

6-2018

New Hampshire WRRC Information Transfer

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Recommended Citation

McDowell, William H., "New Hampshire WRRC Information Transfer" (2018). *NH Water Resources Research Center Scholarship*. 191.
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New Hampshire WRRC Information Transfer

Basic Information

Title:	New Hampshire WRRC Information Transfer
Project Number:	2008NH97B
Start Date:	3/1/2008
End Date:	2/28/2018
Funding Source:	104B
Congressional District:	01
Research Category:	Not Applicable
Focus Categories:	Management and Planning, Education, Non Point Pollution
Descriptors:	None
Principal Investigators:	William H. McDowell, Michelle Daley Shattuck

Publications

1. Baillio, J. 2012. 2012. Controls on variability of dissolved greenhouse gas concentration and emissions from small streams in southeastern New Hampshire. M.S. Dissertation, Department of Natural Resources & the Environment, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 111 pages.
2. Daley, M.L. and W.H. McDowell, In Preparation, Human impacts on stream nitrogen chemistry and watershed N retention across a wide range of rural to urban catchments, Ecological Applications.
3. Hope, A.J., W.H. McDowell, W.M. Wollheim, Submitted, Ecosystem metabolism and nutrient uptake in an urban, piped headwater stream, Biogeochemistry.
4. Liptzin, D., M.L. Daley, and W.H. McDowell. Accepted. A comparison of wet deposition collectors at a coastal rural site. Submitted to Water, Air, & Soil Pollution. April 2013.
5. Parham, L. 2012. Spatial and temporal variation in degradation of dissolved organic carbon on the main stem of the Lamprey River. M.S. Dissertation, Department of Natural Resources & the Environment, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 66 pages.
6. Hope, A.J., W.H. McDowell, W.M. Wollheim. 2013. Ecosystem metabolism and nutrient uptake in an urban, piped headwater stream. Biogeochemistry. September 2013. DOI 10.1007/s10533-013-9900-y
7. Liptzin, D., M.L. Daley, and W.H. McDowell. 2013. A comparison of wet deposition collectors at a coastal rural site. Water, Air, & Soil Pollution. 224(5):1558. 2013.
8. Heffernan, J.B., P.A. Soranno, M.J. Angilletta, L.B. Buckley, D.S. Gruner, T.H. Keitt, J.R. Kellner, J.S. Kominoski, A.V. Rocha, J. Xiao, T.K. Harms, S.J. Goring, L.E. Koenig, W.H. McDowell, H. Powell, A.D. Richardson, C.A. Stow, R. Vargas, K.C. Weathers. 2014. Macrosystems ecology: understanding ecological patterns and processes at continental scales. *Frontiers in Ecology and the Environment* 12: 5-14.
9. Kaushal, S.S., W.H. McDowell, and W.M. Wollheim. 2014. Tracking evolution of urban biogeochemical cycles: past, present, and future. *Biogeochemistry* 121:1-21.
10. Koenig, L.E., A.J. Baumann, and W.H. McDowell. 2014. Improving automated phosphorus measurements in freshwater: an analytical approach to eliminating silica interference. *Limnology and Oceanography: Methods*. *Limnology and Oceanography: Methods*. 12:223–231. DOI: 10.4319/lom.2014.12.223. March 2014.
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New Hampshire WRRRC Information Transfer

12. Meyer, A. 2014. Response of ammonium uptake to carbon availability in an agriculturally influenced first order stream. M.S. Dissertation, Department of Natural Resources & the Environment, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 50 pages.
13. Shonka, N. 2014. Water quality sensors provide insight into the suspended solids dynamics of high flow storm events in the Lamprey River. M.S. Dissertation, Department of Natural Resources & the Environment, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 93 pages.
14. Sullivan, M. 2014. Groundwater nitrogen attenuation in suburban and urban riparian zones. M.S. Dissertation, Department of Natural Resources & the Environment, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 94 pages.
15. Appling, A. Leon, M. and McDowell, W.H. 2014. Reducing bias and quantifying uncertainty in watershed flux estimates: The R package loadflex. Submitted December 2014 to Ecosphere.
16. Appling, A.P., Leon, M.C. and McDowell, W.H. 2015. Reducing bias and quantifying uncertainty in watershed flux estimates: The R package loadflex. *Ecosphere*. 6(12): Article 269. DOI: 10.1890/ES14-00517.1 .
17. Kaushal, S.S., McDowell, W.H., Wollheim, W.M., Newcomer Johnson, T.A., Mayer, P.M., Belt, K.T. and Pennino, M.J. 2015. Urban Evolution: The Role of Water. *Water*. 7:4063-4087. doi: 10.3390/w7084063.
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19. Pellissier, P.A., S.V. Ollinger, L.C. Lepine, M.W. Palace, and W.H. McDowell. 2015. Remote sensing of foliar nitrogen in cultivated grasslands of human dominated landscapes. *Remote Sensing of Environment*. 167:88-97.
20. Rodriguez-Cardona, B. 2015. Nitrate uptake kinetics in streams: Is carbon the driver? M.S. Dissertation, Department of Natural Resources & the Environment, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 67 pages.
21. Rodriguez-Cardona, B., Wymore, A.S. and McDowell, W.H. 2016. DOC:NO₃ ratios and NO₃ uptake in forested headwater streams. *Journal of Geophysical Research: Biogeosciences* . 121(1):205-217. doi:10.1002/2015JG003146.
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23. Contosta, A. R., Adolph, A., Burchsted, D., Burakowski, E., Green, M., Guerra, D., Albert, M., Dibb, K., Martin, M., McDowell, W.H., Routhier, M., Wake, C., Whitaker, R., and Wollheim, W. 2016. A longer vernal window: the role of winter coldness and snowpack in driving spring transitions and lags. *Global Change Biology*. DOI: 10.1111/gcb.13517.
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25. Koenig, L.E., Shattuck, M.D., Snyder, L.E., Potter, J.D. and McDowell, W.H. 2017. Deconstructing the effects of flow on stream solute interactions using a high-frequency aquatic sensor network. In review for *Water Resources Research*. Special issue “Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds”.
26. Snyder, L.E., Potter, J.D. and McDowell, W.H. 2017. An Evaluation of Nitrate, fDOM, and Turbidity Sensors in New Hampshire Streams. In review *Water Resources Research*. Special issue “Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds”.
27. Wymore, A.S., Coble, A.A. Rodríguez-Cardona, B., McDowell, W.H. 2016. Nitrate uptake across biomes and the influence of elemental stoichiometry: A new look at LINX II. *Global Biogeochemical Cycles*, 30, doi:10.1002/2016GB005468.

New Hampshire WRRRC Information Transfer

28. Wymore, AS, B Rodríguez-Cardona, and WH McDowell. 2016. Understanding dissolved organic matter biogeochemistry through in situ nutrient manipulations in stream ecosystems. *Journal of Visualized Experiments*. 116: doi: 10.3791/54704 , <http://www.jove.com/video/54704>.
29. Wymore, AS, J Potter, L Snyder, B Rodríguez-Cardona, and WH McDowell. 2017. Using in-situ optical sensors to understand the coupled biogeochemistry of carbon and nitrogen across a stream network. In review *Water Resources Research*. Special issue “Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds”.

Information Transfer

Unbridled development and population growth can have detrimental impacts to water resources and ecosystem services. Rapid population growth is occurring in New Hampshire and state regulations, planning board decisions and zoning classifications all attempt to minimize the environmental impact of this rapid population growth. Most land use planning decisions are made at the local level on a town by town basis, often by volunteers who serve on various boards, commissions and committees. Decisions by these various resource managers are often made without a full understanding of the consequences that their decisions will have on water resources or ecosystem services.

This project provided salary for the Center's Director and Associate Director to meet with state representatives, local town officials, watershed groups, school groups, the general public and scientists to discuss WRRC findings that relate to population growth, land use change and climate variability. Over the past year, the NH WRRC meet with the following organizations to discuss water resource issues: Durham Unitarian Universalist Fellowship, NH Fish and Game, Natural Resources Conservation Service (NRCS), Trout Unlimited (TU), Piscataqua Region Estuaries Partnership (PREP), NH Department of Environmental Services (DES), the US Geological Survey and the US Environmental Protection Agency (EPA). The NH WRRC website (<http://www.wrcc.unh.edu/>) is also used to disseminate information on water resources, and is updated and maintained by salary provided by this project. The Director and Associate Director dedicate time discussing current and future research in the Lamprey River Hydrologic Observatory, which is partially funded by the longstanding 104B project "Water Quality and the Landscape: Long-term monitoring of a rapidly developing suburban watershed". On January 8, 2018 the NH WRRC funded and organized the **Eleventh Annual Lamprey River Symposium** (see also below). Presentations focused on nutrients and other solutes, bacteria, sediment, hydrology, groundwater, climate and land use change, water quality indicators and monitoring programs in coastal New Hampshire. The symposium attracted approximately 90 attendees, including scientists, regional leaders, town officials, members of state agencies, and federal agencies. The agenda can be found on the NH WRRC Lamprey River Hydrologic Observatory Symposium [website](#). This annual symposium and other discussions in which the Center's Director and Associate Director participate further the research and information transfer goals of the NH WRRC.

2017 Information Transfer Activities Supported by Section 104b Funding and Matching Funds

Data sharing with Lamprey River watershed local advisory committee

The Lamprey River Advisory Committee (LRAC) is undergoing a long-term analysis of Lamprey River water quality data collected by both the Lamprey River Watershed Association's (LRWA) volunteer monitoring program and the NH WRRC 104B project "Water Quality and the Landscape: Long-term monitoring of a rapidly developing suburban watershed". The NH WRRC associate director serves on the LRAC and is a member of the water quality sub-committee which is advising a LRAC funded intern who is conducting the long-term water quality analysis. Temporal and spatial trends in dissolved oxygen, pH and nitrate have been examined thus far and further analysis is underway.

Nitrogen Data in New Hampshire's Great Bay watershed

Over the last nine years, there has been significant focus on nitrogen loading to New Hampshire's largest estuary, the Great Bay estuary, and the impairment to aquatic life it has caused. In August 2009, Great Bay, Little Bay and the tidal rivers were added to the New Hampshire 2008 303d list of impaired waters rendering them in violation of the federal Clean Water Act. Based on the most recent "State of Our Estuaries Report" prepared by PREP (2018), 33% of the nitrogen entering Great Bay and Little Bay is from point sources; the majority (67%) enters via non-point sources of pollution. The Lamprey River is the largest tributary to Great Bay, and thus the long-term data provided by the NH WRRC from the LRHO are of considerable value for watershed management. The NH WRRC provides the best dataset in NH for assessing the spatial and temporal variability in N concentrations and export in response to suburbanization and changes in land use. These 17+ years of data will be instrumental in assessing the success of current and future efforts to reduce non-point sources of nitrogen pollution reaching Great Bay. There is much interest in LRHO datasets from NH DES, PREP, EPA and other municipal, regional, state and federal agents. Many of the presentations listed below and meetings attended focused on transferring information on nutrient cycling to stakeholders throughout NH's coastal watershed and beyond. The NH WRRC has received several phone calls and meeting requests to discuss the Great Bay nitrogen issue. The NH WRRC was also asked by PREP to update the nutrient loading indicator for the 2018 State of Our Estuaries report.

Water quality monitoring advice for wood restoration projects in NH streams

The Natural Resources Conservation Service and TU have selected 23 Wetlands Reserve Program (WRP) properties in NH for wood loading restoration work. The project involves adding wood into small segments of 1st and 2nd order stream channels (averaging about 1,000 feet) with a primary goal of recreating and increasing fish spawning and rearing habitat as well as preventing bank erosion and improving stream geomorphology. A supplemental goal of this work is to study the changes in water quality and nutrient uptake which may be enhanced by adding carbon (in the form of wood) to streams. The NH WRRC Director, Associate Director and the WQAL manager have been advising the NRCS and TU on how to best understand changes in water quality and nutrient dynamics with existing financial resources. With collaboration between the NRCS, TU and the NH WRRC, baseline water quality monitoring began in 2014. Wood installations occurred mainly in 2015 and 2016 and a few properties were restored in 2017.

Drinking water quality in New Hampshire

The recent Perfluorooctanoic Acid (PFOA) and lead contamination of southern NH drinking water has prompted several inquiries to the NH WRRC and the Water Quality Analysis Laboratory (WQAL) from residents and local media concerned with drinking water quality in the state.

Symposia, Conferences and Seminars Organized and Funded

The NH WRRC funded and organized the "**Eleventh Annual Lamprey River Symposium**" held January 8, 2018 in Durham, NH. The symposium is dedicated to exchanging the results of recent research on the water quality, hydrology, water resources issues, and management of the Lamprey River basin. The Symposium is a vehicle for researchers to share data and insights with other researchers, as well as those in the management and policy arena who would benefit from exposure to the latest research on the watershed. The symposium drew approximately 90 attendees, including researchers, legislators, water system operators, town officials, regional leaders and government officials. The symposium contained 8 presentations split up over three sessions with ample time for discussion. The day ended with an open discussion on research priorities in the Lamprey watershed and southeast NH. This event was funded and organized by the NH WRRC. NH EPSCoR assisted with registration and printing. Survey results indicate that most of the attendees found the topics covered to be either helpful or very helpful.

The NH WRRC sponsored the 10th annual "**NH Water and Watershed Conference**" which was held on March 24, 2017 in Plymouth, NH. This event was designed to meet the information and networking needs of lake, river, and watershed groups; environmental organizations; volunteer monitors; municipal board and staff members; elected officials; local and regional planners; policy makers; scientists; educators; consultants and students. The 2017 conference was focused on what has transpired during the past ten years and what we might expect during the next ten years and beyond. The NH WRRC co-sponsored this conference along with Plymouth State University and the Center for the Environment, NH EPSCoR, NH DES, US Geological Survey New England Water Science Center and a few others. The conference featured a plenary speaker, approximately 30 talks, a poster session, and a workshop style session in the afternoon designed to summarize progress over the past 10 years. The conference drew approximately 250 people, including researchers, legislators, water system operators, land use planners, and government officials. The Center's Associate Director also serves on the planning committee for the annual NH Water and Watershed Conference.

Information transfer activities of the NH WRRC

Publications

Bucci, J. P., M. D. Shattuck, S. A. Aytur, R. Carey and W. H. McDowell (2017). A case study characterizing animal fecal sources in surface water using a mitochondrial DNA marker. *Environmental Monitoring and Assessment* 189(8).

Contosta, A. R., A. Adolph, D. Burchsted, E. Burakowski, M. Green, D. Guerra, M. Albert, J. Dibb, M. Martin, W. H. McDowell, M. Routhier, C. Wake, R. Whitaker and W. Wollheim (2017). A longer vernal window: the role of winter coldness and snowpack in driving spring transitions and lags. *Global Change Biology* 23(4): 1610-1625.

Hunt, C. W., L. Snyder, J. E. Salisbury, D. Vandemark and W. H. McDowell (2017). SIPCO2: A simple, inexpensive surface water pCO₂ sensor. *Limnology and Oceanography-Methods* 15(3): 291-301.

Koenig, L.E., Shattuck, M.D., Snyder, L.E., Potter, J.D. and McDowell, W.H. 2017. Deconstructing the effects of flow on DOC, nitrate, and major ion interactions using a high-frequency aquatic sensor network. *Water Resources Research*. 53: 10,655–10,673. DOI: 10.1002/2017WR020739.

Snyder, L.E., Potter, J.D. and McDowell, W.H. 2018. An Evaluation of Nitrate, fDOM, and Turbidity Sensors in New Hampshire Streams. *Water Resources Research*. Special issue “Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds”. DOI: 10.1002/2017WR020678

Wymore, AS, J Potter, L Snyder, B Rodríguez-Cardona, and WH McDowell. 2018. Using in-situ optical sensors to understand the biogeochemistry of dissolved organic matter across a stream network. *Water Resources Research*. DOI: 10.1002/2017WR022168.

Conference Proceedings & Abstracts:

Contosta, A., Burchsted, D., Burakowski, E., Green, M., Guerra, D., Albert, M., Dibb, J., Martin, M., McDowell, W.H., Routhier, M., Wake, C., Whitaker, R. and Wollheim, W. 2017. A longer vernal window: How winter coldness and snowpack influence spring transitions and lags. Northeast Ecosystem Research Cooperative Conference. March 28-29, 2017, Saratoga Springs, New York, USA.

Goodale, C. N. Ohte and WH McDowell. 2017. Convened the Biogeochemistry of nitrogen session at the 9th International Symposium on Ecosystem Behavior. BIOGEOMON August 20-24, 2017. Litomyšl Chateau, Czech Republic.

Koenig, L.E., L.E. Snyder, A.P. Appling, C. Hunt, J.D. Potter, W.H. McDowell. 2017. Annual patterns in aquatic metabolism and CO₂ emissions from New Hampshire streams (Oral). June 4-9, 2017 Society for Freshwater Science meeting, Raleigh, NC.

McDowell, W.H., J. Potter. 2017. Tradeoffs in Greenhouse Gas Fluxes from Aquatic Ecosystems Along a Rural to Urban Gradient are Driven by N Loading. 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

Shattuck, M.D. and McDowell, W.H. 2017. U.S. Geological Survey - New England Water Science Center Science Symposium: Coastal Nitrogen Research. April, 18, 2017. Worcester, MA.

Shattuck, M.D., Koenig, L. Potter, J.D., Snyder, L.E. and McDowell, W.H. 2017. Regional coherence in solute interactions during stormflow in a statewide aquatic sensor network. NH Water & Watershed Conference. March, 24, 2017. Plymouth, NH.

Wymore, A., S. Kaushal, W.H. McDowell, P. Kortelainen, E. Bernhardt, P. Johnes, W. Dodds, S. Johnson, J. Brookshire, R. Spencer, B. Rodriguez-Cardona, A. Helton, R. Barnes, A. Algerich, S. Haq, P. Sullivan, C. Lopez-Lloreda, A. Coble, M.D. Shattuck. 2017. Carbon and nitrogen stoichiometry across stream ecosystems. 2017 Fall Meeting, AGU, New Orleans, LA, 11-15 Dec.

Presentations/Information Transfer

Koenig, L. 2017. For the 5th consecutive year, Koenig served as the instructor for the STEM mini-course offered August 21st-25th, 2017 through the CONNECT program at UNH (<http://www.unh.edu/connect/>). The objective of the course is to provide an opportunity for incoming freshmen that come from groups with historically low retention in STEM majors (e.g. low-income, multicultural, first-generation college students) to build community, discover college resources, and bolster skills that are needed to succeed in their academic programs (e.g. writing of lab/research reports, basic math and statistics for analyzing scientific data). There were 13 students in the class, but the broader CONNECT program served approximately 80 students in 2017.

McDowell, W.H. 2017. Taking river biogeochemistry into the fourth dimension. Presentation to NSF EPSCoR program officers. 20 April, 2017.

McDowell, W.H. 2017. The NH Agricultural Experiment Station at the University of New Hampshire welcomed Dr. Catalino Blanche, national program leader in the Division of Environmental Systems with the U.S. Department of Agriculture. Dr. Blanche provides national leadership for forestry and research programs related to the production, protection, and utilization of forest resources, including for the McIntire-Stennis Cooperative Forestry Program. Dr. McDowell discussed with Dr. Blanche the nitrogen issues in Great Bay and the role of nitrogen cycling in suburbanizing forested watersheds that drain to the bay. Dr. McDowell also discussed the NH EPSCoR Ecosystems & Society project's investment in scientific instrumentation to build a sensor network and showed Dr. Blanche the aquatic sensors installed in the Lamprey River (the largest tributary to Great Bay) at Wiswall Dam in Durham, NH. April 26, 2017.

McDowell, W.H. and Shattuck, M. D. "Nonpoint Nitrogen Sources and Transport in New Hampshire's Great Bay Watershed". Presented 31 October 2017, at the workshop entitled "Nitrogen, Septic Systems, Great Bay and Why it Matters", Great Bay National Estuarine Research Reserve, Greenland, NH.

Shattuck, M.D. and McDowell, W.H. 2017 Nonpoint nitrogen sources and transport in the Great Bay watershed. Unitarian Universalist Church. April 30, 2017. Durham, NH.