Vermont Water Resources and Lake Studies Center
George D. Aiken Center for Natural Resources

Annual Technical Report
2019

Products

PUBLISHED

Peer-reviewed publications

Euclide, PT, Marsden JE. 2018. Role of drainage and barriers in the genetic structuring of a tessellated darter metapopulation. Conservation Genetics 19:1378–92 https://doi.org/10.1007/s10592-018-1107-2

Giddings LA, Chlipala G, Driscoll H, Bhave K ,Kunstman K, Green S, Morillo K, Peterson H, Maienschein-Cline M. 2020. Seasonal Ely Rock Copper Mine Superfund Site Shotgun Metagenomic and Metatranscriptomic Data Analysis. *Data Brief*. 32, 106282. https://doi.org/10.1016/j.dib.2020.106282

Giddings LA, Chlipala G, Kunstman K, Green S, Morillo K, Bhave K, Peterson H, Driscoll H, Maienschein-Cline M. 2020. Characterization of an Acid Rock Drainage Microbiome and Transcriptome at the Ely Copper Mine Superfund Site. *PLoS ONE*. 15 (8), e0237599. https://doi.org/10.1371/journal.pone.0237599

Hammond Wagner CR, Greenhalgh S, Niles M, Zia A, Bowden WB. 2020. Evaluating water quality regulation as a driver of farmer behavior: a social-ecological systems approach. *Ecology and Society* 25(4):35. https://doi.org/10.5751/ES-12034-250435

Hamshaw SD, Engel T, Rizzo DM, O'Neil-Dunne J, Dewoolkar, MM. 2019. Application of unmanned aircraft system (UAS) for monitoring bank erosion along river corridors. Geomatics, Natural Hazards and Risk. 10:1285-1305. https://doi.org/10.1080/19475705.2019.1571533

Millarhouse A, Vatovec C, Niles M, Ivakhiv A. 2020. What's in your body of water? Reducing the psychological distance of pharmaceutical pollution through metaphoric framing in risk communication. *Environmental Management*. 65: 630–641. https://doi.org/10.1007/s00267-020-01275-8

Perillo VL, Ross DS, Wemple BC, Balling C, Lemieux LE. 2019. Stream corridor soil phosphorus availability in a forested–agricultural mixed land use watershed. *Journal of Environmental Quality,* 48(1), 185–192. https://doi.org/10.2134/jeq2018.05.0186

Stockwell JD, Doubek JP, Adrian R, Anneville O, Carey CC, Carvalho L, et al. 2020. Storm impacts on phytoplankton community dynamics in lakes. *Global Change Biology* 26:2756-2784. https://doi.org/10.1111/gcb.15033

Posters

Lancelloti, B. 2019. Spring snowmelt: a 'hot moment' for denitrification in riparian areas? Poster presented by Brittany Lancellotti at the American Geophysical Union's Fall 2019 Meeting in Francisco, CA. Abstract: https://agu.confex.com/agu/fm19/meetingapp.cgi/Paper/613320

Data and Software

Giddings LA, Chlipala G, Kunstman K; Green S, Morillo K, Bhave K, et al. 2020. Characterization of an acid rock drainage microbiome and transcriptome at the Ely Copper Mine Superfund site. figshare. Collection. https://doi.org/10.6084/m9.figshare.c.4864863.v2

Global Evaluation of the Impacts of Storms on freshwater Habitat and Structure of phytoplankton Assemblages (GEISHA). 2020. R-package “algaeClassify”. Available on the CRAN repository. Contains R-code designed to facilitate the application of common morpho-functional (MFG; Salmaso et al.

2015 <doi:10.1111/fwb.12520>) and life-history classifications (CSR, Reynolds 1988) to phytoplankton species lists and/or trait datasets (https://cran.r-project.org/web/packages/algaeClassify/).

Stockwell JD, Anneville O, Patil VP (2020) 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

Theses and Dissertations

Euclide, Peter T. 2018. Genetic and Demographic Consequences of Lake and River Habitat Fragmentation on Fishes in Vermont. PhD Dissertation, University of Vermont. https://scholarworks.uvm.edu/graddis/887

Kozel, Carrie L. 2017. Early Feeding in Lake Trout Fry (*Salvelinus namaycush*) as a Mechanism for Ameliorating Thiamine Deficiency Complex. MS thesis, University of Vermont. https://scholarworks.uvm.edu/graddis/685

Millarhouse A. "What’s In Your Body Of Water? Reducing The Psychological Distance Of Pharmaceutical Pollution Through Metaphor In Risk Communication" (2017). University of Vermont Graduate College Thesis. 767. https://scholarworks.uvm.edu/graddis/767

IN PREP

Peer-reviewed publications

Diamond, Sydney E., R. Harvey, A. Heathcote, A. Lini, and A.M. Morales-Williams. Response and recovery of diatom communities to acidification in a high elevation lake. *Journal of Paleolimnology*. *In prep.*

Diamond, Sydney E., R. Harvey, and A.M. Morales-Williams. Environmental drivers of the emergence and success of cyanobacteria in lakes recovering from acidification. *In prep.*

Doubek JP, Anneville O, Dur G, Lewandowska AM, Patil VP, Rusak JA, et al. The extent and variability of storm-induced temperature changes in lakes measured with long-term and high-frequency data. *Limnology and Oceanography*. *Minor revision*.

Lancelloti B, Adair E, Perdrial J. Impacts of land use and landscape position on the denitrification capacity of riparian soils during spring snowmelt. *In prep.*

Lancelloti B, Adair E, Perdrial J. Measuring the abundance of functional nitrification and denitrification genes within riparian soils of different land use and landscape position *In prep.*

Perillo V, Cad-Menun B, Ivancic M, Ross D, Wemple B. Land use and landscape position influence soil organic phosphorus speciation in a mixed land-use watershed. *Journal of Environmental Quality*. *Submitted Jan 2021.*

Stewart TR, Mäkinen M, Goulon C, Guillard J, Marjomäki T, Lasne E, Karjalainen J, Stockwell JD. Influence of warming temperatures on coregonine embryogenesis within and among species. *In prep.*

Stewart TR, Zucchetta M, Karjalainen J, Goulon C, Anneville O, Vinson MR, Wanzenböck J, Winfield IJ, Stockwell JD. A Modeling Approach to Better Understand Impacts of Changing Thermal Habitat on Coregonine Spawning and Egg Incubation Across Latitudes and Continents. *In prep.*

Theses and Dissertations

Lancelloti B. Identifying drivers of change in the denitrification capacity of riparian soils during the spring snowmelt/runoff period. Dissertation chapter. In prep.

Information Transfer Program

Researchers shared their research findings with public or educational audiences. ○ Diamond S. A look into the past: understanding how shifts in diatom communities are indicative of recovery from acidification. Lake Champlain Sea Grant: Zoom a Scientist. 2020.

Lancelloti B. March 31, 2021. What's going on down there? How does Vermont's spring snowmelt period affect the soil ecosystem? Outreach talk for Teen Science Café network. https://teensciencecafe.org/about/

Lancelloti B. November 2020. What does a soil scientist do? Presentation and Q&A to two classes at Northfield Middle School in Northfield, VT.

Scientists share their research findings in professional meetings. ○ Diamond S, Harvey RA, Morales-Williams A. 2019. Response and Recovery from Acidification in Vermont Lakes: Assessing the Sensitivity of Acid Impaired Lakes to Cyanobacteria Blooms. North American Lake Management Society. Burlington, VT.

Diamond S, Harvey R, Heathcote A, Lini A, Morales-Williams A. 2019. Browning or Greening? Diatom Community Changes in an Acid Impaired Lake. Association for the Science of Limnology and Oceanography. San Juan, PR.

Lancelloti, B. Adair, E. Perdrial, J. February 24, 2021. Drivers of change in denitrification capacity of riparian soils during the spring snowmelt. Lake Champlain Sea Grant Research Seminar Series.

Stewart TR, Mäkinen M, Brun C, Goulon C, Guillard J, Lasne E, Karjalainen J, Stockwell JD. 2020. Influence of changing lake temperatures on coregonine embryogenesis at local to global scales. 14th International Coregonid Symposium (WebCoregonid2020). June 2020.

Stockwell JD. September 30, 2020. Storm Impacts on Phytoplankton Community Dynamics in Lakes. Lake Champlain Sea Grant Research Seminar Series. Available at: https://www.uvm.edu/seagrant/storm-impacts-phytoplankton-community-dynamics-lakes

The Vermont Water Center helped craft and disseminate a press release about the Stockwell et al. (2020) paper that was covered widely. *What We Don't Know (About Lakes) Could Hurt Us: As extreme weather increases, scientists from 20 countries warn of risk to lakes and water quality.*

- Grist: 10/03/2020. Storms wreak havoc on land. We're only beginning to understand what they do underwater.
- Long Room 5/03/2020. Lakes could be dramatically altered by extreme weather changes.
- Physorg 5/03/2020. What we don't know (about lakes) could hurt us.
- Newswise 5/03/2020. What we don't know (about lakes) could hurt us.
- EurekAlert! 5/03/2020. What we don't know (about lakes) could hurt us

- Scitech Daily: 5/03/2020. Scientists from 20 countries warn of risk to lakes and water quality as extreme weather increases.
- Foreign Affairs New Zealand 5/03/2020. MIL-OSI New Zealand: We don't know much about lakes and climate change, says researcher

- Voxy.co.nz. 5/03/2020. Little known about lakes and climate change, says researcher – NIWA

- Scoop 5/03/2020. Little known about lakes and climate change, Says Researcher

- INRAE actualités – https://www.inrae.fr/actualites/CP-lac-ecosysteme-tempete.

The Vermont Water Resources and Lake Studies Center maintains a website, which includes information about the Center, funded projects, a list of peer-reviewed publications from USGS 104b funds, and links to related programs and resources. The website includes a one-page summary describing the Center and funded projects, which is used for communication with the general public, state stakeholders, and federal stakeholders, including legislators. The Water Center also maintains a separate email list of 132 partners and stakeholders to whom we send RFP announcements, fellowship opportunities, publication announcements, etc.

The Vermont Water Center contributes content and support to the website and quarterly newsletter EcoNewsVT newsletter, which has grown to345 subscribers since it began in 2014. Developed in collaboration with Lake Champlain Sea Grant, Northeastern States Research Cooperative, and the Forest Ecosystem Monitoring Cooperative, the newsletter informs national and state regulatory agencies, scientists, NGOs, land-owners, and educators about recent research conducted in Vermont and its implications for resource management and policy at all levels. http://www.econewsvt.org

Student Support

Undergrad students: 5 (Lancelloti three undergraduate internships, Caroline Dunbar, Dylan McDonough)
Grad students: 3 (Lancelloti, Diamond, Taylor Stewart)
Post-docs: 3 (Jon Doubek, Jennie Brentrup, Rosalie Bruël)

Notable Achievements and Awards

The journal article *Storm impacts on phytoplankton community dynamics in lakes* was among the twenty most downloaded articles in 2020 in the journal Global Change Biology (ISI Impact Factor 8.56). A related press release was covered by over a dozen media outlets.

A graduate student-led metagenomic analyses on riparian soil samples will allow study of the microbial community composition of each sample and pinpoint the abundance of a wide variety of genes that impact soil biogeochemical cycling. This will create a novel and cutting-edge dataset that will be used to describe how soil microbial communities change according to land use and landscape position during spring snowmelt.

Graduate student-led research will result in the first published report of bloom-forming cyanobacteria in Vermont's high elevation acid-impaired lakes. Combined with modeling long-term ecological change undertaken in collaboration with the Vermont Department of Natural Resources, the research will contribute to the development and implementation of biotic indices for rapid assessment of water quality impairment.

Graduate student research on how freshwater whitefish populations have adapted historically to environmental variability in Lake Champlain and other lakes will help understand the range of possible responses to climate change and assist managers to conserve fisheries. Experiments conducted as part of the project were run in tandem with the University of Jyväskylä, allowing for a more global comparison.

Impact Of Storms On Lake Phytoplankton Community Dynamics

Project Type: Annual Base Grant
Project ID: 2019VT260B

Project Impact:

Through the Vermont Water Resources and Lake Studies Center, USGS 104b funding supports Vermont-centered research linked to the Global Lake Ecological Observatory Network (GLEON) initiative called “Storm-blitz”. Storm-blitz aims to answer questions about the impacts of extreme events on lake characteristics and phytoplankton communities. Although climate change is expected to cause more intense and frequent extreme weather events, a systematic review of the literature underlined a severe lack of understanding of how storms might alter freshwater phytoplankton communities. 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. In its 2020 paper “Storm impacts on phytoplankton community dynamics in lakes,” the group identified how storms interact with lake and watershed attributes and their antecedent conditions to generate changes in lake physical and chemical environments. Related datasets and computed derived data are accessible through the FEMC archive/portal system. Those data will be used to carry on testing hypotheses and further analysis.

Influence Of Changing Lake Temperatures On Early Life Stages Of Freshwater Whitefishes At Local To Global Scales: Modeling And Experimental Approaches

Project Type: Annual Base Grant
Project ID: 2019VT261B

Project Impact:

Water temperature in lakes is increasing due to climate change, but we do not understand how managed resources will adapt (or not) to such changes. Freshwater whitefishes, Salmonidae Coregoninae, are of great socio-economic value but critically sensitive to the effects of increased water temperatures because they are cold, stenothermic fishes. The evolutionary responses of many species are predicted to be inadequate to counter the speed and magnitude of climate change, leaving species vulnerable to decline and extinction. Shifts in physiology or reproductive phenology of populations living close to their physiological limits will be required if species are to persist as water temperatures continue to increase across the globe. Research funded by the Vermont Water Center through the USGS Water Resources Research Act 104b Program used a cross-lake, cross-continent, cross-species approach to experimentally evaluate the response of coregonine embryos to changing incubation thermal regimes. Our experiments demonstrated both similar and contrasting reaction norms to temperature for life-history and morphological traits in conspecific and congeneric coregonines. Additionally, the field sampling support from this project enabled an additional laboratory experiment to be conducted examining the effect of light on embryo incubations for freshwater whitefish. Propelled by this research, a degree-day model to evaluate latitudinal differences in, and potential impacts of, changing thermal habitat on the relationship between spawning and hatching dates is now under development. Knowing how populations have adapted historically to environmental variability will help us understand the range of possible responses to climate change and assist managers to conserve coregonines.

Response Of Phytoplankton Communities To Recovery From Acidification In Vermont Lakes

Project Type: Annual Base Grant
Project ID: 2019VT262B

Project Impact:

In the project “Response of phytoplankton communities to recovery from acidification in Vermont lakes,” researchers analyzed long-term monitoring and meteorological data for Vermont’s 12 acid-impaired lakes and found that, in most lakes, as pH and acid-neutralizing capacity has increased, so have concentrations of dissolved organic carbon (DOC). To assess the biological response to these processes, we collected monthly phytoplankton samples in four focus ponds (Beaver, Big Mud, Bourn, Haystack) representing a gradient of DOC concentration during ice-free seasons of 2018 and 2019. We also reconstructed paleo-chemistry and diatom community composition in Beaver Pond from approximately 1836 to the present. We found that phytoplankton community composition varied seasonally within and between lakes but was generally dominated by chrysophytes and dinoflagellates with the exception of Big Mud Pond, which was dominated by filamentous green algae. We found low concentrations of potentially bloom-forming cyanobacteria at all sites (Dolichospermum spp., Microcystis spp.), and we did not observe bloom events during the study period. Paleo analyses for Beaver Pond indicate that the largest shift in in diatom community composition has occurred over the last 30 years, but that modern assemblages are significantly different than pre-acidification. This supports our prediction that modern biological communities are influenced by additional interacting pressures despite recovery from acidification. Together, our modern and paleolimnological analyses indicate that sensitive, high-elevation ecosystems are rapidly changing in response to multiple pressures. Funding for assessment of the risk of shifts to a cyanobacteria-dominated state has been secured.

Identifying Drivers Of Change In Denitrification Capacity Of Riparian Soils During The Spring Snowmelt/runoff Period

Project Type: Annual Base Grant
Project ID: 2019VT263B

Project Impact:

Movement of nutrients during the dynamic spring snowmelt period has been linked to harmful algal blooms in Lake Champlain and other water bodies. Normally, riparian areas reduce nutrient loading to adjacent water bodies; however, soil denitrification exhibits high spatial and temporal variability. To better understand how the denitrification capacity of riparian soils changes, we measured actual denitrification rates (ADR) and key drivers of denitrification in one upland and one wetland spot along one forested and one agricultural soil transect during eight sampling events throughout spring snowmelt. Employing existing high frequency soil sensors to monitor changes in soil conditions, we collected soil samples for inorganic N and organic C analysis and downstream molecular analysis and performed quantitative polymerase chain reaction (qPCR) to quantify functional genes for nitrification, denitrification, and the bacterial community. We also performed a metagenomic analysis on all soil samples to identify and quantify many different functional genes, which will enable study of the microbial community composition of each sample and pinpoint the abundance of a wide variety of genes that impact soil biogeochemical cycling. Initial results indicate that the agricultural site had an increased magnitude of actual denitrification rates compared to the forested site. At both sites, functional denitrification genes were significantly more abundant than nitrification genes. The metagenomic analysis produced a unique and robust dataset that will be used to describe how soil microbial communities change according to land use and landscape position during spring snowmelt.