Vermont Water Resources and Lakes Studies Center

Annual Program Report
June 18, 2020 – June 17, 2021

The Vermont Water Resources and Lake Studies Center (Vermont Water Center) facilitates water resources related research and supports faculty and students at Vermont colleges and universities. Research priorities are identified through collaboration with the United States Geological Survey (USGS), the State of Vermont Department of Environmental Conservation, Lake Champlain Sea Grant, Lake Champlain Basin Program, and other programs in the state. By regularly working with state, regional, and national partners, the Vermont Water Center links scientific research with decision making in water resource management and policy development. The Director of the Water Center is also the director of Lake Champlain Sea Grant (LCSG) and both programs share the same advisory board, which leverages the strengths of each program. Following is a description of projects and related publications supported by the Vermont Water Center in 2020.

Cyanobacteria bloom impacts on fish: Ecological and human health considerations

Investigators Natalie Flores and Jason Stockwell

Introduction

Cyanobacteria cause major problems for freshwater resources both locally and globally. Toxins produced by cyanobacteria (cyanotoxins) remain a primary focus for research and management due to the potential to cause harm to wildlife, pets, and humans. People can be exposed to cyanotoxins directly by drinking water, swimming/recreation, and inhalation, and indirectly through contaminated food.

Methods

We set two gillnets and two fyke nets placed in different locations around the lake on the evening of the 14th of August to collect samples from the fish community. Our prior work on Shelburne Pond shows that cyanobacteria blooms typically peak around this time. We retrieved the nets on the morning of the 15th of August and collected up to 10 individuals of each species captured. Fish collected included the full spectrum of trophic levels, from bottom feeders to top predators. We have completed processing all fish lipid samples and run them on the gas chromatograph. Resulting chromatograms are currently being processed to obtain the fatty acid data. The resulting data will be presented to the University of Vermont and Vermont and Lake Champlain fisheries management communities later in spring 2022.

Results

The results obtained from this effort will shed light onto the effects that the seasonal cyanobacteria blooms have on fish in Vermont lakes. Specifically, we will determine if there is evidence of species-specific accumulation of cyanobacteria toxins in fish. We will also determine effects that blooms have on the nutritional quality of fish in terms of their fatty acids and whether fish from a cyanobacteria-impaired lake exhibit essential fatty acid deficiency. Our work will shed more light on this understudied area of research and help inform management.

How much Carbon is in those mussels? The potential impact of a Quagga Mussel invasion on energy pathways in Lake Champlain

Investigator Ellen Marsden

Introduction

Zebra mussels (D.polymorpha), close relatives to quagga mussels, have been in Lake Champlain since at least 1993; their impacts on fish communities and water quality have been limited. However, invasion by quagga mussels maybe a different story. Quagga mussels can easily colonize all depths of Lake Champlain and can easily outcompete zebra mussels. Thus, quagga mussels will have a greater impact on the Lake Champlain system than the established zebra mussel. Quagga mussels could drastically influence nutrient cycling and food web structure.

Methods

Digital photos were used to map the distribution of zebra mussels throughout Lake Champlain. A GoPro high-definition camera and an AquaVu underwater drop-camera were mounted on a weighted frame, with the cameras pointed downward and held at a fixed distance from the base of the frame with the edges of the frame in the camera field of view. A label was attached to the frame to identify the date, location, depth, and identification code for each photo. The frame was from a boat until in contact with the substrate; images from the GoPro (set to automatically take still images every 20 sec) encompass the same 'sample' area, with a scale marked along the bottom frame for reference.

Results

Initial findings confirm that quagga mussels have not yet become established in Lake Champlain and that zebra mussel densities vary widely across regions of the lake. Zebra mussel cover ranges from 0% to nearly 100% at shallow (<10m) depths, and typically drops to 0-5% at and below 20m depth. Size distribution analysis is forthcoming, but observations suggest zebra mussels are geographically size structured within the lake and are sparse in Malletts Bay and the southern lake (south of Crown Point). Results of carbon content are expected in late Spring 2022 as they were delayed due to the COVID-19 pandemic.

Products

Berger D, C Vichi, A Chiapella, JD Stockwell, JE Marsden. May 2022. How Much Carbon is in Those Mussels? An Analysis of the Distribution and Carbon Storage of Dreissenid Mussels in Lake Champlain. 'Presentation at Lake Champlain Research Conference, 2022."

Hydraulic modeling to support Vermont's functioning floodplain initiative

Investigator Kristen Underwood

Introduction

Connected and functioning alluvial floodplains have the potential to reduce flood risk to downstream communities by attenuating peak discharges. Floodplains are also valued for their ecosystem functions including sediment and nutrient storage, groundwater recharge, and support to aquatic and riparian habitats. There is a need to better define the geographical extents of floodplain inundation, as well as the frequency, duration and timing of flooding events to understand the risks to humans and built infrastructure, and the potential benefits of inundation for sediment and nutrient storage, flood peak attenuation, and support to aquatic and riparian habitats.

Methods

A Height Above Nearest Drainage (HAND) map is created from a digital elevation model (DEM), representing the elevation difference between each land surface cell and the stream bottom cell to which it drains. We executed the probHAND model for the Lake Champlain Basin in Vermont using a 1 m hydro-flattened DEM derived from LiDAR datasets collected between 2013 and 2017, all with a QL2 rating.

Results

We mapped ~400 km^2 of floodplain along 1,700 km of rivers in Vermont. On average for the Lake Champlain Basin, VT, 95th percentile maps have floodplain widths of 124 and 188 m, for the 2- to 500-year floods, respectively. By expanding the probability of inundation to include areas with a low, but real, chance of inundation (i.e., 5th percentile), the full width of potential floodplain areas increases by 30–32% (depending on the magnitude of the flood event), adding 57 and 87 m of floodplain width to the 2- and 500-year floods, respectively.

Products

Diehl RM, KL Underwood. Dec. 8, 2021. Where May the Waters Rise: Creating better flood maps with a lidar derived elevation model. “Presentation at Vermont Enterprise GIS Consortium GeoEnlightenment Session (virtual).” https://www.youtube.com/watch?v=fFOxcT6_JB0

Diehl RM, B Wemple, S Drago, J Gourevitch, KL Underwood, D Ross. Dec 1–17, 2020. *Building an understanding of floodplain functioning to inform effective management in the Lake Champlain Basin*. Abstract H154-04 presented at 2020 AGU Fall Meeting (virtual).

Matt J, KL Underwood, J Gourevitch, RM Diehl, RM Seigel, LC Worley, BC Wemple, DM Rizzo, Dec1–17, 2020. *An enhanced low-complexity hydraulic model for assessment of floodplain rehabilitation alternatives*. “Presentation at 2020 AGU Fall Meeting (virtual), 2020.”

Underwood KL, RM Diehl, JE Matt, S Drago. 2021. Integration of stream geomorphic assessment data with low-complexity hydraulic models to improve floodplain mapping. “Technical report at the Vermont Water Resources and Lake Studies Center, 2021.”

Impact of storms on lake phytoplankton community dynamics

Investigators Jason Stockwell and Jennifer Brentrup

Introduction

Although climate change is expected to cause more intense and frequent extreme weather events, we only have a basic understanding of how these events might alter freshwater phytoplankton communities. Storms can have strong impacts on thermal stratification and mixing dynamics of lakes, which in turn may influence niche availability and phytoplankton succession, and thus taxonomic and functional diversity of freshwater phytoplankton communities. A working group ("Storm-Blitz") was organized within the Global Lake Ecological Observatory Network (GLEON) in 2013 to address questions about the impacts of storms on phytoplankton community through sharing of long-term datasets and high-frequency data in lakes across the globe.

Methods

Our limited knowledge on storm impacts on phytoplankton communities is related to difficulties in i) disentangling storm-related impacts from the influences of environmental factors, especially those involved in seasonal dynamics, ii) identifying general rules across lakes due to individual characteristics of lakes and watersheds. To overcome these two difficulties, the group proposed multi-variate comparative approaches and developed a R-package to assist the use of heterogeneous phytoplankton datasets for inter-lake comparisons. Based on analysis of the aggregated long-term data sets, the group demonstrated that long-term series can be efficiently used to answer questions related to storm impacts on lake physical and biological characteristics such as water temperature and phytoplankton communities.

Results

In the short term, this project reinforced collaboration among participating international partners while promoting the scientific use of different databases obtained by different teams. In the long term, the project will provide open-access data derived from long-term phytoplankton counting and environmental monitoring to be publicly available and used by the greater scientific and management communities. Study results and management implications will be shared at local conferences with local and state water quality managers to encourage including resiliency measures for storm events in nutrient loading plans, such as total maximum daily loads (TMDLs). We anticipate the results will facilitate future international research proposals to empirically test resultant paradigms and frameworks derived from our efforts.

Products

Stockwell JD, O Anneville, VP Patil. 2021. Global Evaluation of the Impacts of Storms on freshwater Habitat and Structure of phytoplankton Assemblages (GEISHA). Available online at: https://www.uvm.edu/femc/data/archive/project/geisha-stormblitzfr

Stockwell JD, R Adrian, O Anneville, J Brentrup, R Bruel, L Carvalho, JP Doubek, G Dur, A Lewandowska, V Patil, J Rusak, N Salmaso, SJ Thackeray, P Urrutia-Cordero, RI Woolway. 2021. A global dataset on weather, lake physics, and phytoplankton dynamics. "Presentation at Symposium for European Freshwater Sciences (virtual), 2021."

Administration and Information Transfer

Investigators William "Breck" Bowden (Director) and Julianna White

The Vermont Water Resources and Lake Studies Center facilitates water resources-related research and supports faculty and students at Vermont colleges and universities. Water resources management research, including physical, biological, chemical, social science, and engineering were solicited in the 2020-2021 RFP. Four research projects, including one graduate student projects from University of Vermont and three faculty projects from University of Vermont were selected, based on reviews by external peers and the advisory board. Five undergraduate students, two graduate students, and three post doctorate scholars were funded through 104b and matching funds from these projects. The Water Center supports administration of projects; financial and technical reporting; linkages among researchers, stakeholders, and decision-makers; and communication of results. This supported sites such as the VT Water Center website and related programs and resources for public education and use.

Vermont Water Center publications resulting from support in previous years

Doubek JP, O Anneville, G Dur, AM Lewandowska, VP Patil, JA Rusak, N Salmaso, CT Seltmann, D Straile, P Urrutia-Cordero, P Venail, R Adrian, MB Alfonso, CL DeGasperi, E de Eyto, H Feuchtmayr, EE Gaiser, SF Girdner, JL Graham, H-P Grossart, J Hejzlar, S Jacquet, G Kirillin, ME Llames, S-IS Matsuzaki, ER Nodine, MC Piccolo, DC Pierson, A Rimmer, LG Rudstam, S Sadro, HM Swain, SJ Thackeray, W Thiery, P Verburg, T Zohary, JD Stockwell. 2021. The extent and variability of storm-induced temperature changes in lakes measured with long-term and high-frequency data. Limnology and Oceanography 66:1979-1992. https://doi.org/10.1002/lno.11739

Perillo, VL, BJ Cade-Menun, M Ivancic, DS Ross, BC Wemple. 2021. Land use and landscape position influence soil organic phosphorus speciation in a mixed land use watershed. Journal of Environmental Quality https://doi.org/10.1002/jeq2.20237

Stockwell JD, O Anneville, VP Patil. 2021. Global Evaluation of the Impacts of Storms on freshwater Habitat and Structure of phytoplankton Assemblages (GEISHA). Available online at: https://www.uvm.edu/femc/data/archive/project/geisha-stormblitzfr

Lancelloti, B. 2021. Investigating spatial and temporal variability of environmental and biological controls on riparian soil denitrification. PhD dissertation. UVM ScholarWorks ISSN: 2576-7550. Available from https://scholarworks.uvm.edu/graddis/1482/