were ranked, and this information as well as the "Water Quality Risk Zones" will be used to guide FNLC's future outreach, planning, and BMP implementation efforts.

Track 2B: Agriculture ***Montpelier BC Classroom***

2B-1: Re-conceptualizing the Soil and Water Assessment Tool to Predict Subsurface Water Flow Through Macroporous Soils

Aubert R. Michaud, Organisme de bassin versant Baie Missisquoi. Additional Authors: David Poon, Joann K. Whalen

More water and nutrients from artificially-drained agricultural land reach surface waters by leaching through macropores than by percolating through the soil matrix. However, the Soil and Water Assessment Tool (SWAT) describes water flows poorly in land with subsurface drainage because it does not partition water between macropore and matrix transport processes. We produced a new percolation algorithm to distinguish the macropore flow pathway, which was integrated in the SWAT-MAC model and used to predict water flows in Ewing subwatershed (30 km2), a downstream Pike River agricultural tributary. The performance of the algorithm was compared to a chemical-based hydrograph separation of streamflow into distinct hydrologic pathways: groundwater resurgence, surface runoff, and tile drainage components (matrix flow and preferential flow). The separation empirical method used electrical conductivity (EC)–discharge relationships developed from the stream water EC at the subwatershed outlet and from EC values of surface runoff and tile drain water in 10 fields within the subwatershed. The four component hydrograph model revealed that 46 to 67% of the TP load at the outlet originated from surface runoff during peak flow, while tile drainage accounted for 27-29% of total load. Preferential flow was responsible for most of the particulate P (72-86%) and dissolved reactive P loads (43-85%) lost through tile drainage. Groundwater resurgence was a minor source of TP, whereas other sources such as streambank erosion and resuspended sediments contributed up to 21% of the TP load and from 36 to 41% of the particulate P load at the subwatershed outlet.

The macropore flow algorithm in the SWAT-MAC model improved water allocation between the annual surface runoff and subsurface flow. More macropore flow was predicted into tile drains under fine-textured soils than coarse-textured soils, which is consistent with experimental observations. However, macropore flow was underestimated in the non-growing season and over-predicted during the growing season, which can be adjusted in the macropore flow algorithm by accounting for dynamic macropore connectivity or effective macro-porosity. We conclude that the percolation algorithm of SWAT-MAC represents the macropore flow pathway and improves the description of water movement through agricultural soils with subsurface drainage systems.

2B-2: Phosphorus Losses in Surface and Tile Drainage from Northern New York Corn Fields

Laura Klaiber, Miner Institute. Additional Authors: Stephen Kramer, Mark Haney

To better understand the extent and patterns of phosphorus (P) loss from northeastern dairy farms, Miner Institute has instrumented corn fields in northern New York with edge-of-field (EOF) water quality monitoring stations. These stations continuously measure and sample the drainage leaving the fields as surface runoff and tile drainage and samples are analyzed for dissolved reactive P, total P, and total suspended solids. The number of fields monitored each year varied depending on the number of funded projects, but between 2014 and 2021, surface and subsurface drainage water quality from six different corn silage fields was measured under a variety of management scenarios, providing 29 site-years of data. Common amongst all fields was conservation tillage in fall and/or spring and annual dairy manure applications supplemented with inorganic fertilizers as needed according to standard agronomic soil tests. Patterns of loss for both DRP and total P were very similar. On average, 0.21 and 0.39 lbs/acre/year of DRP and total P, respectively, were lost in EOF drainage. The total P lost represented 1.8% of the amount applied over the same period. Importantly, 67% of both DRP and total P losses occurred from surface runoff, despite surface runoff producing just 17% of the total drainage from the fields. The disproportionate contribution of surface runoff to field-scale P losses relative to drainage volumes was observed across most site-years. This is a result of the substantially higher concentrations of total P in surface runoff relative to tile drainage. Therefore, the significant reduction in surface runoff that typically accompanies the installation of systematic tile drainage, does have the potential for reductions in field-scale P losses in these landscapes. However, the data demonstrates there are circumstances in which elevated P losses can occur through the tiles and these risk factors must be better understood and managed to optimize the economic and environmental sustainability of the northeastern dairy industry.

2B-3: Dimensioning and Locating Experimental Riparian Buffers Using Distributed Hydrological Modeling

Guillaume Morin, Institut national de la recherche scientifique. Additional Authors: Cedrick Guedessou, Silvio Gumiere, Étienne Foulon and Alain N. Rousseau

Beneficial management practices (BMP) generally refer to a set of structural and non-structural ways of mitigating diffuse agricultural pollution. Vegetated riparian buffers are widely accepted non-structural BMPs, but current legislation in Quebec requires a fixed and minimal width, regardless of actual field characteristics which inevitably

leads to variable performances. On the other end, physically-based models can provide a framework to design vegetated riparian buffers for a desired level of environmental performance. Among these models, distributed hydrologic models provide field-scale simulation results, such as runoff and infiltration, given various meteorological conditions. These results can then be used as input to a riparian buffer model to estimate the width of a vegetated strip given a targeted sediment trapping efficiency. This methodological framework can be applied at the watershed scale, helping stakeholders implement riparian buffers tailored to local field and meteorological conditions. This presentation will describe the application of this framework to the Castor watershed, a 14-km² agricultural watershed located in Montérégie (50 km south of Montreal, Canada). Input data included LiDAR data, hydrographic network, soil types, meteorological conditions, rooting depths, and sediment characteristics. HYDROTEL, a distributed hydrologic model was used to calculate runoff at the field scale and VFDM (Vegetated Filter Dimensioning Model for agricultural watersheds) was used to calculate riparian buffer widths. A 70% sediment trapping efficiency was used to design the buffer strips, but this target remains theoretical at this point and should be complemented by a cost-benefit analysis. Cost could include implementation and maintenance of the buffer strips, opportunity cost, while benefits should include environmental as well societal benefits. Indeed, a compromise must be found between maximizing available land for agricultural production and mitigating diffuse pollution. Concertation with local farmers is central to this research project and thus a map of riparian buffer widths was used as a communication tool to identify potential locations of variable-width vegetated buffer strips within the watershed. Modeling results will be validated through the implementation and monitoring of experimental riparian buffers at the edge of fields owned by participating farmers.

2B-4: Monitoring the Environmental Status of an Integrated Watershed Management Project Using a Suite of Indices

Etienne Foulon, Institut national de la recherche scientifique, Centre eau terre et environnement. Additional Authors: Mohamed Laabouli, Alain N. Rousseau

Determining the success of a collective project aimed at improving the water quality of an agricultural watershed requires continuous and unbiased documentation. Given the inherent complexity, inclusive monitoring at plot and river-reach scales (small scale), at the subwatershed and hillslope scales (medium scale) and at the watershed scale becomes necessary. It is also important to consider the multidisciplinarity of the project to ensure an adequate follow-up of the actions undertaken and their measurable consequences. This paper presents a comprehensive literature review with two specific objectives. First, a comprehensive review of methodology to document soil health and biota diversity, physical, chemical, biological and geomorphological integrity of watercourses was carried out in order to identify the environmental quality indices. Then, the results were used to determine how to best implement monitoring of agri-environmental practices for the Beaver Brook watershed as part of a pilot project supported by the Québec Water Strategy 2018-2030. Out of 1680 (Scopus) and 2220 (Web of Science) databases, 957 were systematically analyzed to identify the most promising indices used to track the health of environmental components of a watershed. The resulting tool includes the use of the water quality index devised by the Canadian Council of Ministers of the Environment (CCME) as well as derivative index based on harmonic averages. Sediment health and pollution is monitored using the pollution index and sediment quality index. The soil management assessment framework and the iSQAPER web app are used to monitor soil health. Integrated watershed health, including the environment health, vulnerability as well as the socio-economical context, is computed from a South Korean index. Overall, these indices will ensure the continuous follow up of the environmental status of the Beaver Brook watershed and communication to key stakeholders, alleviating one of the key hindrances to a successful collaborative project.

Track 2C: Lake Species and Habitats

Adirondack C Classroom

2C-1: A Preliminary List of Mayflies (Ephemeroptera), Stoneflies (Plecoptera) and Caddisflies (Trichoptera) from Lake Champlain with Discussion of Unique Habitats and Species of Conservation Concern

Luke Myers, Lake Champlain Research Institute, SUNY Plattsburgh. Additional Authors: Timothy Mihuc

Mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) (EPT) are common in freshwater systems and are known to be extremely useful as indicators of water quality. In addition to being useful indicators of water quality there are many species of conservation concern vulnerable to extirpation and extinction. Complete distributional data for many species is often incomplete and baseline surveys are needed for Lake

Champlain. The fauna of other large freshwater lakes has been explored in some detail for Lake Superior, Lake Michigan and Lake Erie. Other than a few scattered records in the scientific literature and a preliminary list including 3 species of mayflies and 7 species of caddisflies provided by Meyer and Gruendling (1979) the fauna of Lake Champlain remains unexplored and undocumented. Most biomonitoring studies utilize immature stages of aquatic insects in the development of indicies and rapid bioassesment protocols, however there are extreme limitations in the ability to provide species level identifications using immature specimens especially in these three orders. This lack of taxonomic resolution often requires researchers to make broad generalizations about habitat requirements, geographic range and life history strategies at the level of generic or family level groupings. Our study primarily targeted adult specimens utilizing various standard collection techniques including; light trapping, aerial netting, beating sheets, hand picking and rearing of immature specimens. We provide data on the distribution and occurrence of 23 species of mayflies (Ephemeroptera), 5 species of stoneflies (Plecoptera) and 73 species of caddisflies (Trichoptera) from 27 different survey locations throughout the lake over a 12 year period. Three species documented during our surveys should be considered as vulnerable to extinction and extirpation; Neophylax ottawa Vineyard and Wiggins, 1987 (Ottawa Little Caddisfly), Ceraclea albostictus (Hagen, 1861) (White-spotted Long Horned Caddisfly), Acroneuria frisoni Stark and Brown, 1991 (Central Stonefly). The results of these surveys should be considered preliminary, further investigations are necessary and will likely yield numerous additional records.

2C-2: Tracking Stocked and Naturally-produced Lake Trout Demonstrates Differences in Seasonal Habitat Selection

Matthew Futia, University of Vermont. Additional Authors: Aaron Fisk, Ellen Marsden

Naturally-produced (wild) adult lake trout have been largely absent (< 2%) from annual spawning surveys in Lake Champlain after five decades of stocking and nearly a decade of natural recruitment. Spawning is assessed at two near-shore sites that may attract stocked lake trout because they are close to stocking sites and hatchery effluent. We hypothesized that lake trout hatched in the lake may seek different spawning sites than those used by stocked lake trout. Our goal was to identify wild lake trout spawning locations and also compare the year-round seasonal distributions of stocked and wild adults. We tagged 45 stocked (638 ± 95 mm) and 29 wild (523 ± 97 mm) lake trout with acoustic transmitters and deployed receivers throughout Lake Champlain, with several receivers focused on putative spawning sites. Detections during the spawning season confirmed that two sites sampled during annual spawning surveys were used intensively by stocked individuals and infrequently by wild fish. However, both stocked and wild fish were detected at alternative spawning sites. Subtle differences in seasonal distributions of stocked and wild lake trout were also observed, providing insight into optimal locations for monitoring both adult populations and demonstrating different habitat preferences between the stocked and wild populations.

2C-3: Use of Genetic Tools to Assess Stocking Performance and Wild Recruitment in a Recovering Lake Trout Population

Benjamin Marcy-Quay, University of Vermont. Additional Authors: Ellen Marsden

As the native top predator in Lake Champlain and the focus of a popular recreational fishery, lake trout (Salvelinus namaycush) play an important role in the lake's ecosystem, local economies, and enjoyment by humans living nearby. After more than 40 years of annual stocking, wild juvenile lake trout are finally recruiting into the adult population. From a management perspective, this wild recruitment is a positive change but also one that raises concerns about the changing balance between predators and prey in the lake. Shifts favoring the survival of wild fish could similarly affect stocked juveniles, suggesting that the current stocking strategies may produce different results than they have in the past. Likewise, wild recruitment must be the result of natural reproduction by stocked adults, but whether those adults comprise a representative sample of all fish in the lake or are dominated by those from a single source is unknown. Stocked lake trout currently originate from one of two sources: Seneca-strain fish stocked in spring at age-1 by New York and Champlain-strain fish stocked in fall at age-0 by Vermont. However, the actual performance differences between these two strategies are also unknown. A better understanding of both the strategy-specific performance of stocked fish as well as the wild population's source and abundance are therefore needed to manage the population and inform restoration efforts elsewhere. Our ongoing work seeks to answer these questions by producing (a) contemporary estimates of stocked and wild lake trout survival, (b) strain-specific estimates of survival using genetic stock discrimination, and (c) employing close-kin mark-recapture to estimate the parental population contributing to wild recruitment. To accomplish these objectives we have

collected tissue samples from 2,230 individuals, developed a high-power genetic marker panel, and have begun generating preliminary data for a subset of fish.

2C-4: Assessing and Improving Landlocked Atlantic Salmon Restoration in Lake Champlain with Parentage Based Tagging

Kurt Heim, U.S. Fish and Wildlife Service. Additional Authors: William Ardren

Lake Champlain historically supported large river run populations of landlocked Atlantic salmon. By the mid-1800s, these populations were extirpated because of overharvest, habitat degradation, and dam construction. State and federal collaborators have been working since the 1970s to (1) provide fishing opportunities for salmon and (2) restore river-run spawning populations. Hatcheries are an integral part of these efforts and improving hatchery techniques to achieve recreational and conservation goals is a major focus. To this end, the U.S. Fish and Wildlife Service began a large-scale tagging program in 2021 to assess which stocking practices produce the highest returns to rivers and wild-spawning success. We are using parentage based tagging (PBT) to tag fish. The PBT tagging is accomplished by genotyping broodstock and organization of their offspring into lots (i.e., PBT groups). These PBT groups, comprised of unique families, provide a unique genetic tag to recognize offspring recaptured in the wild by genetic parentage assignment. From 2021 – 2024, 19 PBT groups will be released annually (~360,000 tagged fish/year) and their survival in the lake, return to rivers, and natural offspring production will be monitored through 2029. We are testing various hatchery approaches including stocking fish of various age (fry, smolt, or mature adults) and genetic characteristics (a low-thiamine tolerant strain and a genetically diverse strain) produced at White River and Dwight D. Eisenhower National Fish Hatcheries. We are also evaluating different stocking locations within rivers (e.g., upriver, or downriver) and the use of experimental net pens to increase survival and river imprinting. Results of this study will guide future decisions by mangers to use hatcheries in the most prudent ways to increase returns to rivers and improve spawning success of salmon in the wild. Moreover, implementing PBT at these hatcheries provides an exciting avenue for future studies to continue adaptive management efforts to restore wild salmon and improve fishing opportunities in Lake Champlain and its tributaries.

Track 2D: Streams, Rivers, and Floodplains Part 2 ***Adirondack D Classroom***

2D-1: Development of a Flood Forecasting System for Lake Champlain

Daniel Titze, Cooperative Institute for Great Lakes Research, University of Michigan. Additional Authors: Dmitry Beletsky, James Kessler, Lacey A. Mason, Eric Anderson, Lauren Fry, Laura Read, William Saunders, Philip Chu, Jesse Feyen, Deborah Lee

In 2016, the International Joint Commission began a $14M, 5-Year study to explore solutions to flooding in the binational Lake Champlain-Richelieu River system. The study was prompted by the record flood of 2011, which caused destruction of property and infrastructure in the binational basin. Flooding can occur in the spring as a result of rapid snowmelt and intense rain, and can be enhanced by storm surges and wind waves that build over the long north-south fetch of the lake.

To better predict and prepare for flood events, a flood forecasting system is being developed for the Lake Champlain-Richelieu River basin, which couples state-of-the-art hydrologic, hydrodynamic, and wave models. The system will resolve wind-driven spatial variability in water levels, surface waves, and the associated extent of coastal inundation, thus improving upon an existing one-dimensional model that is currently used for forecasting in the basin. The modeling framework couples the National Water Model configuration of the Weather Research and Forecasting-Hydrologic distributed model (WRF-Hydro) to a three-dimensional hydrodynamic model based on the Finite Volume Community Ocean Model (FVCOM). Wind waves in the lake are predicted by an application of the WAVEWATCH III spectral wave model, with wetting/drying in floodplain areas informed by FVCOM.

Hindcast results from the hydrodynamic model show strong agreement with water level observations both temporally and spatially, and demonstrate the model's skill in representing seasonal and storm-driven water level fluctuations. A new wave buoy was deployed on the lake in May 2021, and observations from the buoy are being used to calibrate and validate the wave model. An experimental real-time application of the forecasting system began operation in 2020.

2D-2: Quantifying the Flow Buffering Capacity of Wetlands Using the Strahler Order – The Case Study of the Lake Champlain Basin

Simon Lachapelle, Institut National de la Recherche Scientifique - Centre Eau Terre Environnement (INRS-ETE). Additional Authors: Stéphane Savary, Alain N. Rousseau

Wetlands have a direct influence on water movement through a watershed. In many cases, they can flatten flood waves and amplify low-water levels. Thus, wetland protection and/or rehabilitation should focus on those with the highest buffering capacity potential. The objective of this study was to identify which wetlands have a substantial effect on the flows of the 20 major tributaries of Lake Champlain using their locations according to the Strahler order of the hydrographic network. Our underlying hypothesis was that upstream wetlands should have an impactful buffering capacity on extreme flows when compared with those located downstream.

Using the PHYSITEL-HYDROTEL distributed hydrological modeling platform, calibrated for the Lake Champlain Richelieu River basin, segments and associated hillslopes of the hydrographic network were labelled with their Strahler order. Riparian and isolated wetlands were labelled with the Strahler order of these hillslopes. Three categories of simulations were performed where specific Strahler order wetlands were withdrawn: (i) sequentially with replacement, (ii) cumulatively from downstream to upstream, and (iii) cumulatively from upstream to downstream. To evaluate various indicators of high flows (Q2, Q20, and Q50) and low flows (7Q2, 7Q10, and 30Q5), 64-year long time series of each lake tributary outlet flows were ranked using the Weibull empirical formula.

Our preliminary results indicate the outlet flows of all 20 Lake Champlain tributaries were affected by the sequential and cumulative removals of wetlands. However, the various hydrological indicators of large subwatersheds with wetlands draining a small portion of their drainage area were not as sensitive. Generally speaking, the cumulative drainage area of wetlands represents the governing factor of the hydrological response of a watershed. Although it is widely accepted that wetlands do buffer extreme flows, using their location with respect to their associated Strahler order provided a way to determine that they do not individually affect flows with the same magnitude, but most of the time those located on first order hillslopes had the most substantial effect.

2D-3: First Instance Inundated Area Mapping Using a Zero-Dimensional Model over Small Watersheds

Camila Alejandra Gordon, Institut National de la Recherche Scientifique. Additional Authors: Zainab El Batti, Etienne Foulon, Alain N. Rousseau

The extraordinary spring floods of 2017 and 2019 severely affected properties, and thus provided significant incentives for Quebec to update current flood inundation maps. Indeed, most of these maps do not reflect actual flood risks due to the lack of information in many regions. Classical hydrodynamic models, such as HEC-RAS (1D, mixed, or full 2D), are mainly used to perform the mapping. Yet, they require significant expertise, hydrometric data, and high-resolution bathymetric surveys. Given the emergent need to update flood inundation maps and minimize associated financial costs (data collection and human resources), simplified alternative methods are welcome. Several models have been developed to fulfill this need, including the geomatic Height Above the Nearest Drainage (HAND) method, which solely relies on a digital elevation model (DEM) and a stream network. The HAND method was implemented in PHYSITEL, a specialized GIS for distributed hydrological models, and thus can provide a first-hand approach to delineate the inundated areas within a watershed. The information provided by HAND and the application of the Manning equation allows for constructing a synthetic rating curve for any homogeneous river reach. Hence, obtaining a first-instance flood analysis in areas where bathymetric data are limited.

This study compares the inundated surfaces provided by HEC-RAS and that resulting from the application of the rating curves approach based on coupling HAND with the Manning equation. This comparison is being performed on the La Raquette River basin, west of Montreal, Canada. Water depth and inundated area will be used as performance indicators. Ultimately, the effectiveness and adaptability of each methodological framework will be evaluated based on available information, implementation time, computational time, and accuracy. The comparison will show the relevance of the two methods and demonstrate the usefulness of a zero-dimensional model for first instance flood mapping.

2D-4: Toward Establishment of Filtering Vegetated Buffers: Planning Process and Acceptance Factors

Laurence Turmel-Courchesne, Université Laval. Additional Authors: Chaisse Leal, Laurie; Bourgeois, Bérenger; Morin, Guillaume; V. Guedessou Cedrick; J. Gumiere, Silvio; N. Rousseau, Alain; Poulin, Monique

Inputs of phosphorus, nitrogen and sediments in runoff is a major cause of degradation of water quality in agricultural landscapes. Innovative approaches to plan and implement vegetated buffer strips are needed to maximize their efficiency and their adoption by landowners, which is critical to ensure the maintenance of their long-term benefits. In spring and fall 2022, a field experiment will be established alongside a small stream in an agricultural area of Montérégie, Quebec, Canada. The overall aim of this project is to improve implementation techniques and selection of plant species to promote maximal survival rates and growth. Vegetated buffers will be planted with a mix of shrubs and herbaceous species or with herbaceous species only (four mixtures tested). We will also evaluate the effect of soil preparation, weed management and strategies to create a suitable environment for seeds and shrubs to establish. Herbaceous and shrub species were selected based on functional traits and additional criteria to ensure acceptability from the producer's standpoint. In this presentation, we will discuss the decision-making process that led to the selection of the species and their layout on the field. Some lessons learned from a year of dialogue with producers will also be shared.

2:45pm – 4:00pm: **Concurrent Session #3**

Track 3B: Community Action ***Montpelier BC Classroom***

3B-1: An Innovative Collective Project to Improve the Water Quality of an Agricultural Watershed

Etienne Foulon, Institut national de la recherche scientifique, Centre eau terre et environnement. Additional Authors: Alain N. Rousseau, Karine Dauphin, André Pion

Collective agro-environmental projects have not always resulted in significant improvements in water quality. To change this, a different approach becomes necessary and that is the motivation behind the Castor watershed pilot project in Montérégie, Quebec. Based on previous experiences, implementation was done using the following points: (i) farmers and other key stakeholders should be at the forefront of the process; (ii) scientific support must be provided throughout the project; (iii) realistic funding should be available to meet the objectives; (iv) agronomic expertise and environmental leadership should guide the selection of the study watershed; (v) effective collaboration between stakeholders should be managed by the Québec Watershed Organization (ROBVQ); and (vi) the project must be envisioned for eleven years. As such, the government of Québec is providing $5.2M of financial support; with $3M being allocated to the ROBVQ to support the implementation of beneficial management practices (BMP) and $2.2M earmarked for research and monitoring. The project started in March 2020 with the formation of a committee representing the twenty-five enterprises farming the watershed. With the ROBVQ and the National Institute of Scientific Research (INRS) coordinating research teams from six universities, this committee commissions projects to ensure improvements to water quality, agricultural land, sediments, soil microbiota, and air quality management without negatively impacting farm productivity. To date about 50 monitoring devices and measuring stations have been installed in the watershed to track the efficiency of the enacted research and field operations. In 2023, at the end of the first phase of the project, experimental results will allow for watershed-wide implementation of the most effective BMPs. The bottom-up approach, combined with continued funding, will ensure the sustainability of the applied practices and continued monitoring of environmental benefits. The socio-cultural benefits of this project, built from the onset with sustainability in mind, will help with the negative perception of farmers as indifferent stakeholders. Combining agro-environmental research, socio-economics, policy development, BMPs and overall education while developing a bottom-up awareness, will ensure an improvement in the environmental quality of the Castor agricultural watershed.

3B-2: Barriers and opportunities related to the implementation of agri-environmental programs in Quebec (Canada)

Faby Anne G Mimeault, Université du Québec en Outaouais. Additional Authors: Jérôme Dupras, Alejandra Zaga Mendez, Jean-François Bissonnette, Mikaël Scattolin

Governments adopt strategies and policies to reduce the impacts of agricultural activities on watercourses and aquatic ecosystems. Agri-environmental incentive programs, also referred as payments for ecosystem services (PES) programs, are conservation instruments that compensate farmers who adopt one or more agri-environmental practices. However, farmers' enrollment in PES programs remains low. If financial incentives are insufficient to encourage farmers to implement agri-environmental practices on their lands, farmers' needs, interests and values may provide clues to the design of more effective programs. Through the Quebec Water Strategy 2018-2030, our research project aims to intensify the agri-environmental shift by demonstrating the social and ecological benefits of improving agricultural practices. In particular, our research seeks to better understand socio-economic barriers and opportunities related to the implementation of agri-environmental practices in Quebec (Canada). Our research is conducted in a rural community delimited by a sub-watershed in southern Quebec, which is part of the Missisquoi Basin, a sub-basin of the Lake Champlain Basin. Inspired by the grounded

theory methodology, we conduct a literature review, field observations, and semi-structured interviews with farmers and relevant stakeholders. We reviewed the literature on agri-environmental incentive programs around the world to identify their characteristics and the ecological impacts of the practices they fund. This analytical focus formed the basis for assembling a short list of the most promising initiatives. Preliminary results reveal that the degree of financial support may well be the most important determinant of farmer enrolment at first, although other incentive measures, such as technical support and advice, should also be offered. Finally, we find that the socio-economic context must be considered when designing agri-environmental incentive programs, as this could lead to more attractive incentive programs whose adoption withstands the test of time.

3B-3: Understanding Knowledge and Stewardship Actions of the Public Across the Lake Champlain Basin to Inform Future Outreach

Kris Stepenuck, University of Vermont. Additional Authors: Jane Kolodinsky, Michael Moser, Lori Fisher

The Lake Champlain Basin Program (LCBP) and partner organizations have provided educational programs to advance public understanding of connections between land use and water quality and to foster individual to engagement in stewardship activities within the Lake Champlain basin for decades. However, public understanding of lake and watershed issues and stewardship actions have not been assessed. This hinders the ability of the LCBP and other organizations to target outreach in ways that most effectively promote public involvement in activities that minimize water quality impacts or build resilience to climate change. Broad community engagement is of particular importance in the Lake Champlain basin due to the high land to water ratio of 18:1, exceeding that of all other large lakes in North America and heightening the impact of land uses on water quality. An acre of water in the Great Lakes drains only between 1.5 acres of land for Lake Superior and 4.0 acres of land for Lake Ontario. To address this gap in knowledge and to inform future outreach, a survey of residents of the Lake Champlain basin was carried out in summer 2021. To date, over 1,500 survey responses have been received, with statistically-representative samples from residents living within Vermont, Quebec and New York's Lake Champlain watershed basin areas to examine and compare results and make outreach recommendations within and across these geographies with a high level of confidence. Both knowledge and action indices were developed based on survey questions to coalesce results and make comparisons to demographic data. Descriptive statistics characterizing lake and watershed knowledge and stewardship actions and key bivariate analyses will be shared in this presentation. In addition, key recommendations for future outreach in the basin will be proposed.

3B-4: Investigating Interventions to Increase Environmental Literacy among K-12 Teachers and BIPOC Students

Jillian Kara, SUNY Plattsburgh. Additional Authors: Dr. Kimberly J Coleman

This presentation will report on a partnership between the Center for Earth and Environmental Science at SUNY Plattsburgh, the Rubenstein School of Environment and Natural Resources at the University of Vermont (UVM), UVM Extension, Upward Bound at both SUNY Plattsburgh and UVM, and the Lake Champlain Sea Grant Watershed Alliance Program. The goal of the partnership is to provide K-12 teachers with resources and training to aid in the successful integration of interdisciplinary watershed science curricula, while also providing an entry point for potential first generation college students to the field of watershed science, and show them the opportunities that exist for them in that field. We conducted pre/post-test surveys with the students to understand if this programming changes the students' interest in watershed science and the field of natural resources more broadly. Our presentation will report on the findings from the analysis of the pre/post-test surveys and will make recommendations for future work.

Track 3C: Phytoplankton and Data Collection *Adirondack C Classroom*

3C-1: Changes in Lake Champlain Phytoplankton Community Composition and Distribution From 1970 to 2020

Kayleen Snyder, Lake Champlain Research Institute. Additional authors: Timothy Mihuc

Phytoplankton make up the basis for most aquatic food webs, making them vital for freshwater ecological processes. Changes in phytoplankton composition and distribution threatens energy flow throughout the food chain and the overall health of the lake. Using monitoring data from Lake Champlain Research Institute and Long Term Monitoring Program (LTM), we compared composition and distribution of the phytoplankton community in Lake Champlain in1970, 2005, and 2020 at 7 different sites. This study is a continuation of a study done in 2005 comparing phytoplankton community composition and distribution from 1970 to 2005 in Lake Champlain. By including data from 2020 we will be able to examine long-term patterns in Lake Champlain's phytoplankton community and relationships with physical, biological, and chemical variables in Lake Champlain. Phytoplankton samples from 1970 were collected using a Van-Dorn bottle at a vertical distance of 5m and filtered through a #20 silk bottling cloth. The 2005 and 2020 data were collected using a 0.63-micron mesh Wisconsin plankton net pulled vertically at a depth of twice the secchi depth. We examined 5 main algae groups, including Cyanobacteria,

Chlorophyceae, Desmids, Diatoms, and Protozoa. Changes in composition and distribution were determined by comparing percent abundance seasonally and species rank order for 1970, 2005, and 2020. The most significant change observed was an overall increase in Cyanobacteria from 1970 to 2020 and a shift in dominant Cyanobacteria to Microcystis in recent years.

3C-2: Algal Growth in Lake George, NY as an Indicator of Water Quality Impacts from Land Use – Analysis from 2020 and initial results from 2021

Brea Arvidson, Lake George Association. Additional authors: Chris Navitsky

Harmful Algal Blooms (HABs) pose a worsening threat to water resources and communities in the Lake George basin. Algal bloom complaints and observations have been increasing throughout recent years; however, 2020 marked the first official HAB documented in Lake George and 2021 saw additional HABs in July, September and October. Understanding that land use impacts water chemistry and periphytic algae are a higher-sensitivity organism than higher order biota (e.g. macroinvertebrates), we can use periphytic algae an effective tool that can indicate natural and anthropogenic changes that may not be detected by chemical monitoring alone.

This study uses collection, analysis, and field observation of periphyton biomass, algal community composition, and periphytic diatom identification to provide insights into the influence of groundwater and land use on the near-shore water quality of Lake George. After a 4-week period, periphyton samples were collected in July and September 2020 and 2021 from clay tiles stationed at 1m in Cook Bay and Oneida Bay, and 1m and 4m in Dunham's Bay in Lake George. Additional 1m sites in Huddle Bay and the Narrows were included in 2021 for additional site diversity in the study. The preserved samples were analyzed using USGS NAWQA protocol and diatom community metrics were calculated.

From analysis of the initial season results, we establish a composition baseline for each bay that can be used to determine seasonal changes, change at deeper sites, annual trends, and comparison between the bays.

3C-3: Developing low-cost cyanobacteria, algae, turbidity, and temperature sensor systems for water quality monitoring of Lake Champlain waterfront areas

Clayton Williams, Saint Michael's College. Additional authors: Tian Xia; Jessica Sheridan; Wenzhe Chen; Ana M. Morales-Williams

Cyanobacteria and algal blooms pose major ecosystem management, public health, and recreational use challenges in Lake Champlain. Nationally recognized, community and state lead cyanobacteria monitoring programs provide a wealth of information about the water quality of Lake Champlain's beaches and shoreline, but these data are not always accessible by the public in real-time and not always in the format, frequency, and/or quantitative unit needed by some scientific research applications. Sensor systems could be used to enhance current monitoring programs, but the cost of sensor systems often exceeds the budget of research and community science water monitoring programs. Given the cost limitations of commercial sensors, we are developing our own open-source and low-cost water quality sensor system. Our sensor system is designed to communicate with Burlington's smart city low power, wide area network (LoRaWAN) and costs a fraction of the price of commercial sensors (around 300 USD at present). We believe our sensor system will produce affordable and reliable data that will increase the spatial and temporal scope of community and academic research science programs in Lake Champlain. Once deployed, our sensor system will provide real-time, quantitative data on bloom conditions along public beaches, which would complement existing community and state cyanobacteria monitoring programs and provide additional identification of cyanobacteria blooms. Our sensor design is based around a 3D printed fluorometer that measures chlorophyll a fluoresce (phytoplankton biomass; µg-chl/L), phycocyanin fluorescence (cyanobacteria presence; µg-PC/L), turbidity (near infrared light scatter; FTU) and water temperature (°C). The sensor system is run using a microcontroller built on Arduino Software (IDE). The sensors are enclosed within a kid's lunchbox-size, waterproof pelican case equipped with a peristaltic pump and communications antenna. The sensor system has a similar detection range as commercial sensors and works in the dark as well as under full sunlight. We are currently designing printed circuit boards for the electronics and running laboratory testing of the system. Our sensor system will be deployed for in-lake testing starting spring of 2022. We hope to deploy sensor systems at public and private beaches from Blanchard to Crescent Beach.

3C-4: A Shiny app for the interactive display of near real-time data from the Upper Saranac Lake Environmental Monitoring Platform

Brendan Wiltse, Paul Smith's College Adirondack Watershed Institute

Continuous near real-time data collection and reporting is becoming increasingly commonplace among limnologists and aquatic ecologists. These systems range from simple temperature loggers to complex lake profiling platforms. The high temporal resolution has allowed for a deeper understanding of ecosystem function and process. A significant challenge of managing these systems is data handling and display. In some cases, the data collected may be valuable to other researchers and the public. Since May 2017, the Paul Smith's College Adirondack Watershed Institute (AWI) has managed a near real-time environmental monitoring platform on Upper Saranac Lake. The platform collects meteorological and lake profile data from the lake and transmits the data to the AWI lab through a cellular connection. Both the meteorological and lake profile data are of interest to local communities because of their relevance to boater safety and recreational activities such as fishing. Maintaining a website to display these data has been a significant challenge. In April 2021, AWI built an entirely new web interface from scratch using R and R Shiny. The website displays more data than in the past and allows users to interact with it in different ways. In addition, much of the data QA/QC and cleaning process is now done through R scripts scheduled as cron jobs. Cron jobs are also used to post twice-daily updates, including a photo from the platform camera, to a dedicated Twitter account. Posting data to Twitter has increased public engagement and awareness of this valuable tool. Finally, additional functionality is in development to allow the platform to dynamically respond to direct messages on Twitter. Direct messaging will enable the public to message the platform with specific requests, such as the current water temperature or wind speed, and receive a response with the most recent data. The codebase for this project is publicly available through GitHub. We believe that public engagement and understanding of the value of environmental data are fundamental to the long-term protection of the environment. The creative use of social media and modern computer programming tools allows us to create new and more engaging tools for the public.

Track 3D: Municipal/Developed Lands Infrastructure ***Adirondack D Classroom***

3D-1: Subsurface horizontal-flow gravel wetlands in Vermont – permitting, performance, and chloride concerns

Andres Torizzo, Watershed Consulting Associates. Additional authors: Eric Roy, Donna M. Rizzo, Nisha Nadkarni

Subsurface horizontal-flow gravel wetlands (SHGW) are water treatment practices that use a saturated layer of gravel and wetland vegetation to filter stormwater and remove pollutants. In recent years, the implementation of SHGWs has proliferated among Vermont municipalities to meet impending phosphorus (P) control requirements under state stormwater permit applications. While the 2017 Vermont Stormwater Management Manual provides overall guidance for design of SHGWs, the design specifications (e.g., treatment cell configurations, types of gravel media, and wetland muck composition) for these permits are vague. The impact of these design nuances on practice performance is not well researched and the lack of performance data poses concerns about P and chloride impacts on surface waters in the Lake Champlain Basin. To evaluate hydraulic performance, P capture, and chloride dynamics, two SHGW systems located in Burlington and Essex Junction, VT are being monitored over a two-year period. Automated water sampling units collected composite samples over 20 individual storm events for subsequent water quality analysis. Area-velocity sensors and volumetric weirs at each inlet and outlet location were deployed to measure total flow entering and leaving each system. Year 1 results suggest that flow attenuation is highly variable in each system and is typically influenced by the total rainfall, the presence of baseflow 24 hours before a storm, and the design characteristics of the selected gravel media and wetland muck. The engineered wetland muck used in both systems contributes to a greater export of total P (TP) from both systems than TP import. Road salt application near the Burlington-based SHGW introduces acute levels of chloride that likely contribute to poor vegetation performance and therefore reduced pollutant removal. The sites are currently being monitored for a second year. Findings from the two-year study period will provide further guidance on SHGW design specifications and inform State stormwater regulators.

3D-2: Subsurface horizontal-flow gravel wetlands in Vermont – material selection impacts on performance

Eric Roy, University of Vermont. Additional authors: Marcos Kubow, Andres Torrizo, and Donna M. Rizzo

Subsurface horizontal-flow gravel wetlands (SHGW) are water treatment practices that use a saturated layer of gravel and wetland vegetation to filter stormwater and remove pollutants. In recent years, the implementation of SHGWs has proliferated among Vermont municipalities to meet impending phosphorus (P) control requirements

under state stormwater permit applications. While the 2017 Vermont Stormwater Management Manual provides overall guidance for design of SHGWs, the design specifications (e.g., treatment cell configurations, types of gravel media, and wetland muck composition) for these permits are vague. The impact of these design nuances on practice performance is not well researched and the lack of performance data poses concerns about P and chloride impacts on surface waters in the Lake Champlain Basin. As a complement to our ongoing field study of gravel wetlands, we have completed a series of laboratory studies to determine the roles of materials used in SHGWs on P and chloride dynamics. Lab results indicate that some engineered wetland mucks will likely release substantial amounts of P post-installation, while gravels have limited ability to sorb dissolved P. Engineered mucks also largely failed to meet hydraulic conductivity targets. Neither engineered wetland mucks nor gravels substantially influenced chloride concentrations in our lab testing. We have developed new recommendations to guide the selection of materials for the wetland muck layer.

3D-3: Nitrate Reduction from Woodchip Bioreactor Technology at a Small Community Treatment Plant

Chris Navitsky, Lake George Waterkeeper. Additional authors: Jim Sutherland, PhD; Kathy Suozzo, P.E.

Excessive amounts of reactive nitrogen (Nr) entering aquatic ecosystems accelerate eutrophication. The circa 1960 Town of Bolton Wastewater Treatment Plant, Warren County, New York (USA) historically discharged plant effluent for final polishing to natural sand infiltration beds which entered the ground water and then Lake George tributaries. The lack of a denitrification unit process at the Bolton plant resulted in the construction of a woodchip bioreactor demonstration project for denitrification of plant effluent prior to sand bed discharge. This denitrifying bioreactor (DNBR) installation was the first real time, in-situ application of this “green technology” for a small wastewater treatment plant world-wide. The Bolton DNBR reduced nitrate-nitrogen concentrations in the tertiary effluent by ~38 percent when compared with untreated tertiary effluent. This presentation will evaluate using this passive environmentally compatible technology, which combined with diligent operator attention, could be implemented into actual full-scale field applications using lessons learned at the Bolton facility to guide future installations as well as detail the variables that affect treatment efficiencies. Recommendations will be presented to improve the technology for the possible future implementation of woodchip bioreactors.

4:00pm – 5:00pm: **Poster Session**

P-01: Bird and pollinator friendly farming practices co-benefit clean water, healthy soils, and climate solutions in the Lake Champlain Basin

Cassandra Wolfanger, Audubon Vermont and Lake Champlain Sea Grant

Intensification of agricultural practices over the last several decades has contributed to soil erosion, eutrophic conditions in many waterbodies, and biodiversity loss. Habitat has further been degraded by crop monocultures and exotic species invasions in disturbed landscapes. In concurrence, many bird species, especially aerial insectivores, have experienced population declines at alarming rates. Important native pollinators like bumblebees are also declining, with several wild species already extirpated in Vermont. A response to these trends has been to incorporate conservation enhancements into agricultural practices to benefit wildlife, clean water, and soil health. Audubon Vermont and the Gund Institute at the University of Vermont have partnered for an initiative that promotes on-farm habitat for birds and pollinators, focused on areas out of production (i.e., hedgerows and fallow fields), grasslands, forest patches, and riparian areas. We aim to help farmers to create structurally heterogeneous and resilient habitats composed of diverse native species. Removing invasive plants, cultivating diverse crops, reducing pesticide use, incorporating bird and pollinator friendly seeds into cover crop mixes, and erecting wildlife structures can increase the abundance and diversity of pollinator and bird species that in turn provide important on-farm services, such as crop pollination and pest control. Further informed by Lake Champlain Sea Grant and UVM Extension’s Watershed Forestry Program, we have promoted habitat in riparian zones that can intercept surface run-off and mitigate flooding to co-benefit water quality while sequestering carbon. Here we present the current status of the program and future goals. To date, we have developed management plans for 15 Vermont farms, conducted surveys for birds and pollinators, recommended planting and/or cutting options, and assisted with application for cost-sharing opportunities. Our work aims to support long-term productivity of the land and financial sustainability of farm operations and we plan to display our work on high-visibility demonstration sites. We will document the ecological and economic benefits of these practices by researching literature on the most efficient and practical methods and working on-the-ground with farmers. We seek to better understand their

motives, interests, and abilities to incorporate conservation practices on their farms that co-benefit wildlife, water, soil, and climate.

P-02: Statistical meta-analysis of agricultural BMPs and BMP group performance

Brendan Lombard, Undergraduate Researcher. Additional Authors: Dr. Elizabeth Doran

Eutrophication threatens freshwater quality and is oftentimes exacerbated by agricultural practices that produce nutrient rich runoff. This can lead to harmful algal blooms, like those observed in Lake Champlain's Missisquoi Bay, which may grow more severe in a changing climate. Farmers can adopt agricultural best management practices (BMPs) to reduce the nutrient concentration in the runoff from their farms; however, the reported efficacy of these practices is highly variable, with a range of efficacies frequently reported for a single management practice. Furthermore, there is a lack of data specific to Vermont's Missisquoi basin. Water quality BMPs often overlap with those used by farmers to mitigate the impacts of climate change to their farms as well. A database, consisting of eight BMPs, their observed reduction efficacies and 20 variables, was constructed; the meta-analysis of which provided weighted average reductions in total phosphorus (TP) and total nitrogen (TN) for each BMP. The Integrative Assessment Model (IAM) is an agent-based model used to predict algal blooms in the Missisquoi Bay under different climate change, economic, and LULCC (land use and land cover change) scenarios. The model also predicts probability of BMP adoption among farmers and assumes certain performances of these BMPs. This study obtains informed, weighted estimates of TP and TN reduction efficacies for BMPs and BMP groups and compares them to the assumptions used in the IAM to better inform the model, and thus provide a better understanding of the future state of the lake and the role BMP's play in the lake system's resilience.

P-03: Temporal effect of green manure use on soil microbial community in field cropping systems

Thiago Gumiere, Université Laval. Additional Authors: Carl Lalonde-Haman, Jhemson Brédy, Silvio J. Gumiere, Caroline Halde, Cedrick V. Guedessou, Etienne Foulon, Alain N. Rousseau

Agricultural production has been classified as the second activity responsible for greenhouse gas emissions and the first for terrestrial acidification and eutrophication. Thus, the development of sustainable soil management in agroecosystems is crucial. The use of green manure as a cover crop has shown positive results in improving soil quality. Green manures may promote soil decompaction, nematode control, and protection against erosion, also increasing nutrient cycling and phosphorus bioavailability. However, the effect of green manure use on the soil microbiome remains unclear, limiting the development of soil microbial indicators more suitable for agroecosystems. As part of the Quebec Water Strategy 2018-2030 (SQE), our project aims to evaluate the effect of green manures on the microbial community, soil physical properties, and the hydrological response in field cropping systems of the River Brook basin located in Montérégie, QC, Canada. The selected fields have a gradient in the history of green manure use (control field without any green manure, 18 months, and five years of green manure use). The expected results will allow us to i) understand the chemical and physical conditions of the soil, as well as the leaching of nitrites and nitrates in the drainage water associated with the field history of green manure use; ii) establish the dynamics of the soil microbial community (structure and taxonomic composition, microbial interaction, and functional prediction) over time depending on green manure use, compared to a control field; and iii) designate new molecular microbial indicators of soil health associated with green manure use. Overall, this project will ensure a proper build-up from experimental scale to watershed scale in the application of best management practices is possible for the benefits of the whole Beaver Brook watershed.

P-04: Wool and Water: Environmental Education through Participatory Fiber Arts

Michale Glennon, Paul Smith's College Adirondack Watershed Institute

The Clean Water Act is among the most important pieces of environmental legislation in US history and provides vital protection for the nation's waterways. The Paul Smith's College Adirondack Watershed Institute was awarded a grant from the Champlain Valley Natural Heritage Partnership to support education and outreach activities associated with next year's 50th anniversary celebration of the Clean Water Act. A key component of our activities is a collaborative fiber arts project to celebrate the rural, agricultural, and artistic heritage of the region and promote place-based STEAM experiences. Using long-term monitoring data from the Lake Champlain Basin Program, we are engaging with participants in the representation of changing water quality conditions with knitting, crochet, and other fiber arts in order to create permanent visual representations of how the lake has changed over time. The project is occurring over a 15-month period with special observations and display of resulting products during Water Week 2022 and International Water Day on March 22, 2022. In

preparation, we created Wool and Water, a display of knit and crochet items that illustrate the representation of scientific data with fiber arts. The display features a number of items ranging from decorative to wearable with which are illustrated several water quality concepts and long-term trends ranging from road salt impacts to climate change to microplastic pollution. The Wool and Water display has generated a large interest among regional audiences who plan to participate in the project. To date, it has been displayed at the Paul Smith's College Visitor Interpretive Center and at Traditional Arts in Upstate New York (TAUNY) and will travel to additional venues and be used as a teaching tool through the duration of the project. It has also has been the subject of radio and webinar interviews and presentations. We will use a poster format to display a number of items from Wool and Water and to illustrate the blending of science and art as a means of environmental education and engagement. Associated text will explain the items displayed and the means by which interested attendees may participate in the project.

P-05: Characterization of Viral and Bacterial Dynamics in Lake Champlain Cyanobacterial Harmful Algal Blooms

Briana Gifty and Johson Atanga, Middlebury College. Additional Authors: Erin Eggleston

Harmful cyanobacterial blooms (CHABs) are a growing concern for Vermont's freshwater aquatic ecosystems. These cyanobacteria produce a multitude of toxins which can be detrimental to wildlife and people including neurotoxins, hepatotoxins, and cytotoxins. In recent years the increase in CHAB prevalence has been associated with environmental changes such as eutrophication of lakes. As a result, the approaches to combating increasing CHAB frequency and severity have been largely geochemical. However, CHABs are increasing in oligotrophic aquatic environments as well, suggesting a gap in our understanding of CHAB formation and decline. Adjusting lake nutrient levels has not sufficiently decreased the prevalence of CHABs. With this knowledge we have decided to take a more holistic microbial community and ecological approach. Viruses present in aquatic ecosystems can often infect cyanobacteria hosts and lyse them. In summer 2021 we collected water samples from various locations in Lake Champlain to analyze the lake virome compositions. Using epifluorescence microscopy we compare bacterial, virus-like particle, and cyanobacterial counts to data from previous summers. Viral and bacterial DNA was extracted to generate metagenomic and viromic data for microbial community analyses. Additionally, we attempted to culture and isolate cyanobacterial species from the Gloeotrichia and Dolichospermum genera. With this research we hope to further understand the microbial community structure and function of Lake Champlain CHABs and identify potential CHAB mitigation strategies.

P-06: Baseline Phosphorus Monitoring in Preparation for a Watershed Action Plan for Lake St. Catherine

Andrew Vermilyea, Castleton University. Additional Authors: Chris Ciccarelli

Lakeside homeowners in Vermont are becoming increasingly interested in the water quality of the lakes they live on in order to protect investments, their health, and the health of the aquatic ecosystem for generations into the future. The Lake St. Catherine Association (LSCA) in partnership with the Poultney Mettowee Natural Resources Conservation District (PMNRCD) and Castleton University have been awarded funding by the Lake Champlain Basin Program (LCBP) to initiate this multi-faceted work. One aspect of this project is to characterize the input of sediment and phosphorus from the tributaries that flow into Lake St. Catherine. A Castleton University, undergraduate student driven project was initiated to (1) establish a fixed stream monitoring station on the main tributary at Endless Brook; (2) measure and analyze suspended solid and total phosphorus (TP) concentrations; and to (3) explore the role of land use and land cover (LULC) on water quality. Continuous discharge and correlations between TP concentration and discharge has led to preliminary determinations of TP export for comparison to other watershed in the Lake Champlain basin. The next steps will include surveys of other tributaries in conjunction with LULC assessments via GIS to discover the role of any specific LULC types on the observed trends in TP export, which will be used to inform the watershed action plan for the lake.

P-07: Consequences of Winter Thaw and High-Flow Events on Nutrient Loading into the Lake Champlain Basin

Sonya Vogel, University of Vermont. Additional Authors: Carol Adair, Meghan Taylor, Andrew Schroth

Winter hydrology has historically been characterized by persistent cold temperatures and snowpack, resulting in limited nutrient mobility due to low streamflow and hydrologic connectivity. However, changing winter dynamics in the northeastern United States have increased the frequency and magnitude of winter thaws and rain-on-snow events. In northwestern Vermont, these events contribute to the occurrence of mid-winter high-flow events with presumably enhanced winter nutrient loading. Yet, the difficulty of measuring nutrient export during the winter

has created a gap in our understanding of how these events impact water quality. In this work, we are seeking to improve our quantitative and qualitative understanding of these events with focus on their contribution to nutrient loading in select tributaries of Lake Champlain that are monitored by the Vermont Department of Environmental Conservation during the growing season. Our field work comprises five rivers within the Lake Champlain Basin- three of the largest tributaries to the Lake (Missisquoi, Winooski and Lamoille Rivers) that have snowmelt regimes dominated by weather and melt that occurs in the Green Mountains, and two smaller systems (Mill and La Platte Rivers) that are mostly impacted by Champlain Valley weather and snowpack dynamics. In 2022 we captured multiple winter thaw events, with substantial impacts on nutrient budgets for each site. However, there was significant variability in the relative impact of each event on nutrient loading between sites and between events. Furthermore, the relative impact of these events on loading varied substantially between different forms of nutrients across sites. We use nutrient hysteresis metrics coupled with analysis of event snow and melt characteristics to explore hydrologic mechanisms that could be responsible for nutrient behavior during these events. We clearly demonstrate that these events constitute a significant proportion of annual nutrient loads into the Lake Champlain Basin that will likely continue to increase as the climate changes. Their contribution to nutrient loading is crucial to consider in the policy made to protect the water quality and health of watersheds within the Lake Champlain Basin.

P-08: Using a variety of diet tracers can help managers stay one step ahead of the next big invasion

Ariana Chiapella, University of Vermont. Additional Authors: Jason Stockwell, Martin Kainz, Ellen Marsden

Invasive dreissenid mussels have caused a shift from pelagic to benthic production, and consequently, declines in key invertebrate and fish species in large lakes in North America and western Europe. These predictable impacts can inform expectations of future system productivity – but only if the food web structure is well described. In Lake Champlain, an imminent quagga mussel (Dreissena bugensis) invasion is expected to stress forage fish populations by reducing primary and secondary production. Further, a recent surge in wild lake trout (Salvelinus namaycush) recruitment, added to constant hatchery stocking, may increase top-down pressure. To evaluate the risk quagga mussels pose to forage fishes alewife (Alosa pseudoharengus) and rainbow smelt (Osmerus mordax), we estimated the relative importance of pelagic and benthic energy pathways using Bayesian stable isotope mixing models with stomach contents as priors. We also analyzed fatty acid profiles and compound-specific isotopes on a subset of samples for further inference. Preliminary results suggest the pelagic energy pathway is dominant for both species, leaving them vulnerable to the impacts of a quagga invasion. Adjusting piscivore stocking rates may relieve pressure on forage fish after quagga mussels arrive in Lake Champlain. Using a variety of dietary tracers provides a robust approach to evaluating how food webs may respond to species invasion.

P-09: Artistic Interpretations on How Pollution Impacts the Lake Champlain Watershed

Jill Serrano Michalsky, BluSeed Studios

A team of artists including members of indigenous communities in the North Country are collaborating with lake ecologist Curt Stager from Paul Smith's College on a year-long project to create art focused on water pollution in the Lake Champlain Basin. The works will blend science and the arts in order to help raise public awareness about the ecological condition of the Champlain watershed and encourage residents to reduce their impacts on the basin. The artists will offer public presentations of their work and share how it was guided by scientific information provided by Dr. Stager, concluding with a month-long exhibit at BluSeed Studios in Saranac Lake, NY, in June 2022. The interdisciplinary, multi-cultural project is being funded by the United States Environmental Protection Agency and New England Interstate Water Pollution Control Commission (NEIWPCC's) in partnership with the Lake Champlain Basin Program.

P-10: Our Scrumptious Lake: Phyto-tastic!

Sandy Murphy Independent Literacy Consultant and Tutor. Additional Author: Karen Neeson

Our poster presentation promotes a message expressed by Dan Egan (keynote speaker at the Lake Champlain Conference in Burlington,VT. January 2018) that we literally took to heart, “everyone needs to be educated about the health of our lakes, not just scientists”. This became the catalyst to create a graphic novel focusing on Lake Champlain’s ecosystem and watershed, tailored for middle grade students but appealing to all water lovers. Our humorous interdisciplinary story is a learning resource perfectly suited for science classes, aligned with Next Generation Science Standards and Common Core State Standards. Abenaki culture, Vermont natural history, and social-emotional health are embedded throughout. To ensure our book depicts an accurate representation of Lake Champlain’s cultural heritage and natural history, we sought reliable resources, consulted

with relevant organizations and Abenaki tribe members. The intention of our multi-sensory interactive poster presentation is to inform and recruit diverse, equitable and inclusive communities to care and protect our lakes. Our goal is to evoke wonder, stir empathy, give hope, beckon lake stewardship and forever change one's perception of Lake Champlain. As mothers and educators, we recognize learning is most engaging when content connects with one's heart. Snapshot of Authors: Sandy Murphy was raised on a dairy farm along Lake Champlain. Through her playful exploration of Lake Champlain's expansive shorelines, she has witnessed the beauty of its ever changing moods, landscapes and harshness of its declining health. As an educator, Sandy is inspired by her students' curiosity. As a special educator and reading specialist she has extensive experience with engaging students of all ages and skills. Karen Neeson grew up along the west coast as the daughter of a commercial fisherman but found her true home in Vermont. Karen has a strong connection and respect for water and its diverse ecosystem. As a visual arts and literacy teacher she integrates her skills in art, music, puppetry, and movement with diverse populations.

P-11: Paleolimnological data synthesis to assess and predict long-term ecological change in Vermont inland lakes

Ismar Biberovic, University of Vermont. Additional Authors: Ana Morales-Williams

Lakes in Vermont are experiencing rapid ecosystem scale change in response to anthropogenic pressures, including land-use and climate change. Monitoring records of Vermont lake ecosystems span several decades, but understanding long term change between the pre-colonial settlement period and the present requires proxy approaches. Diatom assemblages are excellent paleolimnological proxies for understanding past environmental conditions and water quality in lakes. Their sensitivity for climatic and limnological parameters is well documented, as well as diverse habitats they colonize. In order to assess long-term, landscape-scale change in Vermont inland lakes, we used the paleo-diatom record from 103 inland Vermont lakes to reconstruct past conditions and infer ecosystem response to disturbance and environmental change. Anthropogenic pressures such as nutrient loading, deforestation, soil and lake acidification, soil degradation and climate change, can significantly alter primary producer community composition and ecosystem function. Anthropogenic alterations in watershed land use can also cause a shift in nutrient, carbon and hydrological regimes, and, as a result, alter diatom assemblages. The objective of this study is to identify environmental drivers that best predict diatom community turnover between two time periods, pre-European settlement and the present. We analyzed diatom species richness from the top and bottom of 103 inland lake sediment cores to investigate the turnover of diatom assemblages between the pre-colonial time period and present. Our preliminary results suggest that at a landscape scale, the main driver of community turnover in Vermont lakes is alkalinity, followed by pH, then total nitrogen (TN) and phosphorus (TP) concentrations, with variability in community turnover between lakes. Ongoing work will incorporate land-use data into our analyses. Understanding lake response to environmental disturbances is crucial not only for water quality and conservation efforts, but also to fully understand long-term cross-ecosystem ecological change in response to anthropogenic disturbance.

P-12: Assessing Internal Phosphorus Loading in Lake Carmi in Response to Whole Lake Aeration

Ashton Kirol, University of Vermont. Additional Authors: Andrew Schroth

Anthropogenic eutrophication degrades water quality and induces harmful cyanobacteria blooms in freshwater lakes. Recovery is often delayed by the continued cycling of phosphorus between lake sediment and the water column in shallow lakes, even after external nutrient loads are reduced. Low dissolved oxygen concentration at the sediment water interface is a strong driver causing bioavailable phosphorus to be released. The state of Vermont implemented an aggressive engineering intervention designed to suppress internal phosphorus loading in Lake Carmi (part of the Missisquoi Bay watershed) through water column aeration. This study assessed physical and biogeochemical changes in Lake Carmi in response to multiple years of aeration using high frequency water column sensors, daily water collection, and monthly sediment core data. Time series analysis and modeling was used to quantify internal phosphorus loading in response to natural and aerated scenarios. These results show that aeration reduced lake stratification, leading to more frequent mixing throughout the summer and fall. The bottom layer of low dissolved oxygen (< 2.5 mg/L O2) was reduced in thickness and duration under aerated conditions. The system became more dynamic and responses to pauses in aeration led to rapid stratification and instances of high internal loading and subsequent mixing. This led to an earlier increase in total phosphorus in the water column compared to the natural system. Modeling was used to simulate a season of continued aeration for comparison. This study shows that whole-lake aeration can be a useful approach to aid shallow eutrophic lake recovery, but

results are highly dependent on weather and uninterrupted operation of the system. These results will inform the viability of aeration as an intervention for internal phosphorus loading in Vermont lakes and more broadly.

P-13: Invasive Predatory Cladocerans Alter Lake Champlain Zooplankton Community

Zachary Cutter, Lake Champlain Research Institute. Additional Authors: Tim Mihuc, Luke Myers

This presentation will explore the changes to the zooplankton community of Lake Champlain brought on by the two invasive zooplankton species, Bythotrephes longimanus invading in August of 2014 and Cercopagis pengoi in August of 2018. Continuous sampling through the 2010's has found that many key species have been impacted by both invaders. The most apparent change is the reduction of Diacyclops thomasi by both invaders and a reduction in Daphnia retrocurva following the introduction of Bythotrephes. Both species are common throughout the lake and thus are an important food source for many organisms. Other cyclopoids, bosminids, and rotifers were also reduced corresponding to both introduced species. The two invaders are unable to coexist with each other or the native predator Leptodora kindtii, displaying seasonal partitioning between their populations. In summary, these findings suggest that the invasion of both Bythotrephes longimanus and Cercopagis pengoi in Lake Champlain have impacted the pelagic zooplankton community structure. Some changes appear to be short term responses while others may result in long-term shifts in community structure.

P-14: Predictive Modeling of Road-salt Related Chloride Pollution within Aquatic Systems of the Adirondack Park and Associated Watersheds

Jesse Rock, Master's Student Paul Smith's College. Additional Authors: Brendan Wiltse

Paved highways are major features of the modern landscape and primary sources of runoff carrying pollutants like de-icing salt into their surrounding landscapes. The negative effects of road salt are broad both in scale of impact and spatial extent. While studies have been conducted looking at where road runoff ends up within the Adirondack Park, there has not been an attempt to predict the severity of pollution levels in individual aquatic systems. The objective of this research was to develop a predictive model that uses roadway type and flow accumulation models to predict chloride pollution levels in aquatic systems within the Adirondack Park and its associated watersheds. The purpose behind the creation of this model was to predict the range of surface water chloride concentrations in streams and lakes within the Adirondack Park as an extensive monitoring system doesn't exist, along with identifying possible sites of impairment. We trained a random forest model using mean late-summer chloride data from over 90 sites in the Adirondack region as the response variable and road runoff flow accumulation coefficients, latitude, longitude, elevation, mean watershed slope, and waterbody type as explanatory variables. Additional field sampling was conducted to further validate the model's performance. Our model could be used as a tool to improve best management practices regarding road-salt application by looking beyond simple road proximity to an aquatic system and to the cumulative impacts of upstream chloride from all roads within a watershed or reach.

P-15: Long Term, High Frequency Measurements of Environmental Soil Parameters Illustrate the Relationship Between Soil CO2 Emissions and Winter Warming Conditions and Variable Snowpack in Lake Champlain Riparian Zones

Meghan Taylor, University of Vermont. Additional Authors: Carol E. Adair; Andrew Schroth; Dustin Kincaid

In snow-covered regions, such as the Lake Champlain Basin (LCB), climatic shifts, are changing winter dynamics with potentially strong effects on carbon cycling in soils. Winter perturbations include variable onset and duration of soil frost, changing snowpack dynamics, melt events, rain on snow events, and extent and duration of winter soil thaw. These perturbations change soil temperature, moisture, and ice content, with impacts on winter hydrologic connectivity, nutrient export, and microbial activity. In particular, the effects of freeze and thaw cycles on soil carbon dynamics with ephemeral snow conditions are not well understood. Deeper snowpack insulates soils facilitating microbial activity while thin or intermittent snowpack may result in deeper soil freeze and less microbial activity and liquid water within the soil profile. However, microbial responses to novel antecedent temperature and moisture conditions and response thresholds are not well constrained. Here we examine interannual, high frequency times series from 2 riparian soil transects in the Lake Champlain Basin to better understand how winter perturbations impact/affect soil conditions, with a focus on freeze-thaw events and the duration and depth of snowpack, and cumulative winter CO2 concentrations, as an indicator of microbial responses to freeze and thaw

events in the soils at multiple depths. Our results will provide in-situ information about how changing winters impact soil conditions and microbial responses, both of which impact on watershed nutrient export.

4:45pm – 6:15pm: **Film Screenings & Snacks with Cash Bar**

Adirondack AB Theatre

Connected, A Journey Through the Champlain Adirondack Biosphere Network (CABN) *(8:28)*

- *This film celebrates the partners working to build a more sustainable future for communities across the Champlain Basin and the Adirondack Mountains. It was directed by Lia Nydes and produced in partnership with the National Park Service and the Center for Environmental Filmmaking, American University.*

Uninvited: The Spread of Invasive Species (NYSDEC) *(52:41)*

- *NYS DEC brings you, "Uninvited: The Spread of Invasive Species". It tells the story of invasive species in NYS and how DEC and partners are tackling them. Uninvited was filmed in 2018. One of the biggest ways you can help stop invasive species is by educating friends, family, and neighbors about the small choices they can make that have a big impact, such as: using local firewood; cleaning, draining, and drying you watercraft and gear; brushing mud and debris off your boots, gear, and pets.*

Day 2: Tuesday 5/24/2022

11:00am – 12:15pm: **Concurrent Session #4**

Track 4B: Road Salt: A Contaminant of Emerging Concern ***Montpelier BC Classroom***

4B-1: Understanding winter maintenance practices of basin communities

Kris Stepenuck, UVM. Additional Authors: Ruth Smtih and Kristina Hartzell

Road salting is a contaminant of emerging concern in the Lake Champlain basin. A survey of municipal highway staff across the Lake Champlain basin and the Adirondacks was recently carried out to better understand practices and technologies used during winter maintenance to reduce snow and ice build up on roads and sidewalks. The survey also aimed to identify barriers to use of reduced salt practices and opportunities for education and assistance that will aid communities and individuals in reducing use of salt to protect the environment and infrastructure. This presentation will summarize findings and share recommendations for outreach and education that can promote reduced use of salt during winter maintenance.

4B-2: An Environmental Monitoring Program to Evaluate the New York State Department of Transportation Road Salt Reduction Pilot Program in the Lake George Drainage Basin

Jim Sutherland, Lake George Association. Additional Authors: Chris Navitsky, Brea Arvidson

Road salt usage to mitigate winter icing in temperate regions has caused widespread salinization of North American and European lakes, and at least 7770 US lakes may be at risk for elevated chloride concentrations from winter deicing. The research presented here was developed from the realization that (1) the chloride concentration in Lake George increased about 3-fold from 5.8 mg Cl L-1 to 15.9 mg Cl L-1 between 1980 and 2009, primarily from winter road de-icing, and that (2) significant efforts were required to focus on reduced road salt application without jeopardizing public safety. Continued salt loading at 2009 rates eventually could alter Lake George phytoplankton community composition, affect water column circulation dynamics, and have adverse effects on public health from sensitivity to sodium. The FUND for Lake George entered into discussions with the New York State Department of Transportation (NYSDOT) about a Pilot Program in the drainage basin where (1) reduced salt application would occur on a State road and (2) environmental monitoring would occur to evaluate the effects of the reduced application on Lake George tributaries. The NYSDOT Road Salt Reduction Pilot Program began in the winter of 2018-2019 along a 17-mile segment of Route 9N along the west side of the Lake. A monitoring program was initiated during 2018 to evaluate the multi-year road salt reduction effort. The realization that tributary watersheds in the Lake George basin were more seriously impacted by NaCl from winter de-icing than the lake itself made it critical to determine how quickly stream chemistry and lake chemistry would respond to reduced salt application. This presentation specifically addresses the non-point loading of chloride in 'test' and 'control' watersheds being monitored as part of the salt reduction program. The non-point source input of chloride also is problematic in the Lake Champlain Basin due to deicing practices that occur in New York and Vermont as stated in several different literature sources.

4B-3: Regional pollution of groundwater by road salt in the Adirondack Park

Dan Kelting, Paul Smith's College Adirondack Watershed Institute. Additional Authors: Corey Laxson and Elizabeth Yerger

Over 7 million metric tons of road salt have been applied to paved roads in the New York State Adirondack Park over the last 40 years. Regional salinization of surface waters from road salting in the Adirondack Parks has been well documented, with state roads identified as the major source of salt. Though it is understood that a fraction of salt laden runoff enters groundwater, the regional extent of groundwater contamination has not been documented. As most residents in the Adirondack Park are on private wells, groundwater contamination by road salt may represent a significant risk to their health as well as increase their costs of homeownership. We examined the extent of groundwater pollution by road salt is a survey of 500 private homeowner wells dispersed across the Adirondack Park. Water samples were collected from these wells and analyzed for sodium (Na) and chloride (Cl) and several other analytes. We assigned wells into three categories: wells located upslope of a paved road, wells located downslope of a local paved road, and wells located downslope of a state road. Na and Cl concentrations in wells located upslope of paved roads where less than 1ppm, consistent with values we have observed from surface water samples from watersheds without paved roads. Median Na and Cl concentrations in wells located downslope of local roads were 6 and 7ppm, respectively, while median Na and Cl concentrations in wells located

downslope of state roads were 33 and 100ppm, respectively. Sixty-eight percent of wells located downslope of state roads had moderately to highly corrosive water, versus 28% of wells located downslope of local roads. The large difference in Na and Cl concentrations and corrosivity between local and state roads reflects the difference in how these roads are treated in winter, with local roads mainly receiving sand and all state roads receiving high application rates of salt. Many homeowners located downslope of state roads are drinking water that exceeds the Na threshold for people on Na restricted diets and may also be exposed to heavy metals leaching from older plumbing as many of their wells have corrosive water.

4B-4: Multi-decadal monitoring reveals salinization impacts of road de-icing salt application in the Lake Champlain watershed

Will Sutor, University of Vermont. Additional Authors: Matthew C. H. Vaughan, Ana M. Morales-Williams, Brendan Wiltse

For the past 80 years, de-icing salt has been applied to roads and other surfaces to increase safety at greater travel speeds. Due to its practicality, abundance, and accessibility, the amount of de-icing salt applied to roadway surfaces in the contiguous US has more than doubled since the early 1970s, which poses a significant threat to nearby aquatic systems. Chloride ions derived from de-icing salts are highly mobile and are not notably transformed through biological or chemical processes. Consequently, chloride may accumulate and persist in water bodies, causing major shifts in microbial populations, community structures, and overall lake metabolism. In this study, we review spatial and temporal trends in chloride concentrations within the Lake Champlain watershed. We use three decades of data from the Lake Champlain Long-term Monitoring Program to examine tributary chloride concentrations and loading, and in-lake patterns of chloride concentration with respect to basins, strata, and site variability. Our results show that chloride concentrations in Lake Champlain have increased by approximately 41% since 1992. Chloride loading from nearly all major tributaries has increased over the same timeframe. The Winooski River, for example, has recently delivered approximately 40,000 metric tons of chloride to Lake Champlain annually, which is roughly double its estimated annual load in the early 1990s. With an aim to inform management strategies, this work provides a cohesive analysis of the current state and future direction of salinization within the Lake Champlain basin and its potential ecosystem impacts.

Track 4C: Cyanobacteria *Adirondack C Classroom*

4C-1: Deciphering the diversity and role of bacteriophage in Lake Champlain

Nana Ankrah, SUNY Plattsburgh. Additional Authors: Luke Myers, Ashley Barkley

It is well established that bacteriophage, viruses that infect bacteria, are the most abundant biological entities on earth. The role of bacteriophage as agents of microbial mortality and modulators of the flow of labile organic nutrients has been well documented in many aquatic systems including Lake Erie and Lake Tai. In contrast to these well characterized systems, our understanding of the diversity and role of bacteriophage in Lake Champlain remains rudimentary. For instance, we know very little about how nutrients released post virus-mediated cell lysis influence the composition, proliferation and toxicity of bloom-forming cyanobacteria in Lake Champlain. To address this knowledge gap, we are isolating bacteriophage and their host bacteria from Lake Champlain to set up model bacteriophage-host infection systems to investigate the role of bacteriophage in Lake Champlain. We are using both culture-based and genomic approaches to characterize the diversity and function of bacteriophage in Lake Champlain. We hypothesize that similar to other freshwater lakes, Lake Champlain has a high diversity of bacteriophage that play diverse roles in controlling microbial population dynamics and the flow of labile nutrients. We currently have in culture ~20 bacteria isolated from Lake Champlain and an enrichment of ~5 unique bacteriophage. Work is currently underway to purify individual bacteriophage from our enrichment for DNA extraction and genome sequencing. Altogether, data from our experiments will provide novel insight into the diversity of viruses in Lake Champlain and provide a framework for understanding bacteriophage-bacteria interactions and their impact on bloom-forming cyanobacteria population dynamics and toxicity in Lake Champlain.

4C-2: Linking Comprehensive Monitoring with a 3D Coupled Hydrodynamic-Aquatic Ecosystem Model to Evaluate Alternatives for Controlling Internal Phosphorus Loading in Missisquoi Bay, Lake Champlain

Andrew Schroth, UVM. Additional Authors: Ashton Kirol, Meghan Arpino, Clelia Marti, Ken Wagner, Dave Braun

Missisquoi Bay is a shallow eutrophic segment of Lake Champlain that can experience persistent and severe cyanobacteria blooms in summer and fall. High external nutrient loads have driven long-term eutrophication and resulted in accumulation of sediment legacy phosphorus (P). However, P release from sediment to the water column (internal P loading) under low oxygen conditions is thought to be a critical driver of cyanobacteria bloom initiation, duration, and severity, and often constitutes the dominant form of P loading that promotes blooms during warm summer months. Through a total maximum daily load (TMDL) water quality target, the EPA has mandated that riverine P loads to the bay be reduced by 64.3%. However, there is substantial concern that robust legacy P sediment reserves will continue to sustain strong cyanobacteria blooms even if the watershed P loading target is achieved. It is therefore imperative to explore strategies to suppress internal P loading to compliment efforts in the watershed. To achieve this overarching goal, we first conducted a bay-wide analysis of sediment P distribution and the occurrence of low oxygen conditions near the sediment-water interface (SWI) to explore the scale of legacy P pollution and potential mobility. We found that moderate to high (>200 mg/kg) concentrations of legacy P were ubiquitous in the bay, and the potential for transient low oxygen SWI conditions commonplace, illustrating the challenging scale of this pollution problem. A process-based model, AEM3D, was used to evaluate P management strategies including chemical P inactivation, dredging, and oxygenation. To explore the optimal timing of implementation, P management simulations were conducted with TMDL-mandated watershed reductions. Finally, to assess the viability of interventions, the cost, permitting feasibility, public acceptance, and ecological impacts of these P management strategies were evaluated, compared, and ranked. This novel integrated study provides the management community with a holistic perspective of available management options to suppress internal P loading and cyanobacteria blooms in Missisquoi Bay, and such an approach could be applied to other systems that struggle with both internal and external nutrient loading.

4C-3: Artificial aeration alters Cyanobacteria functional diversity and stability but not dominance in Lake Carmi, VT

Ana M. Morales-Williams, University of Vermont Rubenstein School of Environment and Natural Resources. Additional Authors: Maria Alfaro, Jeremy Howland, Ashton Kirol, Austin Wilkes, and Andrew Schroth

Cyanobacteria blooms are generally characterized as rapid growth and dominance of a single or a few species, but are actually diverse, fluctuating microbial consortia. Mitigation strategies that target the geochemical response of a dominant bloom organism may overlook the functional diversity of the greater bloom community and rare species, inadvertently favoring growth and dominance of different bloom-forming species. We characterized the taxonomic and functional diversity of the phytoplankton community in eutrophic Lake Carmi, VT, prior to and following installation of an aeration system designed to mitigate internal phosphorus loading. Phytoplankton samples were collected bi-weekly during the ice-free seasons between 2018 and 2021, and high-frequency oxygen and temperature sensor chains were deployed to monitor water column stability and oxygen dynamics. We predicted that artificial oxygenation without mitigation of exogenous nitrogen and phosphorus sources would shift dominance away from coccoid, buoyant Cyanobacteria species in favor of metalimnetic, low-light adapted bloom species. Results indicate that while the total biovolume of Cyanobacteria appears to have decreased initially during aeration, Cyanobacteria dominance remained stable relative to eukaryotic algae and was characterized by proliferation of nitrogen-fixing filamentous species. Second, recurring aerator generator failure over the monitoring period resulted in a pulse-disturbance phenology influencing phytoplankton biomass and community turnover. Finally, our results indicate that while aeration may decrease the appearance of blooms by limiting growth of scum-forming species, functional diversity of bloom communities should be considered when implementing management and mitigation plans.

4C-4: Effects of Disturbance on Phytoplankton Communities in Two Eutrophic Bays of Lake Champlain

Katelynn Warner, University of Vermont. Additional Authors: Andrew Schroth, Ana M. Morales-Williams

Missisquoi Bay and St. Albans Bay are two shallow, eutrophic bays in the northeastern arm of Lake Champlain that are known to experience yearly cyanobacterial blooms. Historically, the timing, duration and dominance of these blooms show interannual variability. In recent years, however, these blooms have been dominated by diverse communities of filamentous nitrogen-fixing taxa including Dolichospermum flos-aquae and Aphanizomenon flos-aquae, though this varies spatially. Integrating weekly phytoplankton, water chemistry, and high-frequency physical and chemical buoy data collected in 2017 and 2018, we investigated the drivers of phytoplankton community composition. We predict that short term fluctuations in taxonomic diversity, dominance, and stability

are driven by stochastic disturbance events such as storm frequency, water column mixing, and internal loading. Preliminary results for 2017 suggest both bays are nitrogen limited or co-limited (TN:TP).

Track 4D: Functioning Floodplain Initiative Part 1 ***Adirondack D Classroom***

4D-1: Developing tools to restore floodplain function in Vermont's Lake Champlain Basin – Overview of the Vermont Functioning Floodplain Initiative

Gretchen Alexander, Vermont DEC. Additional Authors: Roy Schiff, SLR International; Evan Fitzgerald, Fitzgerald Environmental; Kristen Underwood, University of Vermont; Mike Kline, Fluvial Matters; Jody Stryker, Stone Environmental

Connected and naturally functioning floodplains reduce flood risk, protect water quality, enhance fish and wildlife habitat, and store carbon. The Vermont Functioning Floodplain Initiative (FFI) is a new framework to highlight the roles of floodplains and better understand floodplain conditions. Tools are now being developed under the FFI to reconnect rivers to their floodplains in the Vermont sector of the Lake Champlain basin to realize the associated water quality, flood resiliency, and habitat benefits. Our interdisciplinary team of consulting engineers and scientists, researchers from the University of Vermont, and scientists from the State of Vermont have created mapping and decision-support methods to (1) identify the current level of floodplain connection; (2) select reconnection projects; (3) prioritize project types and locations; and (4) quantify the potential effectiveness of floodplain connectivity projects. These tools will lead to improved river-floodplain connection in the future, and will engage stakeholders to illustrate the importance of connected floodplains and facilitate project planning. This collaborative work leverages Vermont Stream Geomorphic Assessment data collected over the last 15 years for over 2,300 miles of river and ongoing floodplain research projects at University of Vermont. Data describing the level of connectivity, project selection priorities, and status of implemented reconnection projects will eventually be housed in a web application. The app will allow users to plan, implement, and track floodplain restoration projects, river corridor protection easements, riparian buffer plantings, wetland restoration practices, water quality improvement projects, and habitat enhancement projects – all to improve the connection between rivers and their floodplains.

4D-2: Integrating Stream Geomorphic Data to Improve Floodplain Mapping Using a Probabilistic Low-Complexity Hydraulic Model

Kristen Underwood, University of Vermont. Additional Authors: Stephanie Drago, Jeremy E. Matt, Rebecca M. Diehl

Low-complexity hydraulic modeling approaches (e.g., HAND) are increasingly applied to map floodplains across large regions. These approaches require minimal parameterization and rely on available topographic data that has improved in resolution in recent years. Still, these modeling approaches have limitations in representing channel-floodplain coupling due to their reliance upon average river geometry calculated over hydrologically-defined (NHD) reaches that may span sub-reaches of variable valley confinement or slope. New modeling approaches are needed that incorporate reach-scale geomorphic data for channels and floodplain (dis)connectivity status to better predict flooding extents and depths, and to quantify the uncertainty of these estimates.

We present results of a pilot study in two Vermont watersheds to transfer a probabilistic modeling approach (probHAND) to reaches defined from stream geomorphic assessments (SGAs). To examine integrity of this approach, we compared the probHAND-modeled floodplains to a floodplain generated using a hydrodynamic model (1D HEC-RAS) in the Mad River. We then compared probHAND floodplains generated from NHD reaches to those generated from SGA reaches, and evaluated geomorphic metrics that may account for variability between the two approaches, in both the Mad River and Black Creek.

Overall, floodplains built on SGA and NHD reaches had a similar performance when compared to a 1D HEC-RAS floodplain for the 1% AEP event along the Mad River. However, at a reach scale, the SGA floodplain captured more variability in inundation patterns than the NHD floodplain when compared to the 100-year floodplain in steeper, naturally confined reaches, coinciding with the village centers of Moretown, Waitsfield and Irasville. Valley confinement was a governing factor in the variability between SGA and NHD floodplains; confined reaches of low entrenchment ratio exhibited a better agreement between SGA and NHD floodplains than unconfined reaches. Floodplain mapping built on geomorphically-defined reaches will improve accuracy of flood stage predictions to better quantify flood hazards posed to riverside infrastructure. Improved fidelity of modeled inundation extents

will also better characterize the nutrient retention and floodwater storage functions of floodplains along Lake Champlain Basin rivers under Vermont's Functioning Floodplain Initiative.

4D-3: Evidence-based prioritization of restoration for phosphorus retention in floodplains and wetlands of the Lake Champlain Basin

Rebecca Diehl, University of Vermont. Additional Authors: Kristen Underwood, Stephanie Drago, Don Ross, Beverley Wemple

Floodplains and riparian wetlands in the Lake Champlain Basin are valued for their capacity to store sediment and nutrients, improving water quality. Yet many rivers are disconnected from their floodplains, limiting access of flood waters, and reducing deposition of sediment and associated nutrients. potentially turning floodplains into net sources of sediment and nutrients. Efforts to restore rivers and their floodplains to improve water quality assume that improved hydrologic connectivity will enhance sediment and nutrient retention, but limited data exists to characterize the variable efficiency of reconnected floodplains to guide river basin planning and tracking of constituents of concern. We describe a dataset of floodplain sediment and total phosphorus deposition observations collected at a variety of sites throughout the Lake Champlain Basin in Vermont between 2019 and 2021 following six localized flood events, and one widespread rainstorm on November 1, 2019. Sediment and total phosphorus deposition rates were highly variable; site-averaged sediment deposition ranged from 0.2-9.8 kg m-2 yr-1, and site-averaged total phosphorus deposition ranged from 0.2-6.5 g P m-2 yr-1. We found that deposition rates were dependent on watershed characteristics, including land cover (e.g., % of watershed in wetland) and land use (e.g., % of watershed impervious), valley attributes (e.g., valley width), and the location of the measurement relative to the stream channel. Floodplains with greater vertical and lateral hydrologic connectivity also had greater annual deposition. From statistical models developed from our data, we demonstrate how increasing hydrologic connectivity is likely to significantly increase the deposition of sediment and phosphorus in the Lake Champlain Basin.

4D-4: Predicting Stream Power from a Low Complexity Hydraulic Model

Jeremy Matt, University of Vermont. Additional Authors: Rebecca M. Diehl, Kristen L. Underwood, Elizabeth M.B. Doran, Ali Javed, Stephanie Drago, Rachel M. Seigel, Donna M. Rizzo

Transport of nutrient-laden sediment into Lake Champlain, resulting in part from human activity and climate change, is causing harmful algal blooms that damage aquatic ecosystems and limit recreation. To effectively manage water quality in Lake Champlain, planners need tools capable of quantifying the erosion and sediment transport dynamics at the entire Lake Champlain Basin (LCB) scale. One common measure of erosion potential is Specific Stream Power (SSP). Physics-based models such as 2D HEC-RAS provide a means for estimating SSP. However, these models are often computationally expensive and require detailed channel information for development and calibration. In contrast, low-complexity models can be implemented over a much wider area because they have relatively low computational costs and require inputs that are more commonly available (e.g., digital elevations, estimates of channel roughness). For this work, we use the probHAND model, a low-complexity probabilistic inundation mapping approach that accounts for uncertainties in topographic, land-cover, and hydraulic inputs. To advance understanding of the LCB sediment dynamics, we propose a method for estimating channel and overbank SSP from probHAND outputs on a per-reach basis and show proof-of-concept in the Mad River Watershed. Accuracy of the probHAND SSP estimates is assessed via comparison to reach-averaged estimates of channel and overbank SSP extracted from a 2D HEC-RAS model. We use a new Machine Learning method designed for clustering time-series data, called SOMTimeS, to sort stream reaches based on the SSP patterns exhibited over a range of inundation depths. We then compared the clustered reach SSP data to the Vermont Agency of Natural Resources Phase I and II stream geomorphic assessment data to identify correlations with geomorphic metrics. This comparison between probHAND SSP and the VTANR geomorphic data, helped to identify the geomorphic settings under which the probHAND SSP model performed well. This method to predict stream power from low-complexity hydraulic models adds value for planners, because the risk of channel erosion and floodplain sediment deposition characteristics can be estimated relatively rapidly over a wide geographic area.

1:15pm – 2:30pm: **Concurrent Session #5**

Track 5A: Cultural Heritage in the Lake Champlain Basin ***Adirondack AB Theatre***

5A-1: 'Our Best Endeavors:' Temperance, Prohibition, and Smuggling in Champlain Valley

Susan McClure, Lake Champlain Maritime Museum

When you think about "Prohibition," most people imagine gangster and bootleggers with tommy guns and fancy cars in the 1920s. But to truly understand federal Prohibition in the Champlain Valley, you have to start earlier than the ratification of the 18th Amendment in 1919. Vermont actually had statewide prohibition from 1853-1903! In 2021, Lake Champlain Maritime Museum created a new onsite and digital exhibit that examined how the Champlain Valley went from being a major producer and consumer of alcohol in the early 1800s to a hotbed of temperance sentiment by the mid-19th century. Susan Evans McClure will share the process of researching and creating the exhibit, and the impact of waterways in changing the tide on local temperance efforts. What caused the members of the Westport Sons of Temperance to proclaim in 1853 that they would "use our best endeavors to procure and sustain a stringent prohibitory law"? And what can this all help us understand about the tension between regulation and personal freedom that plays out in our society today?

5A-2: War and Enslavement in the Champlain Valley

Matthew Keagle, Fort Ticonderoga

Understanding the implications of the American Revolution means understanding the underlying systems in place when it occurred. This paper seeks to explore the often underappreciated presence of enslavement in the Champlain Valley prior to the Revolution and how the war for Independence complicated slavery and freedom in the region. The expansion of enslavement to the Champlain Valley was a direct result of the imperial war fought between 1754 and 1763 that the region is often better known as a primary theatre of. Known as the French and Indian War, or the Seven Years' War, Imperial warfare between the French, British, and Spanish collapsed the distinctive geographies of the Atlantic through military service. Soldiers crossed regions, oceans, and continents and became vectors of ideas and institutions. These individuals were largely responsible for expanding enslavement to the region following the conclusion of the Seven Years' War. This paper will explore my preliminary research on the expansion of race based enslavement in the Champlain Valley from the end of the Seven Years' War through the American War for Independence. The institution made significant gains in this region before the outbreak of war in 1775, providing another element in the Revolutionary conflict as rebels and loyalists, congressional and crown officials, sought to understand and manage the diverse population of the Champlain Valley. As much as imperial warfare was a vector for slavery's expansion, warfare also offered opportunities for people of color to express agency, make social gains, and even escape enslavement. Military service for the nascent United States or the British government in Canada, and the permeability of the contested border, made the Champlain Valley a region where war and enslavement had a complex relationship during the struggle for Independence. Using British and American sources, as well as collections held by the Fort Ticonderoga museum, I intend to present how the military actions that have defined this region in the late 18th century allowed for the expansion of enslavement with profound repercussions for the terms of the American War for Independence and lives of the region's people of color.

5D: Functioning Floodplain Initiative Part 2 *Adirondack D Classroom*

5D-1: A method to classify headwater reaches for stream and floodplain project crediting under the Lake Champlain phosphorus TMDL

Scott Lawson, University of Vermont. Additional Authors: Kristen L. Underwood, Stephanie Drago, Gretchen Alexander, Roy Schiff, Mike Kline

A contributor of P to Lake Champlain is streambank instability, and restoration and conservation projects in the basin aim to mitigate P loading from this source by restoring and protecting floodplain and stream connectivity. The physical characteristics and nutrient loading from headwaters is less known and thus an initial system is needed to classify headwaters, make TMDL TP allocations, and credit projects. Vermont's Functioning Floodplain Initiative (FFI) proposes three headwater zones: intermittent streams (draining < 0.25 mi2), perennial headwater streams (≥ 0.25 mi2 and < 2 mi2) with low slope, and perennial stream with high slope.

To characterize Lake Champlain Basin headwaters in support to the FFI, a method was developed using common hydrographic parameters derived from lidar-based, high-resolution Digital Elevation Model (DEM) as an input. The method creates a hydrologically-enforced surface, delineates stream reaches by drainage area, and classifies those reaches based on slope. The resulting attributed stream network can be used by environmental managers in the Lake Champlain Basin to prioritize channel and floodplain projects for reduced P loading and other co-benefits such as improved aquatic organism passage and greater flood resilience. This method has applicability in many basins beyond Lake Champlain, since it relies solely on topographic inputs, which are widely available at various resolutions across the world.

5D-2: Expanding the Vermont Functioning Floodplain Initiative (FFI) to include Instream and Floodplain Habitat Protection and Restoration Potential

Elizabeth Doran, Civil & Environmental Engineering, University of Vermont. Additional Authors: Roy Schiff, Mike Kline, Kristen Underwood, Rebecca Diehl

The current FFI is building an understanding of constraints to hydrologic and sediment connectivity viewed through the management lens of restoring water quality and building flood resiliency. However, we know that hydrologic and sediment connectivity also influence instream and floodplain habitats. This presentation will introduce the expansion of the FFI to assess departures in instream and floodplain connectivity with respect to habitat loss and restoration potential with example results evaluating floodplain departures. The goal is to enhance ongoing work to map and prioritize existing and potential habitat important to biodiversity and organism movements within and across the riverscape by evaluating and mapping predictions of stream, wetland, and floodplain habitat quality as they correlate with river/floodplain form and process. On the floodplains, we leverage existing mapped natural communities across the state in conjunction with existing FFI inundation maps and other geophysical data to develop a spatial prediction of reference natural communities in the floodplains of the Mad River watershed in the Lake Champlain Basin. Departure from reference conditions is assessed relative to floodplain disconnection as measured in the ongoing FFI. A similar approach will be repeated for instream habitats utilizing existing Reach Habitat Assessment data (Schiff et al., 2008) to identify readily available proxy physical features to indicate habitat restoration opportunities in river corridor plans (Kline, 2010) via definition and assessment of patterns in instream habitat types using surrogate SGA, hydrologic connectivity, and sediment regime departure data being developed in the ongoing FFI. The results will enable prioritization based on a project's habitat protection and restoration benefits and expand the stakeholder community engaged in project identification through the FFI web application.

5D-3: The Vermont Functioning Floodplain Initiative: Crediting River Corridor Projects for Total Phosphorus Attenuation for the Lake Champlain TMDL

Roy Schiff, SLR International and Evan Fitzgerald, Fitzgerald Environmental Associates, LLC. Additional Authors: Mike Kline, Fluvial Matters; Evelyn Boardman, Fitzgerald Environmental

Connected and naturally functioning floodplains protect and improve water quality. The Vermont Functioning Floodplain Initiative (FFI) is a new framework that includes crediting river corridor and floodplain projects with Total Phosphorus Attenuation associated with improved channel stability and enhanced floodplain storage. The novel Lake Champlain TMDL links nutrient loading with unstable streams, and thus 15 years of geomorphic assessment data on Vermont streams is the backbone for understanding both load allocations and potential project credits. This talk will describe the outcome of TP crediting developed with the FFI team in collaboration with the VTDEC Watershed Management and Water Investment divisions. The crediting methods will be available on the FFI web application to allow for project planning at various spatial scales including stream reaches, HUC12 watersheds, Vermont Planning Basins, and the Vermont Sector of the Lake Champlain Basin.

5D-4: The FFI Web Application – Translating Research Outcomes into Project Planning, Implementation, and Tracking of River and Floodplain Reconnection

Jody Stryker, Stone Environmental. Additional Authors: Barbara Patterson, Nick Floersch, Gretchen Alexander, Roy Schiff, Evan Fitzgerald, Evelyn Boardman, Kristen Underwood, Mike Kline

The FFI application is a web-based tool designed to support a range of stakeholders in their efforts to evaluate the existing state of floodplains, the potential for floodplain reconnection, and the most impactful projects that can achieve flood resiliency, water quality, and habitat improvement goals in the Lake Champlain Basin (LCB). The basis of this tool is an established methodology for floodplain and stream connectivity departure scoring and project opportunity assessments developed in Phase 1 of the FFI. The tool provides the user with maps and data to explore the natural, social, and economic value of floodplain functions in the LCB. Using criteria or location-based approaches, the user can identify potential reach-specific projects tailored to the characteristics of each reach. Detailed information about individual and suites of projects can be evaluated, including feasibility scores, potential reconnection benefits, estimated phosphorus crediting, and approximated costs. Outcome tables can be exported from the application and used for further development of project implementation planning by state government and/or watershed management groups. In addition, this tool provides the LCB with the opportunity to track the progress of reconnection projects in the basin, by recalculating connectivity departure scores and the status of floodplain function as projects are completed. Project suitability is also reevaluated as projects are completed and

the connectivity status of reach and watershed connectivity evolves. The tool framework has been developed to progress as the FFI progresses, such that the methodology, data, and functionality can be updated as new research improves our understanding of the processes driving connectivity and departure in Vermont's fluvial systems. The goal is to provide a data-driven and user-friendly decision-support tool that can aid in translating the findings of ongoing innovative research into implementation of practices that reestablish and protect natural floodplain and river processes.