NH Water Resources Research Center
University of New Hampshire

Annual Technical Report
2018

General Information

Products

Journal articles

Coble, A.A., Koenig LE, Potter, J.D., Parham, L.M. and McDowell W.H. 2019. Homogenization of dissolved organic matter within a river network occurs in the smallest headwaters Biogeochemistry. 143(1):85-104.

Coble, AA, AS Wymore, MD Shattuck, JD Potter, and WH McDowell. 2018. Multi-year trends in solute concentrations and fluxes from a suburban watershed: evaluating effects of 100-year flood events. Journal of Geophysical Research – Biogeosciences. 123(9): 3072-3087. DOI: 10.1029/2018JG004657.

Farrell, K. J., Rosemond, A. D., Kominoski, J. S., Bonjour, S. M., Rugg, J., Koenig, L. E., et al. (2018). Variation in Detrital Resource Stoichiometry Signals Differential Carbon to Nutrient Limitation for Stream Consumers Across Biomes. Ecosystems, 21(8), 1676-1691.

Gavin, A. L., Nelson, S. J., Klemmer, A. J., Fernandez, I. J., Strock, K. E., & McDowell, W. H. (2018). Acidification and Climate Linkages to Increased Dissolved Organic Carbon in High-Elevation Lakes. Water Resources Research, 54(8), 5376-5393.

Marinos, R. E., Campbell, J. L., Driscoll, C. T., Likens, G. E., McDowell, W. H., Rosi, E. J., et al. (2018). Give and Take: A Watershed Acid Rain Mitigation Experiment Increases Baseflow Nitrogen Retention but Increases Stormflow Nitrogen Export. Environmental Science & Technology, 52(22), 13155-13165.

Patel K.F., S.J. Nelson, C.J. Spencer, I.J. Fernandez, 2018. Fifteen-year record of soil temperature for the Bear Brook Watershed in Maine. Scientific Data. DOI: 10.1038/sdata.2018.153.

Patel, K., Fernandez, I.J., Nelson, S.J., Gruselle, M.-C., Norton, S.A., and Weiskittel, A.R. 2019. Forest N dynamics after 25 years of whole watershed N enrichment: The Bear Brook Watershed in Maine. Soil Science Society of America Journal. In Press.

Richter, D. D., Billings, S. A., Groffman, P. M., Kelly, E. F., Lohse, K. A., McDowell, W. H., et al. 2018. Ideas and perspectives: Strengthening the biogeosciences in environmental research networks. Biogeosciences. 15(15): 4815-4832. doi:10.5194/bg-15-4815-2018.

Sebestyen, S.D., Kendall, C., Elliott, E.M., Schiff, S.L., Barnes, R.T., Bostic, J.T., Buda, A.R., Burns, D.A., Campbell, J.L., Dail, D.B., Eshleman, K.N., Fernandez, I.J., Finlay, J.C., Goodale, C.L., Griffiths, N.A., Hall, S.J., Lawrence, G.B., Lovett, G.M., McHale, P.J., Mitchell, M.J., Nelson, D.M., Nelson, S.J., Ohte, N., Pardo, L.H., Rose, L.A., Ross, D.S., Sabo, R.D., Shanley, J.B., Shattuck, M.D., Spoelstra, J., Weintraub, S.R., Wickman, T.R., Williard, K.W. J. 2019. Nitrate isotope database for meteoric waters, surface waters, soil waters, and groundwaters. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2019-0003

Sebestyen, S.D., Ross, D.S., Shanley, J.B., Elliott, E.M., Kendall, C., Campbell, J.L., Dail, D.B., Fernandez, I.J., Goodale, C.L., Lawrence, G. and Lovett, G.M., McHale, P.J., Mitchell, M.J., Nelson, S.J., Shattuck, M.D., Wickman, T.R., Barnes, R.T., Bostic, J.T., Buda, A.R., Burns, D.A., Eshleman, K.N., Finlay, J.C., Nelson, D.M., Ohte, N., Pardo, L.H., Rose, L.A., Sabo, R.A., Schiff, S.L., Spoelstra, J., Williard, K.W.J. 2019. Unprocessed atmospheric nitrate in waters of the Northern Forest Region in the USA and Canada. Environmental Science & Technology. Environmental Science and Technology, 53(7): 3620-3633.

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

Wilhelm JF, Bain DJ, Green MB, Bush KF, McDowell WH (2019) Trace metals in Northern New England streams:

Evaluating the role of road salt across broad spatial scales with synoptic snapshots. PLoS ONE 14(2): e0212011. https://doi.org/10.1371/journal.pone.0212011

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.

Theses/dissertations

Gavin, A. 2018. Physical and Chemical Response of Small, North Temperate Lakes to Recovery From Acidification and Climate Change. M.S. Thesis, Ecology and Environmental Sciences, University of Maine, August, 2018.

Press Releases

McDowell, W.H. 2019. Media Advisory: UNH Expert to Comment on EPA Change to Clean Water Act. NH WRRC director McDowell available for interviews. February 2019.

Schaier, S. 2019. Muddy Waters. Navigating potential changes to Clean Water Act. UNH Today January 2, 2019. Interviewed William H. McDowell. https://www.unh.edu/unhtoday/2019/01/muddy-waters

Presentations

Ardon, M.; Zeglin, L.; Utz, R.; Cooper, Scott; Dodds, W; Bixby, R.; Burdett, A.; Follstad S.J.; Griffiths, N.; Harms, T.; Johnson, L.; Johnson, S.; Jones, J.; kominoski, J.; McDowell, W.H.; Rosemond, A.; Trentman, M.T.; Van Horn, D.; Ward, A. 2019. Experimental nutrient enrichment stimulates multipole trophic levels through algal and detrital food web pathways: A global meta-analysis from streams and rivers. 2019 Society for Freshwater Science Annual Meeting. Salt Lake City, UT. May 19-23, 2019.

Bernhardt, E. M. Vlah, M, Cohen, N. Grimm, R. Hall, J. Heffernan, A. Helton, W.H. McDowell, B. McGlynn, J. Read, E. Stanley. 2018. StreamPULSE: Large-scale collaborative monitoring of streams' vital rhythms. Society for Freshwater Science, Detroit, MI May 2018

Chancey, D.D. and W.H. McDowell. 2019. The influence of land use on wood decomposition and algal growth. University of New Hampshire Undergraduate Research Conference. Durham, NH. April 27, 2019.

Coble, A.A., A.S. Wymore, M.D. Shattuck, J.D. Potter, W.H. McDowell. Multi-year trends in solute concentrations and fluxes from a suburban watershed: Evaluating effects of 100-year flood events. Society for Freshwater Science. Detroit Michigan. May 20-24, 2018.

Dessu, S. B., Price, R., Wymore, A., Kominoski, J. S., Davis, S. E., McDowell, W. H., Gaiser, E. 2018. Development and Application of Percentile-Range Indexed Mapping and Evaluation (PRIME) Tool for Long Term Ecological Assessment. 2018 Fall Meeting, AGU, Washington D.C., 10-14 Dec 2018.

Fazekas, H., Wymore, A., McDowell, W.H. 2019. High-frequency data reveals spatiotemporal variability in carbon and nitrogen concentration-discharge relationships across a stream network. 2019 Society for Freshwater Science Annual Meeting. Salt Lake City, UT. May 19-23, 2019.

Fazekas, H.M., Potter, J.D., Snyder, L., Shattuck., M.D. and McDowell, W.H. 2019. High-frequency in situ optical sensors reveal spatial, seasonal, and annual trends in nitrate export to the Great Bay Estuary. ASLO 2019 Aquatic Sciences Meeting. San Juan, PR. 23 February - 2 March 2019.

Fernandez, I. J., Norton, S. A., Nelson, S. J., and Patel, K., 2019, Trajectories of recovery from acid rain over 31 years (ambient) and 2 years (experimental) at the Bear Brook Watershed in Maine (BBWM), USA (oral): Annual meeting of the Society of Freshwater Science, Salt Lake City, Utah.

Gavin, A.L., S.J. Nelson, A.J. Klemmer, I.J. Fernandez, K. Strock, J.E. Saros, C. Funk, J.A. Lynch. Acidification and

Climate Linkages to Increased Dissolved Organic Carbon in High Elevation Lakes. AGU (American Geophysical Union) Annual Meeting, Washington, D.C., December 10-14, 2018.

Gavin, A.L., S.J. Nelson, I.J. Fernandez, J.E. Saros, A.J. Klemmer, K.E. Strock, W.H. McDowell, 2018. Assessing Dissolved Organic Carbon Trends in Maine Lakes. Maine Water Conference, Augusta, ME, March 29, 2018.

Herreid, A., Wymore, A. Varner, R. and McDowell, W.H. Controls on greenhouse gas production in streams across a land use gradient. ASLO 2019 Aquatic Sciences Meeting. San Juan, PR. 23 February - 2 March 2019.

Herreid, A., Wymore, A., Varner, R. K., McDowell, W.H. 2018. Controls on greenhouse gas production in streams across a land use gradient. 2018 Fall Meeting, AGU, Washington D.C., 10-14 Dec 2018.

Marcarelli, A.; Sponseller, R.; Kirk, L.; Arroita, M.; Arnon, S.; Grace, M.; Martí, E.; McDowell, W.H.; Segura, C.; Subalusky, A.; Tank, J.L.; Tromboni, F.; Ulseth, A. 2019. Mirror Mirror: The role of heterotrophy in running waters informed by the strength and variation in the relationship between ER and GPP. 2019 Society for Freshwater Science Annual Meeting. Salt Lake City, UT. May 19-23, 2019.

McDowell, W.H. 2018. Invited participant and presenter at Parallel session 1C, “Optimizing the use and outcomes of national Research Infrastructures through international participation”, International Conference on Research Infrastructures, ICRI, September 12-14, 2018. Vienna, Austria

McDowell, W.H. 2019. Long-term, continuous stream chemistry records provide new insights into watershed function. Annual Meeting of the Hubbard Brook Ecosystem Study. North Woodstock, NH. July 2019.

McDowell, W.H. 2019. Vision and opportunities for connecting NEON to coordinated open watershed networks. Leveraging distributed research networks to understand watershed systems. Workshop for the U.S. Dept. of Energy, Biological & Environmental Research Program. Rockville, MD. January 28-30, 2019.

McDowell, W.H., Herreid, A. Lassaletta, L., Shibata, H. and Potter, J. 2018. Global assessment of N2O emission from aquatic and terrestrial ecosystems: Challenge of the ILTER-N initiative. International Long Term Ecological Reseasrch (ILTER) annual meeting. Taichung, Taiwan, 15-19 October 2018

McDowell, W.H., L.E. Koenig, L.E. Snyder, and J.D. Potter. 2018. Regional coherence of stream nitrate concentrations: implications for theory and management. 2018 meeting of the Northeast chapter of the Geological Society of America. Burlington, VT. 18–20 March 2018.

Nelson, S., A. Gavin, J. Daly, R. Hovel, S. Dykema, 2019. Long-term monitoring lakes in Maine (US-EPA LTM Network). LEA (Lakes Environmental Association) Annual Lake Researcher Retreat, Bridgton, ME, January 11, 2019.

Norton, S. and Fernandez, I. J., 2019, Influences of discharge, pH, and DOC on Rare Earth Element concentrations during recovery from acid rain at the Bear Brook Watershed in Maine (BBWM) (poster): Annual Meeting of the Society of Freshwater Science, Salt Lake City, Utah.

Patel, K., I. Fernandez, M. Gruselle, S. Norton, S. Nelson, A. Weiskittel, 2018. 25 years of whole-watershed experimental N additions in a forested Maine watershed. National Atmospheric Deposition Program Scientific Symposium. Albany, New York. Nov.5-9, 2018.

Patel, K., I. Fernandez, M. Gruselle, S. Norton, S. Nelson, A. Weiskittel, 2018. Multi-decadal evolution of nitrogen dynamics at the Bear Brook Watershed in Maine. Acadia National Park Science Symposium. College of the Atlantic, Bar Harbor, Maine. Oct. 20, 2018.

Patel, K., I. Fernandez, M. Gruselle, S. Norton, S. Nelson, A. Weiskittel, 2018. Multi-decadal evolution of nitrogen dynamics at the Bear Brook Watershed in Maine. North American Forest Soils Conference – International Symposium on Forest Soils. Soils-Forests Interactions in Changing Environments. Quebec City, Quebec, Canada. June 10-16.

Potter, J., A. Wymore, and W.H. McDowell. 2018. Greenhouse gas fluxes from aquatic ecosystems along a rural to urban gradient are driven by N loading. Society for Freshwater Science, Detroit, MI May 2018

Rodríguez-Cardona, B. 2018. Carbon and nitrogen dynamics in streams across biomes. Seminar at the Centre d'Estudis Avançats de Blanes (CEAB), in Blanes, Spain. March 22, 2018.

Rodríguez-Cardona, B. 2019. Signed up as a “Skype a Scientist” participant. Skype a Scientist matches scientists with classrooms around the world. (https://www.skypeascientist.com/)

Rodriguez-Cardona, B., Wymore, A., Kortelainen, P., Argerich, A., Johnson, S. and McDowell, W.H. 2019. Long-term trends in dissolved organic carbon from fluvial systems across biomes. ASLO 2019 Aquatic Sciences Meeting. San Juan, PR. 23 February - 2 March 2019.

Saccardi, B., McDowell, W.H., Wymore, A. and Wollheim, W. 2019. New insights into the CO2 dynamics of streams from NDIR sensors. 2019 Society for Freshwater Science Annual Meeting. Salt Lake City, UT. May 19-23, 2019.

Sebestyen, S., C. Kendall, E. Elliott, S. Schiff, R. Barnes, J. Bostic, T. Buda, D. Burns, J. Campbell, B. Dail, K. Eshleman, I. Fernandez, J. Finlay, C. Goodale, N. Griffiths, S. Hall, G. Lawrence, G. Lovett, P. McHale, M. Mitchell, D. Nelson, S. Nelson, N. Ohte, L. Pardo, L. Rose, D. Ross, R. Sabo, J. Shanley, M. Shattuck, J. Spoelstra, S. Weintraub, T. Wickman, K. Williard, 2018. A database of nitrate isotopes in waters of forests of the USA and Canada. AGU (American Geophysical Union) Annual Meeting, Washington, D.C., December 10-14, 2018.

Shanley, J.B., Sebestyen, S. D., McDowell, W.H., Kram, P., Oulehle, F. 2018. The scientific and societal value of long-term watershed research (Invited). 2018 Fall Meeting, AGU, Washington D.C., 10-14 Dec.

Shattuck, M.D. and McDowell, W.H. 2019. Human impacts on stream nitrogen chemistry and watershed N retention across a wide range of rural to urban catchments. ASLO 2019 Aquatic Sciences Meeting. San Juan, PR. 23 February - 2 March 2019.

Song, C., W. Dodds, J. Ruegg, A. Argerich, C. Baker,W.B. Bowden, M. Douglas, K. Farrell, M.B. Flinn, E.Garcia, A. Helton, T. Harms, J. Shufang,, J. Jones, L. Koenig, J.S. Kominoski, W.H. McDowell, D. McMaster, S.P. Damien;Parker, A.D. Rosemond, C. Ruffing, K. Sheehan, M.T. Trentman, M. Whiles, W. Wollheim, F. Ballantyne. 2018. Warming induces asymmetric convergence of stream metabolic balance. Society for Freshwater Science, Detroit, MI May 2018

Stephanie Dykema, Sarah Nelson, Rachel Hovel, 2019. Phenological response of zooplankton to variation in spring warming and ice-out in small Maine lakes. Maine Sustainability and Water Conference, March 28, 2019, Augusta, ME.

Taylor, V. 2019. Landscape and water chemistry controls of methylmercury levels in streams of a forested watershed in New Hampshire, USA. Poster presentation at the International Conference on Mercury as a Global Contaminant. Krakow, Poland. 8-13 September 2019.

Taylor, V.; Buckman, K.; Chen, C.; Cottingham, K. Effects of dissolved organic carbon on methylmercury loading and bioavailability in stream ecosystems. Oral presentation at the Association for the Study of Limnology and Oceanography Meeting, Victoria, British Columbia, Canada, 12 June 2018. (Special Symposium 63)

Wymore, A., A. Helton, R. Barnes, J. Brookshire, S. Kaushal, E. Bernhardt, W.K. Dodds, P. Johnes, S. Johnson, P. Kortelainen, W.H. McDowell, R. Spencer, B. Rodriguez-Cardona, A. Argerich, A. Coble, C. Lopez-Lloreda, P. Sullivan, S. Haq, M. Shattuck. 2018. (De)-coupling of dissolved organic carbon and dissolved organic nitrogen across stream ecosystems. Society for Freshwater Science, Detroit, MI May 2018.

Wymore, A., Krueger, S., Van Der Hout, J. and McDowell, W.H. 2019. Exploring the ecological duality of dissolved organic nitrogen with field based experimental evidence. ASLO 2019 Aquatic Sciences Meeting. San Juan, PR. 23 February - 2 March 2019.

Wymore, AS. 2018. Global patterns in stream energy and nutrient cycling. Long Term Ecological Research webinar. March 2018. (https://www.youtube.com/watch?v=suEFjtltbEE)

Wymore, AS. 2018. Using long-term observational data to better understand carbon: nitrogen ratios in stream ecosystems. Departmental seminar. University of New Hampshire. April 2018.

Other

Hughes, M. 2019. Salem couple works to clean up swamp 'It just blows my mind how much trash there is'. The Eagle-Tribune. North Andover, Massachusetts. May 2, 2019. Interviewed William H. McDowell. https://www.eagletribune.com/news/salem-couple-works-to-clean-up-swamp/article_f40339af-4281-5940-bea0-88dce993055a.html

McDowell, W.H. 2018. Clean Air Scientific Advisory Committee (CASAC) Oxides of Nitrogen, Oxides of Sulfur, and Particulate Matter - Ecological Criteria National Ambient Air Quality Standards (NAAQS) review panel.

McDowell, W.H. 2018. Graduate short course on watershed biogeochemistry, Beijing Normal University, 11-14 April 2018

McDowell, W.H. 2018. Served on a panel for as part of a Pathway to Professorship program workshop. A panel of full professors shared their insights with Associate Professors who are interested putting a case forward for promotion. October 19, 2018.

Shattuck, M.D. 2019. Guest speaker at Epping Middle School. Talked with 6th graders about the importance of cleaning up the Lamprey River and keeping it clean. Demonstrated use of field meters to determine water quality. April 15, 2019.

Shibata, H. and McDowell, W.H. 2019. Organized the “Challenges for global assessment of nitrogen impacts to human and environments” workshop at the 2nd International L Open Science Meeting. Leipzig, Germany. September 2-6, 2019.

Sidder, Aaron. 2018. Effects of Acid Rain, Climate Change on Freshwater Lakes. AGU - EOS Research Spotlight, 11 July 2018 Available: https://eos.org/research-spotlights/effects-of-acid-rain-climate-change-on-freshwater-lakes

Snyder, L. 2019. Met with a group of 15 Girl Scouts (4th-6th grade) at site DCF in Deerfield, NH as part of their capstone project to discuss the NH water quality sensor network and how seasonality, watershed characteristics and human activity affects water quality. Lisle demonstrated how salt (particularly road salt) affects water quality.

Information Transfer Program

The Information Transfer project provided salary for the Center's Director and Associate Director to meet with state representatives, local town officials, watershed groups, scientists and the general public to discuss NH WRRC findings regarding the impacts of population growth on potable water supply and ecosystem health in New Hampshire and the region. The NH WRRC website (http://www.wrrc.unh.edu/) is used to disseminate information on water resources and is also maintained with funding provided by this project.

This project also provided salary for the NH WRRC Associate Director to participate on the planning committee of the NH Water and Watershed Conference (NHWWC) and to organize the Annual Lamprey River Symposium. The annual NHWWC is designed to meet the information and networking needs of watershed groups, environmental organizations, volunteers, municipal board and staff members, consultants, elected officials, planners, policy makers, scientists, educators, and students. The state conference typically draws over 250 people. The goal of the Annual Lamprey River Symposium is to facilitate discussion and collaboration among scientists working in the Lamprey River basin and to engage local, state and federal officials, watershed organizations, and concerned citizens with the science and its implications for Great Bay and the entire coastal watershed. The symposium attracts approximately 90 attendees. The Lamprey River is the largest tributary to Great Bay and the recent impairment of Great Bay for elevated nitrogen has prompted significant focus on reducing nitrogen loading to the bay. Both the Director and Associate Director have participated in numerous discussions around this topic.

Student Support

Undergraduate students 11
Graduate students 8
Post-docs 2

Notable Achievements and Awards

Adam Wymore was awarded $28,649 from the University of New Hampshire Collaborative Research Excellence (CoRE) Initiative for the project: Watershed Informatics: Integrating big data to understand watersheds in a changing world.

Allison Herreid was selected as an ASLO Limnology and Oceanography Research Exchange (LOREX) program participant. This NSF-funded graduate student program was initiated in order to further connect ASLO members through international research collaboration. Allison will be assessing the influence of N cycling processes on greenhouse gas production (CO2, N2O, and CH4) in streams using steady state nutrient releases in Abisko, Sweden. Summer 2019.

William H. McDowell was elected a 2018 Fellow of the American Association for the Advancement of Science (AAAS). This is a lifetime honor in recognition of his extraordinary achievements in advancing science. November 27, 2018. https://www.aaas.org/news/aaas-honors-accomplished-scientists-2018-elected-fellows.

Projects

Determining the effectiveness of the Clean Air Act and Amendments on the recovery of surface waters in the northeastern US

Project Type: Coordination Grant **Project ID:** EPA/USGS agreement # DW-014-92478401-0 USGS/UNH agreement # G18AP00030

Project Impact: This project continues the important work of the Regionalized Long-Term Monitoring program (RLTM) of the US Environmental Protection Agency (EPA) Long-Term Monitoring (LTM) Network. The RLTM program is operated through EPA's Clean Air Markets Division (CAMD) and RLTM data are incorporated with the other LTM programs to monitor chemical trends and potential environmental responses from the Clean Air Act Amendments of 1990 (CAAA) and subsequent emissions reductions programs. Progress on objectives is reported below: Objectives 1 and 9 are complete for 2018. Sampling and analysis proceeded as described in the QAPP and final data has been submitted to EPA CAMD for 16 RLTM, 12 HELM and 1 Bear Brook Watershed in Maine (BBWM) sites. Objectives 2, 3, 4, 7 are in progress. The following objectives are accomplished and ongoing: Objective 5: Document changes in dissolved organic carbon (DOC), water clarity, and lake thermal structure (Gavin et al. 2018) Objective 6: Analyze optical properties of DOC (SUVA and fluorescence) Objective 8: Evaluate precipitation and other hydrologic indices across the Maine study region (Gavin et al. 2018) This information is fundamental for EPA to meet the Congressional mandate for reporting on the effectiveness of the CAAA. The highly effective combination of site-specific data within a regional context will provide for the recognition of trends and understanding of processes relating to declining SO4, base cation depletion, and changes in N-saturation or DOC contributions to acid-base status. The results are central to the decisions on additional emission changes.

Effects of dissolved organic carbon on methylmercury bioavailability in stream ecosystems

Project Type: National Competitive Grant **Project ID:** 2016NH205G

Project Impact: Our work to date has advanced understanding of how combined landscape and chemical parameters drive levels of methylmercury, a potent neurotoxin, in streams. Watersheds in the Northeastern U.S. are prone to high levels of methylmercury, which can bioaccumulate to toxic levels in stream biota and be transferred to downstream water bodies. In field comparisons of 27 streams across a single watershed, we found that high levels of methylmercury in stream water were most strongly associated with elevated levels of dissolved organic carbon and iron. Stream chemistry was also strongly related to landscape parameters, where streams draining from small lakes had more microbially-mediated dissolved organic carbon and lower levels of methylmercury, whereas streams with wetlands in their catchments had more humic dissolved organic carbon and higher levels of methylmercury. In longitudinal sampling of 3 focal streams, methylmercury, iron, and dissolved organic carbon varied temporally. ethylmercury concentrations in wetland-draining streams were highest when temperatures were warm, promoting reducing conditions in watershed soils and wetlands. As such, this project identified conditions related to elevated methylmercury concentrations in streams on both a spatial and temporal scale, which is important to identifying and monitoring environments sensitive to mercury accumulation. In addition to field work, we have developed protocols for growing natural assemblages of biofilm in stream mesocosms, which are being applied to ongoing experiments on mercury uptake in the presence of different concentrations and characteristics of dissolved organic carbon. Results are being shared with the Lake Sunapee Protective Association and the association's Science Advisory Committee.

Water Quality and the Landscape: Long-term monitoring of rapidly developing suburban watersheds

Project Type: Annual Base Grant **Project ID:** 2003NH21B

Project Impact: This project documents long-term changes to water quality in three of New Hampshire's rapidly developing watersheds: the Ossipee River watershed in central NH and the Lamprey and Oyster River watersheds located in southeast NH. Samples are collected by staff, students and volunteers and analyzed in the NH Water Quality Analysis Laboratory at by staff and students. In the Lamprey and Oyster River watersheds where we have

more than 15 years of data, we have begun to document changes in water quality. We have documented a statistically significant long-term increase in mean annual NO3- in the Lamprey River from 2000-2017. In both the Lamprey and Oyster River watersheds, we have documented a dramatic increase in Na+ and Cl- over a longer time period in response to increased road salt application in these watersheds (Daley et al. 2009 and recent data). Continued long-term monitoring of these sites is necessary to determine if the direction and magnitude of these documented changes will continue with ongoing changes in land use, watershed management practices and climate variability. The Lamprey River is the largest tributary to NH's most significant estuary, the Great Bay estuary. Most of the estuarine waters of the Great Bay were classified as "impaired" by elevated nitrogen in 2009. Our long-term monitoring of surface waters throughout the Lamprey and Oyster watersheds complement existing Great Bay datasets and will provide necessary monitoring data to assess whether future management strategies to reduce the nitrogen load delivered to Great Bay are effective.