

# **New Hampshire Water Resources Research Center**

## **University of New Hampshire**

### **Program Evaluation Report Fiscal Years 2011 - 2015**



**Submitted by:**

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**To:**

**Office of External Research  
Water Resources Discipline  
U.S. Geological Survey**

## Preface

The New Hampshire Water Resources Research Center receives an annual Federal matching grant as authorized by §104 of the Water Resources Research Act of 1984 (Public Law 98-242) as amended by Public Laws 101-397, 104-147, 106-374, and 109-471. §104 of the Act requires that the Secretary of the Interior "conduct a careful and detailed evaluation of each institute at least once every 3 years to determine that the quality and relevance of its water resources research and its effectiveness at producing measured results and applied water supply research as an institution for planning, conducting, and arranging for research warrants its continued support under this section." The U.S. Geological Survey (USGS), Department of the Interior, administers the provisions of the Act. This evaluation report describes, in the format prescribed by the USGS, the research, training, and information transfer activities supported by the §104 grants and required matching funds in fiscal years 2011 through 2015. Prior to 2008, the Act required an evaluation of the program at least once every 5 years. The last evaluation was conducted in 2013, covering fiscal years 2008 through 2010.

New Hampshire Water Resources Research Center  
EVALUATION REPORT  
FY 2011 - FY 2015

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# Introduction

The New Hampshire Water Resources Research Center (NH WRRC), located on the campus of the University of New Hampshire, is an institute that serves as a focal point for research and information on water issues in the state. The NH WRRC actually predates the Federal program. In the late 1950s Professor Gordon Byers began a Water Center at UNH. This Center was incorporated into the Federal program in 1965 as one of the original 14 state institutes established under the Water Resource Research Act of 1964. During this reporting period (FY2011-FY2015) the NH WRRC was directed by Dr. William McDowell with administrative and technical assistance from Michelle (Daley) Shattuck (associate director) and Jody Potter (Water Quality Analysis Lab manager). Michelle (Daley) Shattuck served as the acting director from 2013-2014 while Dr. McDowell served as a Program Officer at the National Science Foundation (NSF) in the Division of Environmental Biology (Ecosystems Cluster).

The NH WRRC is a stand-alone organization, in that it is not directly affiliated with any other administrative unit at UNH. With the present director, it reports administratively to the Associate Dean for Research of the College of Life Sciences and Agriculture. The NH WRRC has no dedicated laboratory or research space, and instead relies on space allocated for the research activities of the WRRC director by COLSA. The NH WRRC does have administrative space on campus, which houses WRRC files and short-term visiting staff and graduate students. The WRRC website ([www.wrrc.unh.edu](http://www.wrrc.unh.edu)) serves as a focal point for information dissemination and includes NH WRRC publications and results from past research, as well as links to other sites of interest to NH citizens and researchers.

## ***The Water Resource Issues and Problems of New Hampshire***

New Hampshire's surface waters are a very valuable resource, contributing to the state's economic base through tourism and recreation (fishing, boating, and swimming), enhanced real estate values and drinking water supplies. Maintaining sufficient water quality to support these uses is imperative to sustaining the state's economy and quality of life. New Hampshire has experienced rapid growth in several counties. From 1990 to 2004 the state grew twice as fast as the rest of New England, with a state-wide average population increase of 17.2% during that period (Society for Protection of NH Forests 2005). New Hampshire's population growth has slowed slightly and from 2000-2010 the state experienced a 6.5% population gain. This was still the largest gain among northeastern states and the fastest-growing areas in New England are concentrated in southern and central NH (Johnson 2012). New Hampshire watersheds rank among the most highly threatened watersheds in the nation because of the high potential for conversion of private forests to residential development. In fact, three of the four most threatened watersheds in the US which could experience the largest change in water quality as a result of increased residential development in private forests occur at least partially in New Hampshire (Stein et al. 2009).

A survey of NH water resource stakeholders was conducted in 1998 to get a sense of New Hampshire's most significant water resource problems and concerns and to develop a list of research priorities for the NH WRRC (Table 1). Almost all of the issues can be included into the broad category of Land Use and Water Quality. Similar results were obtained from the 2009 NH State Water Survey, which showed that 82% of those responding were very concerned or somewhat concerned about the effects of development on water quality, and 77% were concerned about potential contamination of aquifers and drinking water wells. This is not terribly surprising based on the rapid development and population pressures of the recent decades, particularly in southern areas of the state. The long-term effects of development and land use change are

uncertain, with potential impacts on water quantity, in-stream flows, and water quality. Of particular concern are the impacts of non-point sources of pollution such as septic systems, urban runoff, stormwater, application of road salt and fertilizers, deforestation, and wetland conversion.

Table 1. NH WRRC research priority issues, based on a survey of stakeholders.

#### Surface Water

Land use impact on surface water quality

Non-point source pollution

Effects of urban development and storm water runoff on surface water quality

Impacts of highway and road maintenance on surface water quality

Low flow wastewater flow interactions and effect on surface water quality

Linking water quality data and biological functions

Effect of septic systems on surface water quality

#### Groundwater

Bedrock aquifer delineation and protection

Mapping aquifers for GIS data base

Effects of sand and gravel extraction, landfills or municipal transfer stations on groundwater quality

Effects of septic systems on groundwater quality

Groundwater availability

Artificial recharge

#### Land Use/Application

Impact of development/land use on surface and groundwater quality

Biosolids in land farming

Buffer zone/riparian zone effectiveness with different land use

BMP effectiveness

Management/Planning Issues

Impact of development

Level of sustainable development

Watershed

Watershed approach to management decisions

Watershed approach to studying water quality

Systems approach on a watershed scale to management: economic factors and quality of life

Watershed resilience and ecosystem services

Technology Transfer

Water quality and water use

Water conservation education

Water Supply

Quantity and quality issues

Reliability and resilience

Effects of climate change

Planning and conservation

Management, regulation and allocation

Infrastructure improvement

### ***Institute Mission and Vision: An Overview***

The primary charges of each institute are: research, information transfer and education of new professionals. The institutes accomplish these charges through Federal and state funding mechanisms. Annually, the NH WRRC supports several (typically 2-4) research projects with its 104b funding, often hiring one or more

students to help perform the research. Several lake and watershed monitoring groups have also been involved in research projects, allowing for an information exchange between researchers, citizen scientists and the general public. Recent research topics include: effects of suburban development on stream water and groundwater quality which includes long-term monitoring of rapidly developing NH basins, evaluating the impacts of natural dams on stream biogeochemistry at the river network scale, assessing the contribution of wetlands to nitrogen retention in urbanizing coastal watersheds, improving ecosystem indicator tools through genomic analysis of attached algae and assessing ecological stress in New Hampshire streams from road salt. A list of current and previous research projects can be found at our NH WRRC website (<http://www.wrrc.unh.edu/research-projects>). All research results are published and available online at the Center's website (<http://www.wrrc.unh.edu/nh-wrrc-publications>). Information and technology transfer occurs through attending and presenting at town meetings, watershed meetings and state conferences, phone conversations, fact sheet development and press releases in local newspapers. WRRC staff often make public presentations on watershed management, effects of suburbanization on water quality, and various aspects of water quality management. They also make presentations at national and international meetings on a variety of scientific topics.

The Water Quality Analysis Lab (WQAL) is affiliated with the NH WRRC and facilitates water resources research through technical assistance and sample analysis. The WQAL was established by the Department of Natural Resources in 1996 to meet the needs of various research and teaching projects both on and off the UNH campus. It is currently administered by the NH WRRC and housed in James Hall. The mission of the Water Quality Analysis Laboratory is to provide high-quality, reasonably priced analyses in support of research projects conducted by scientists and students throughout the University, state, and nation. Past clients have included numerous research groups on the UNH campus, Federal agencies, scientists from other universities, and private firms. Many thousands of analyses are conducted each year.

To further encourage and support water resources research and education, the NH WRRC has led the development of a hydrologic observatory centered on the Lamprey River of southeastern NH. The entire Lamprey River basin is referred to as the Lamprey River Hydrologic Observatory (LRHO) and serves as a platform for research, student training, and community engagement and outreach. The LRHO captures many of the most important water issues facing the state including water withdrawals and transfers for public drinking water supply, wastewater disposal, numerous dams, low dissolved oxygen levels, arsenic contamination of groundwater, and pressures from rapid population growth and land use change. The LRHO contains lakes with high recreational value, discharges to the state's largest estuary (Great Bay) which is currently impaired by elevated nitrogen, and has both an active watershed association and local advisory committee.

The LRHO currently involves faculty, staff and students from the Department of Natural Resources & the Environment, the Department of Earth Science and the Department of Civil and Environmental Engineering. Research topics addressed as part of the LRHO include the hydrology, biology, biogeochemistry and management of a suburban basin. The NH WRRC has provided laboratory equipment and technical advice needed for various research projects and long-term monitoring of the Lamprey River. The NH WRRC also organizes annual symposia for LRHO researchers and local managers to promote information transfer. A small part of the annual 104b funding supports LRHO monitoring and the annual symposium. Other LRHO research is funded by a wide variety of state, University, and federal grants.

## Section 104 Objectives

The primary emphasis of the 104b funding is water resources research and education of undergraduate and graduate students through support of research projects. Matching funds are also used to support research and education of students, but a large portion of the matching funds are used for information transfer. The NH WRRC research objectives are primarily dictated by the list of research priorities in table 1 but do vary based on the interests of the principal investigators applying for funding. Additional NH WRRC goals are to:

1. Plan, conduct or otherwise arrange for competent research that fosters:
  - Training and education of future water scientists, engineers and technicians
  - The preliminary exploration of new ideas that address water problems or expand understanding of water and water-related phenomena
  - The dissemination of research results to water managers and the public
2. Cooperate closely with other colleges and universities in the State that have demonstrated capabilities for research, information dissemination and graduate training.

<b>Allocation of Federal Grant and Matching Funds Among Program Activities: FY 2011 through FY 2015</b>	
<b>Activity</b>	<b>Percent</b>
Research	50
Information Transfer	22
Education	20
Administration	8
Other (please specify)	0
Total	100



# Administration and Coordination

## *Institute Directors during Evaluation Period*

Name	Academic Discipline	Term
William H. McDowell	Biogeochemistry	Feb 2000-Aug 2013
Michelle Daley	Biogeochemistry	Aug 2013-Aug 2014
William H. McDowell	Biogeochemistry	Aug 2014-Present

## **Advisory Committees**

We formed a formal organized advisory committee in 2011 that is scheduled to meet twice a year. The first meeting is typically scheduled for late summer to review and comment on the annual NH WRRC request for 104b proposals (RFP) and the overall NH WRRC program. The second meeting is scheduled for late November/early December to discuss reviews of the submitted 104b proposals and to select proposals for inclusion in the annual NH WRRC section 104 proposal to the U.S. Geological Survey (USGS). We make use of teleconferencing and videoconferencing to limit travel commitments for non-university members.

A list of advisory committee members since 2011 is below:

- Dan Sundquist, Society for the Protection of New Hampshire Forests, Director of Land Conservation Planning, 2011-2013
- Jacquie Colburn, NH Dept. of Environmental Services, Water/Watershed Bureau Rivers and Lakes Coordinator, 2011-2014
- Keith Robinson, USGS, NH/VT Water Science Center, Director, 2011-Present
- Ted Diers, NH Dept. of Environmental Services, Water/Watershed Bureau Administrator, 2011-Present
- Alison Watts, University of New Hampshire, Assistant Research Professor, 2011-Present
- Matt Davis, University of New Hampshire, Associate Professor of Hydrogeology, 2011-Present
  
- Ken Edwardson, NH Dept. of Environmental Services, Water Quality Assessment Program Coordinator, 2015-present

## **Research Proposal Review and Selection Process**

The request for NH WRRC 104b proposals is distributed in late August/early September each year, with a submission deadline of mid-late October. In November, each proposal receives at least 3 independent reviews critiquing the proposal for the following:

1. Relevance to NH WRRC goals and state water resource issues
2. Scientific merit
3. Qualifications of the investigator(s)
4. Likelihood of success

## 5. Investigator's past record of publication and dissemination of results

Reviewers are first selected based on their scientific expertise and the research proposed. Then reviewers are screened for conflicts of interest and conflicts between reviewers and principal investigators (including co-investigators) are avoided whenever possible. We consider the following to constitute conflicts of interest:

1. Reviewer is named as the lead principal investigator (PI), a co-PI, collaborator or cooperator on the proposal

2. Reviewer would receive funding from the proposal should it be funded

3. Reviewer has a close working relationship with the lead PI or co-PIs. A close working relationship includes, but is not limited to, the following:

- Currently working together on a jointly funded research project
- Currently collaborating on a paper (does not include general synthesis papers)

4. If the reviewer feels uncomfortable providing an unbiased review of the proposal. For example, we do not automatically assume that reviewers have a conflict of interest with a PI or co-PI from the same institution and rely on reviewers to self-assess whether or not an applicant from the same institution represents a conflict of interest for them.

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Members of our advisory committee are often asked to serve as reviewers of projects that fall within their area of expertise. Reviewers are asked to numerically evaluate each proposal and provide overall comments that can be shared anonymously with the principal investigator(s). The director and associate director meet with the advisory committee in late November/early December to discuss the independent peer reviews and select proposals for inclusion in the annual NH WRRC section 104 proposal. Proposal selections and written review summaries are shared anonymously with PIs in early December. Proposals selected for inclusion in the NH WRRC section 104 proposal are revised as necessary in response to reviewer comments. Finalized proposals and budgets are due to the NH WRRC mid/late December. The annual NH WRRC section 104 proposal is then submitted in January. During the 2011-2015 evaluation period, the NH WRRC received 4 to 7 proposals each year and provided funding for 3-6 of the proposals.

### ***Peer Review of Institute Publication***

We rely predominantly on the peer-review process for publishing manuscripts in scientific journals. Any additional institute reports are reviewed by the director and associate director as well as subject matter experts (from the advisory committee and/or external scientists) prior to acceptance and posting on our website. Comments are made to the authors, who then make any necessary changes. Non-technical publications intended for local managers and decision makers are reviewed by UNH Cooperative extension, Great Bay National Estuarine Research Reserve, Piscataqua Region Estuaries Partnership or NH Sea Grant staff.

### ***Number of Principal Investigators Supported, by Rank and Year***

<b>Principal Investigators on Research Projects Supported by §104 Grants and Matching Funds, by Academic</b>
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<b>Rank and Year: FY 2011 through FY 2015</b>					
<b>Academic Rank</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	<b>2015</b>
Assistant Professor and below	1	4	1	7	8
Associate Professor	0	1	2	2	2
Professor	4	4	5	3	4
unknown	0	0	0	0	0
Total	5	9	8	12	14

# Significant Impact

## **Awards**

The NH WRRC has supported numerous projects which resulted in impacts ranging from training the next generation of water resource scientists to providing data that benefits public water supplies and leveraging additional funding for water resources research. NH WRRC researchers have also made numerous high-visibility national presentations, with some being invited talks (refer to the conference proceedings under the research publications section), and produced several manuscripts published in the peer-reviewed scientific literature (refer to the research publications section). Highlighted impacts and outcomes from several NH WRRC projects are described below.

### **2008NH97B: New Hampshire WRRC Information Transfer**

In 2011, the entire Lamprey River and all its major tributaries were designated into the NH Rivers Management and Protection Program (RMPP). Prior to that, the Lamprey only had 17.5 km of the 78 km mainstem reach designated into the NH RMPP. The NH WRRC co-sponsored a conference focused on the Lamprey River watershed in 2009 titled "Your Water, Your Wallet, Your Watershed - Why Working Together Across Town Boundaries Makes \$ense For Protecting Our Water". The conference highlighted the need for watershed-wide land use planning and decision making and gave momentum to an earlier idea that the entire Lamprey should be nominated into the NH Rivers Management and Protection Program (RMPP). A Lamprey River Nomination Committee (LRNC) was formed and in 2010 a nomination package was submitted to the NH Department of Environmental Services (DES). This nomination represented a total of 141 river kilometers and captured 14 towns, two counties and 3 regional planning commissions that all share the Lamprey River watershed. This nomination package was the most complex nomination that the NH State Rivers Management Committee had ever seen and the first one to push for a watershed approach (as opposed to nominating a segment of a river or the main stem of a river, but not its tributaries). The NH State Rivers Management Committee was extremely impressed that elected officials from all of the watershed towns wrote letters of support and by the number and variety of individual support letters. The NH State Rivers Management Committee approved the nomination and the resulting House Bill passed in both the House and the Senate in 2011. The Governor signed this Bill into law on June 7, 2011. This designation has given the Lamprey watershed preferential eligibility over non-designated rivers for state funding and technical resources. A watershed-wide local advisory committee has since been formed with representatives from each of the 14 towns. The NH WRRC associate director volunteers as a representative of Newmarket, NH on the advisory committee. The concept of land use decision-making and natural resource management from a watershed perspective instead of solely by political boundaries with no regard to upstream or downstream neighbors is an outcome of outreach efforts made by the NH WRRC and other organizations and individuals. This outcome is one in which the NH WRRC takes great pride.

### **2003NH21B: Water Quality and the Landscape: Long-term monitoring of rapidly developing suburban watersheds**

#### *Data for Public Water Supplies*

The NH WRRC's long-term water quality data on the rapidly developing suburban Lamprey River watershed is available to towns as they investigate new potential sources for public water supply. The town of Durham and UNH rely heavily on the Lamprey River for water supply since the town's local surface water source, the Oyster River, is unable to meet the town's demand. New Hampshire in-stream flow rules limit the amount of water that can be withdrawn from the Lamprey under low-flow conditions and thus the Lamprey may not provide enough water for the town during the late summer when flows are low and students returning to UNH

place a large demand on the water supply. Both Durham and Newmarket, NH have investigated using the Lamprey River to artificially recharge water supply aquifers during high flow conditions to meet the town's water supply needs during drier periods. The NH WRRC has provided both towns and their consulting firms with long-term water quality data on the Lamprey River to inform the water supply decision-making processes. As more towns in the future look to the Lamprey for water supply, the long-term dataset provided by the NH WRRC will become increasingly valuable.

#### *Data for the New Hampshire Surface Water Quality Assessment Program*

New Hampshire currently has dozens of watersheds listed as impaired due to elevated chloride levels resulting from salt use in winter road maintenance with the majority of those watershed located in the southern part of the state. College Brook is one of the impaired watersheds and the impairment listing was based on data produced from this project. Long-term monitoring of College Brook shows that mean annual chloride concentrations continue to exceed the US Environmental Protection Agency (EPA) chronic toxicity standard of 230 mg/L.

#### *Nitrogen Data in New Hampshire's Great Bay watershed*

Since 2009, 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, changes in land use and climate variability. The now 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 NH WRRC presentations made and meetings attended (supported by 2008NH97B) 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.

#### *Leveraged Funding*

Results from long-term water quality monitoring in the LRHO have helped leverage funding for additional research on nitrogen cycling and water quality variability in NH's suburbanizing watersheds. Because of the significant interest in nitrogen loading to Great Bay, existing information on the spatial and temporal variability of nitrogen concentrations in the LRHO and the relationships that the NH WRRC has formed with various stakeholders in NH, the NH WRRC director and staff received federal funding for the following projects:

- Nitrogen Sources and Transport Pathways: Science and Management Collaboration to Reduce Nitrogen Loads in the Great Bay Estuarine Ecosystem (PI), National Estuarine Research Reserve System Science Collaborative, 2010-2014, \$599,514
- Understanding the Mechanisms Controlling Storm Event Nitrogen Fluxes from the Lamprey River Watershed Using Continuous in situ Sensors (co-PI), NH Sea Grant, 2012-2014, \$174,500

- Interactions among Climate, Land Use and Ecological Services (co-PI), NSF EPSCoR RII Track-1, 2011-2018, \$20,000,000
- Collaborative Research: Strengthening the scientific basis for decision-making: Advancing sustainability science and knowledge-action capacities in coupled coastal systems (co-PI), NSF, 2013-2016, \$3,000,000
- Collaborative Research: Defining stream biomes in order to better understand and forecast stream ecosystem change, NSF Macrosystems Biology (co-PI), 2015-2020, \$594,172

#### *Training the Next Generation of Water Resource Scientists*

This project has supported 31 undergraduates, 17 graduate students (17 MS and 2 PhD) and 5 postdoctoral researchers over this 5-year evaluation period. Two former undergraduate students were inspired to pursue a PhD. Chelsea Varrio is pursuing a PhD in Ecology & Evolutionary Biology Dartmouth College and Valerie Schoepfer is pursuing a PhD in Environmental Services at Southern Cross University in Lismore, New South Wales, Australia. NH DES's Coastal Program Manager, Mr. Steve Couture, attributes his interest in water to NH WRRD Director Dr. Bill McDowell's Ecology of Polluted Waters undergraduate class.

#### **2011NH141B: Arsenic chemical dynamics in NH groundwater reservoirs: Insights from temporal variability in multi-element signatures of statewide samples**

This project provides valuable data on the quality of drinking water supplies in the state. Results show that concentrations of arsenic in groundwater from both private and public water supplies across the state are highly variable, with many samples exceeding the EPA-recommended drinking water limit (10 ppb). Of the nearly 900 samples studied, nearly 70 samples exceeded the EPA recommended drinking water limit, with two samples exceeding 100 ppb and 11 samples exceeding 50 ppb. Of the samples studied, 87% fell below the EPA recommended limit for drinking water, and 79% fell below 5 ppb, which is often suggested as a more appropriate recommended maximum contaminant level for drinking water.

This project also provided valuable research experience to an undergraduate student who was training to become a science teacher. Mr. John Clark (UNH undergraduate) felt that his involvement in this project provided him with the opportunity to participate in "genuine" scientific research that he could model with future middle school students. His attraction to the project came because of his belief that this was a project that involved chemistry, public health and environmental sciences, in such a way that he could engage his future students. Since the completion of this project Mr. Clark has finished his professional degree to be a secondary school science teacher and is now a technology educator at Dover Middle School in Dover, NH.

#### **2011NH148B Nutrient Loading Coefficients for NH Watersheds: Development and Connectivity**

The research findings of this project prompted the Newfound Lake Regional Association to have the watershed towns consider changing their current development ordinances to utilize variable buffer width requirements based on slope. At least two towns to date have incorporated this innovative recommendation and additional towns are considering the measure.

#### **2012NH174B Participatory Water Quality Assessment Through the NH Lakes Lay Monitoring Program**

The Town of Wolfeboro and Lake Wentworth Foundation developed a Watershed Management Plan to protect Lake Wentworth and Crescent Lake. Tributary and in-lake water quality data collected through the NH LLMP were used to calibrate a watershed land use nutrient loading model as well as a lake response model for

the resulting phosphorous nutrient loading. The second phase of the project was to implement best management practices to control sediment and nutrient runoff into Lake Wentworth. The resulting information is also being used by the Town of Wolfeboro, the Lake Wentworth Association and the Lake Wentworth Foundation to consider regulation and zoning amendments, to target educational/outreach efforts and to continue to prioritize problem areas for remediation.

### **2014NH183B: Natural dams and biogeochemistry at the river network scale: implications for water quality**

Charles Stoll, one of the students supported through this research project, is a first-generation college student who worked for the first ten years of his adult life as a plumber. He has presented this research at local (NH EPSCoR), regional (NESTVAL), and national (AAG) meetings. Charles received his BA in May 2015 and continued to work on this this research project the following summer. Charles is currently preparing an undergraduate first-author manuscript for review for publication in *Northeastern Geographer*.

This NH WRRC supported project has leveraged the following funding for additional research:

- Strengthening the scientific basis for making decisions about dams: Multi-scale, coupled-systems research on ecological, social, and economic trade-offs. NSF OIA-1539071. \$100,184.
- Geomorphic Response of the Turner Dam Removal. Trout Unlimited, Squan-a-Tissit and Boston Chapters. \$5,000.

### **2015NH191B: Improved Ecosystem Indicator Tools for Water Quality Management - Genomic Analysis of Periphyton to Identify Stressors**

This research project was the subject of an honors thesis by an undergraduate student at the University of New Hampshire, Department of Environmental Engineering, Ms. Allison Wood. Ms. Wood did much of the sample preparation, literature review, data analysis and report development. She also presented the results of her work at a state-wide conference (the NH Water and Watershed Conference) and submitted an honors thesis to the University. Ms Wood will spend the year following graduation as an ORISE (Oak Ridge Institute for Science and Education) intern in the EPA Region 1 Office and will be partnering with scientists at Harvard to explore the policy barriers to developing new water technologies.

### **USGS STUDENT INTERNSHIPS**

Ursula Jongebloed served as an USGS intern on the project "Investigations into the bioavailability and bioaccumulation of selenium (Se) and mercury (Hg) in the San Francisco Bay Estuary". Ursula began the internship at the USGS National Research Program office in Menlo Park, California in June 2015 after completing her sophomore year at Dartmouth College (located in Hanover, New Hampshire). The internship experience was very rewarding for both Ursula and her USGS mentor Robin Stewart. The internship experience was so successful that Ursula is preparing a manuscript along with co-authors Robin Stewart and Amy Kleckner on the trends in dissolved and particulate selenium concentrations with respect to bivalve Se concentrations and water year in the San Francisco Estuary. This manuscript is in preparation for a special issue "Undergraduate Research in Water - Training the Next Generation of Water Scientists" in the *Journal of Contemporary Water Research and Education*.

### ***Research, Information Transfer, and Education***

#### **1. Data in Support of Public Water Supplies**

- Data from the LRHO (specifically dissolved organic carbon (DOC) since DOC forms trihalomethanes when chlorinated) has been a valuable source of information to support public water supplies. The town of Durham and UNH rely heavily on the Lamprey River as a direct water supply source and both the town of Durham and Newmarket, NH have investigated using the Lamprey River to artificially recharge water supply aquifers during high flow conditions to meet the towns' water supply needs during drier periods.

- Groundwater is a significant source of water supply in the state providing water to 60% of the population. NH WRRC results show that concentrations of arsenic in groundwater from both private and public water supplies across the state are highly variable, with 13% of the samples exceeding the EPA-recommended drinking water limit (10 ppb).

## 2. Long-term Data in Support of Watershed Management

- New Hampshire currently has dozens of streams listed as impaired due to elevated chloride levels resulting from salt use in winter road maintenance with the majority of those watersheds located in the southern part of the state. Long-term monitoring supported by the 2003NH21B project provides data on the spatial and temporal variability in chloride concentrations in several NH streams. These data will be instrumental in assessing the success of current and future efforts to reduce impairments from road salt use.

- Since 2009, 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. The Lamprey River is the largest tributary to Great Bay and 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, changes in land use and climate variability. The now 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.

## 3. Training the Next Generation of Water Resource Scientists

- 104 students have been directly involved in NH WRRC research. One of those students is now a middle school teacher where he brings science and technology to the classroom.

- Two NH WRRC supported undergraduate students are currently preparing manuscripts for publication in peer-reviewed journals

- A USGS student intern was sponsored by the NH WRRC during this evaluation period

## 4. Dissemination of Results

- 77 presentations on NH WRRC research were given at national meetings during this evaluation period, two of which were invited talks

- 23 peer-reviewed publications were produced during this evaluation period

## 5. Leveraged Funding

NH WRRC research has led to several follow-on grants ranging from small local grants (e.g. Geomorphic Response of the Turner Dam Removal. Trout Unlimited, Squan-a-Tissit and Boston Chapters. \$5,000) to large prestigious NSF grants (e.g. Interactions among Climate, Land Use and Ecological Services, NSF \$20,000,000).



# Budget Information

## 104 Program Federal and Required Matching Funds

### Total Federal and Required Matching Funds Available to the New Hampshire Water Resources Research Center under §104 of the Water Resources Research Act of 1984

	2011	2012	2013	2014	2015	Total Federal	Total Match	Total Funds
<b>104(b) Total Federal</b>	\$92,335	\$92,335	\$55,525	\$92,335	\$92,335	\$424,865	X	X
<b>104(b) Total Match</b>	\$184,670	\$184,670	\$111,050	\$184,670	\$184,670	X	\$849,730	X
<b>104(b) Total Funds</b>	\$277,005	\$277,005	\$166,575	\$277,005	\$277,005	X	X	\$1,274,595
<b>104(g) Total Federal</b>	\$0	\$0	\$0	\$0	\$0	\$0	X	X
<b>104(g) Total Match</b>	\$0	\$0	\$0	\$0	\$0	X	\$0	X
<b>104(g) Total Funds</b>	\$0	\$0	\$0	\$0	\$0	X	X	\$0
<b>Total</b>	\$277,005	\$277,005	\$166,575	\$277,005	\$277,005	\$424,865	\$849,730	\$1,274,595

### Discretionary Base Funding

Appropriated or Other Discretionary Funds Available to the Institute: FY 2011 through FY 2015					
Source of Discretionary Funds	2011	2012	2013	2014	2015
N/A	\$0	\$0	\$0	\$0	\$0

### Other Water Resources Research Funding

Total and Average Value of Water Resources Grants, Contracts, and Cooperative Agreements in Which the Institute Had a Major Role During the Evaluation Period: FY 2011 through FY 2015	
Total Value of Awards, in dollars	\$39,196,453
Number of Awards	40
Average Value of Awards	\$979,911

Please list in the table below the 10 largest grants (other than section 104 grants), contracts, and cooperative agreements for which the Director or staff of the institute played a major role in assembling the proposal or otherwise obtaining the grant or contract. Include the dollar amount of the contract, grant, or cooperative agreement, the year that it was initiated, and the source of the funds. USGS-Water Resources Research Institute Internships and funds from other federal agencies passed through to your institute by the USGS should be included here.

The Ten Largest Water Resources Grants, Contracts, and Cooperative Agreements in Which the

<b>Institute Had a Major Role during the Period of the Evaluation: FY 2011 through FY 2015</b>			
<b>Title/Topic</b>	<b>Source of Fundings</b>	<b>Year Initiated</b>	<b>Amount</b>
Interactions among Climate, Land Use and Ecological Services	NSF EPSCoR RII Track-1	2011-2018	\$20,000,000
Sustaining coastal systems: Linking science and decision-making to reduce pollution related impairment (co-PI)	NSF EPSCoR RII Track-2	2013-2016	\$3,000,000
Determining the effectiveness of the Clean Air Act and Amendments on the recovery of surface waters in the northeastern US	EPA	2006-2011	\$1,006,087
Northeastern States Research Cooperative - Theme 2	USDA	2011-2016	\$695,215
Nitrogen Sources and Transport Pathways: Science and Management Collaboration to Reduce Nitrogen Loads in the Great Bay Estuarine Ecosystem	NOAA NERR	2010-2014	\$599,514
Determining the effectiveness of the Clean Air Act and Amendments on the recovery of surface waters in the northeastern US	EPA	2011-2014	\$594,898
Collaborative Research: Defining stream biomes in order to better understand and forecast stream ecosystem change	NSF	2015-2020	\$594,602
Determining the effectiveness of the Clean Air Act and Amendments on the recovery of surface waters in the northeastern US	EPA	2014-2018	\$401,255
UNH Organic Dairy Farm Agroecosystem Study (w/J. Aber, PI)	USDA Northeastern SARE	2011-2015	\$392,658
Luquillo CZO: The role of hot spots and hot moments in tropical landscape evolution and functioning of the critical zone	NSF	2013-2019	\$5,722,604

We excluded the following grants from the list above to demonstrate the variety of significant grants during the evaluation period. If these grants were included, the total of the largest 10 grants would be **\$34,007,660**.

Northeastern States Research Cooperative - Theme 2 (J. Aber, PI), USDA, 2008-2013, \$797,046

Northeastern States Research Cooperative - Theme 2 (J. Aber, PI), USDA, 2009-2014, \$797,046

Northeastern States Research Cooperative - Theme 2, USDA, 2010-2015, \$795,250

Northeastern States Research Cooperative - Theme 2, USDA, 2012-2017, \$426,859

Northeastern States Research Cooperative - Theme 2, USDA, 2014-2019, \$417,186

# Research

## Summary of Research Projects

Number of Research Projects and Percentage of Research Funds, by Research Category: FY 2011 through FY 2015		
Research Category	Number	Percent of Funds
Biological Sciences	0	0.0
Climate and Hydrologic Processes	4	0.0
Ecological Processes	0	0.0
Engineering	0	0.0
Ground-water Flow and Transport	0	0.0
Social Sciences	0	0.0
Water Quality	15	100.0
Not Applicable	2	0.0

## Research Projects

Project Number	Title	PI	Total budget
2011NH141B	Arsenic chemical dynamics in NH groundwater reservoirs: Insights from temporal variability in multi-element signatures of statewide samples	Julia Bryce	\$111,747
2003NH21B	Water Quality and the Landscape: Long-term monitoring of rapidly developing suburban watersheds	William McDowell	\$494,737
2011NH148B	Nutrient Loading Coefficients for NH Watersheds: Development and Connectivity	Jeffrey Schloss	\$31,884
2011NH164S	Determining the Effectiveness of the Clean Air Act and Amendments for the Recovery of Surface Waters in the Northeastern U.S.	William McDowell	\$0
2012NH165B	Determining the Impact of Coal Tar Based Driveway Sealant on Polycyclic Aromatic Hydrocarbon Concentrations in NH Waterbodies.	Alison Watts	\$23,216
2012NH168B	James Hall Vegetated Roof Nutrient Removal Efficiency and Hydrologic Response	Robert Roseen	\$49,034
2014NH183B	Natural dams and biogeochemistry at the river network scale: implications for water quality	Denise Burchsted	\$157,076
2014NH185B	Contribution of fluvial wetlands to nitrogen retention in urbanizing coastal watersheds in New England across multiple scales	Anne Lightbody	\$76,091
2014NH192S	Determining the Effectiveness of the Clean Air Act and Amendments for the Recovery of Surface Waters in the Northeastern U.S.	[unknown PI name]	\$202,226
2015NH191B	Improved Ecosystem Indicator Tools for Water Quality Management – Genomic Analysis of Periphyton to Identify Stressors	Alison Watts	\$36,119

## **Research Publications**

### **2008NH97B: New Hampshire WRRRC Information Transfer**

#### Articles in Refereed Scientific Journals

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. DOI: [10.1016/j.rse.2015.06.009](https://doi.org/10.1016/j.rse.2015.06.009)

#### Conferences

Argerich, A., S.L. Johnson, S.D. Sebestyen, C.C. Rhoades, E. Greathouse, P.M. Wohlgemuth, F.N. Scatena, W.H. McDowell, G.E. Likens, J.D. Knoepp, J.B. Jones, G.G. Ice, J.L. Campbell, D.M. Amatyia, and M.B. Adams. 2012. Effects of forest disturbances on stream nitrate concentrations in sites participating in StreamChemDB. LTER All Scientists Meeting, Estes Park, CO.

Argerich, A., S.L. Johnson, S.D. Sebestyen, C.C. Rhoades, E. Greathouse, M.B. Adams, D.M. Amatyia, J.L. Campbell, G.G. Ice, J.B. Jones, J.D. Knoepp, G.E. Likens, W.H. McDowell, and P.M. Wohlgemuth. 2012. Temporal trends in stream N concentrations and biogeochemical responses to disturbances in long term reference watersheds. National Council for Water Quality Monitoring, Annual Meeting, Portland, Oregon.

Argerich, S., S.L. Johnson, S.D. Sebestyen, C.C. Rhoades, E. Greathouse, P.M. Wohlgemuth, F.N. Scatena, W.H. McDowell, G.E. Likens, J.D. Knoepp, J.B. Jones, G.G. Ice, J.L. Campbell, D.M. Amatyia, and M.B. Adams. 2012. Effects of forest disturbances on stream nitrate concentrations. Annual Meeting of the Ecological Society of America, Portland, Oregon.

Frey, S.D., R. Bowden, E. Brzostek, A. Burton, B. Caldwell, S. Crow, C. Goodale, S. Grandy, A. Finzi, M. Kramer, K. Lajtha, M. Martin, W. McDowell, R. Minocha, K. Nadelhoffer, S. Ollinger, P. Templer, and K. Wicking. 2012. Temperate forest soils sequester as much carbon as trees in response to nitrogen deposition. LTER All Scientists Meeting, Estes Park, Colorado.

McDowell, W.H. 2012. NEON and STREON: Opportunities and challenges for the aquatic community. Annual meeting of the Society for Freshwater Sciences, Louisville, Kentucky.

Diemer, L. A., McDowell, W. H., Prokushkin, A. S. 2014. Nutrient uptake decreases along a gradient of DOC:NO<sub>3</sub> in arctic streams of central Siberia. Aquatic Sciences Meeting. Portland, Oregon.

Greathouse, E.A., S.L. Johnson, D. Henshaw, S.D. Sebestyen, C.C. Rhoades, W.H. McDowell, J. Jones, G. Ice, and A. Argerich. Current status of StreamChemDB, a proposed web-accessible database of stream chemistry at U.S. Forest Service Experimental Forests and National Science Foundation Long-term Ecological Research sites. National Council for Water Quality Monitoring, Annual Meeting, Portland, Oregon.

Koenig L.E., A. Ramirez and W.H. McDowell. 2014. Quantifying carbon losses from tropical watersheds: The effects of urbanization on organic and inorganic carbon flux. Joint Aquatic Sciences Meeting. Portland, Oregon.

McDowell, W.H. 2013. Soils and stream chemistry: When, where and why are they linked? European Geophysical Union Annual Meeting, Vienna, Austria April 2013 (invited keynote presentation).

McDowell, W.H. Freshwater Science: Lessons Learned and Looking Ahead. Plenary Address, First Annual Symposium on Aquatic Science, University of Maine, Orono, Maine. (CZO, LTER, EPSCoR, and NH AES)

Price, A. J.; Wollheim, W. M.; Mulukutla, G.; and McDowell, W. H. 2013. Headwater catchment nitrogen flux and storm response among land use types through seasons. (Abstract ID: 8050). Annual Meeting of the Society for Freshwater Science, Jacksonville, Florida

Dodds, W.K., J. Ruegg, K. Sheehan, C. Song, F. Ballantyne, C. Baker, W.B. Bowden, K. Farrell, M.B. Flinn, E. Garcia, T. Harms, J. Jones, L. Koenig, J.S. Kominoski, W.H. McDowell, D. McMaster, S. Parker, M.T. Trentman, M. Whiles, W.M. Wollheim, A. Argerich and B. Penaluna. 2015. Biome Context and Lotic Ecosystem Rates. American Geophysical Union Fall Meeting. San Francisco, California.

McDowell, W.G., Webster, K, Nelson, S, McDowell, W.H. and Haney, J. 2015. Regulation and results: biotic and abiotic changes to northeastern lakes following tightening of air emissions rules. Society for Freshwater Science Annual Meeting. Milwaukee, Wisconsin.

McDowell, W.H. 2015. International Critical Zone Science: Opportunities to Build a Global Understanding of Land-Water Linkages. American Geophysical Union Fall Meeting. San Francisco, California

McDowell, W.H., Potter, J., Nelson, S.J. 2015. DOC concentrations of New England (USA) lakes: Is there a response to changing atmospheric deposition? Acid Rain 2015. Rochester, New York.

Rueegg, J., Sheehan, K., Baker, C., Daniels, M., Dodds, W., Farrell, K., Flinn, M., Gido, K., Harms, T., Jones, J., Koenig, L., Kominoski, J., McDowell, W.H., Bowden, W., Rosemond, A.D., Trentman, M., Whiles, M., Wollheim, W. and Parker, S.P. 2015. Baseflow patterns of geomorphic heterogeneity in stream networks across biomes. Society for Freshwater Science Annual Meeting. Milwaukee, Wisconsin.

Wymore, A.S., Z.G. Compton, P. Keim, C.M. Liu, W.H. McDowell, L.B. Price, T.G. Whitham, and J.C. Marks. 2012. Leaf litter phytochemistry influences stream fungi:bacterial ratios, microbial community structure and ecosystem-level processes. Annual Meeting of the Society for Freshwater Sciences, Louisville, Kentucky.

### **2003NH21B: Water Quality and the Landscape: Long-term monitoring of rapidly developing suburban watersheds**

#### Articles in Refereed Scientific Journals

Hope, A.J., W.H. McDowell, W.M. Wollheim. 2013. Ecosystem metabolism and nutrient uptake in an urban, piped headwater stream. *Biogeochemistry*. DOI 10.1007/s10533-013-9900-y

#### Research Publications

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. DOI: [10.1007/s11270-013-1558-5](https://doi.org/10.1007/s11270-013-1558-5)

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. DOI: [10.1890/130017](https://doi.org/10.1890/130017)

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](https://doi.org/10.4319/lom.2014.12.223).

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](https://doi.org/10.1890/ES14-00517.1).

Flint, S.F. and W.H. McDowell. 2015. Effects of headwater wetlands on dissolved nitrogen and dissolved organic carbon concentrations in a suburban New Hampshire watershed. *Freshwater Science* 34:456-471. DOI [10.1086/680985](https://doi.org/10.1086/680985)

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](https://doi.org/10.3390/w7084063).

McDowell, W.H. 2015. NEON and STREON: Opportunities and challenges for the aquatic sciences. *Freshwater Science*. 34:386-391. DOI: [10.1086/679489](https://doi.org/10.1086/679489).

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. DOI: [10.1016/j.rse.2015.06.009](https://doi.org/10.1016/j.rse.2015.06.009)

Wymore A.S., Rodriguez-Cardona B. and McDowell, W.H. 2015. Direct response of dissolved organic nitrogen to nitrate availability in headwater streams. *Biogeochemistry*. 126:1-10. DOI [10.1007/s10533-015-0153-9](https://doi.org/10.1007/s10533-015-0153-9).

Rodriguez-Cardona, B., Wymore, A.S. and McDowell, W.H. 2016. DOC:NO<sub>3</sub> ratios and NO<sub>3</sub> uptake in forested headwater streams. *Journal of Geophysical Research: Biogeosciences*. 121(1):205-217. DOI:[10.1002/2015JG003146](https://doi.org/10.1002/2015JG003146).

## Dissertations

Baillio, J. 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.

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.

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.

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, New Hampshire, 93 pages.

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, New Hampshire, 94 pages.

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.

#### Conference Proceedings

McDowell, W.H. and M.L. Daley. 2011. Net Manageable Nitrogen: Definition and Rationale for a new approach to nitrogen management in moderately impacted watersheds, American Geophysical Union Fall Conference, San Francisco, California.

McDowell, W.H., M.L. Daley and J.D. Potter. 2011. Dissolved organic matter dynamics in a suburban basin: wetlands and people drive quantity and quality, North American Benthological Society Meeting, Providence, Rhode Island.

Liptzin, D., M.L. Daley, and W.H. McDowell. 2012. A collector comparison for wet deposition at a coastal New Hampshire site. NADP National meeting, Portland, Maine.

Lombard, M.A., H. Mao, M. Daley, J. Bryce, W.H. McDowell, and R. Talbot. 2012. Relationships between mercury and sea salt ion concentrations in rainwater from a marine site. Northeastern Section of the Geological Society of America, Hartford, Connecticut.

McDowell, W.H. 2012. Consequences of climate and land use change for ecosystems and ecosystem services in New Hampshire. Invited symposium presentation, Ecosummit, Ecological Society of America, Columbus, Ohio.

McDowell, W.H. 2012. Management of urbanizing watersheds: Central tendencies, outliers, and the art of the possible. Invited presentation, AGU Annual fall meeting, San Francisco, California.

Koenig, L. E.; Baumann, A. J.; McDowell, W. H. 2013. Improving automated phosphate analysis to eliminate silicate interference. (Abstract ID: 8116). Annual Meeting of the Society for Freshwater Science, Jacksonville, FL, May 2013

McDowell, W. G.; Rosemond, A. D.; McDowell, W. H.; Byers, J. E. 2013. Impacts, dead or alive: Effects of mass mortality of an abundant invasive species on ecosystem function. (Abstract ID: 7715). Annual Meeting of the Society for Freshwater Science, Jacksonville, FL, May 2013.

Smith, Thor E., McDowell, William H., Wollheim, Wilfred M., Daley, Michelle, Mulukutla, Gopal, Baumann, Adam J., Snyder, Lisle, and Price, Allison. 2013. Sampling the Lamprey River watershed across space and time; New data collection efforts toward understanding nitrogen sources. The Geological Society of America Northeastern Section - 48th Annual Meeting. Omni-Mount Washington Hotel, Bretton Woods, New Hampshire. March 2013. Abstract accepted but not presented due to federal employee travel restrictions.

Bucci, J. P., I. Sidor, A. Walant, M. Daley, J. Potter, W. McDowell. 2014. Detection of a Mitochondrial DNA Biomarker in Surface Water within Suburban Streams Impacted by Animal Fecal Waste: Does Flow Matter. American Society for Microbiology 2014 General Meeting. Boston, Massachusetts.

Daley, M.L., J.D. Potter, A. Kobylinski, C. French, S. Miller, C. Keely, J. Bucci, W.H. McDowell. 2014. Collaborative science to identify non-point nitrogen sources in a coastal New England watershed and reduce nitrogen delivery to an impaired estuary. Joint Aquatic Sciences Meeting. Portland, Oregon.

McDowell, W.H., Potter, J. D., Daley, M. L., Snyder, L., Mulukutla, G. 2014. Using sensors and sensor networks to quantify ecosystem services in developed and rural watersheds. Joint Aquatic Sciences Meeting. Portland, Oregon.

Potter, J.D. Snyder, L., Mulukutla, G., McDowell, W. H. 2014. Addressing anthropogenic effects on aquatic biogeochemistry using a distributed sensor network in New Hampshire. Joint Aquatic Sciences Meeting. Portland, Oregon.



Rodriguez-Cardona, B., McDowell, W. H. 2014. Nitrate uptake kinetics in suburban streams of New Hampshire. Joint Aquatic Sciences Meeting. Portland, Oregon.

Wymore, A. S., Mineau, M. M., Potter, J. D., Marks, J. C., McDowell, W. H. 2014. Leaf litter leachate controls bacterial communities and ecosystem processing rates. Joint Aquatic Sciences Meeting. Portland, Oregon.

Wymore, A.S. et al. 2014. Identifying the Sources of Dissolved Organic Matter in Streams Using Elemental Analysis Isotopic Ratio Mass Spectroscopy (EA-IRMS) Across a Land Use Gradient. American Geophysical Union Fall Meeting. San Francisco, California.

Appling, A., Leon, M. and McDowell, W.H. 2015. Optimizing watershed flux estimates: the R package 'loadflex'. Society for Freshwater Science Annual Meeting. Milwaukee, Wisconsin.

Contosta, A., A.C. Adolph, D. Burchsted, M. Green, W.H. McDowell, and the New Hampshire EPSCoR Ecosystems & Society Sensor Team. 2015. The Vernal Window Flow Path: a Cascade of Ecological Transitions Delineated at Scales from Points to Pixels. American Geophysical Union Fall Meeting. San Francisco, California.

Koenig, L., L.E. Snyder, W.H. McDowell and C.W. Hunt. 2015. The contribution of aquatic metabolism to CO<sub>2</sub> emissions from New Hampshire streams. American Geophysical Union Fall Meeting. San Francisco, California.

McDowell, W.H. 2015. Aquatic sensor networks: Is there regional coherence in the response of stream chemistry to seasonal and hydrologic drivers? (abstract #90) HydroEco 2015, 5th International Conference on Hydrology and Ecology. Vienna, Austria, 13-16 April 2015.

McDowell, W.H., Potter, J, Snyder, L, Daley, M., Appling, A., Koenig, L, Rodriguez-Cardona, B., Wymore, A. and Brereton, R. 2015. Using a sensor network to understand drivers of nutrient and organic matter concentrations at multiple spatial and temporal scales. Society for Freshwater Science Annual Meeting. Milwaukee, Wisconsin.

Potter, J, McDowell, W.H. and Snyder, L. 2015. Patterns and drivers of specific conductance in New Hampshire rivers. Society for Freshwater Science Annual Meeting. Milwaukee, Wisconsin.

Rodriguez-Cardona, B. and McDowell, W.H. 2015. Influences of DOC on nitrate uptake in suburban streams. Society for Freshwater Science Annual Meeting, Milwaukee, Wisconsin.

Rodriguez-Cardona, B., A. Wymore, L. Koenig, A.A. Coble and W.H. McDowell. 2015. Response of non-added solutes during nutrient addition experiments in streams. American Geophysical Union Fall Meeting. San Francisco, California.

Schade, J.D., J. Bailio, and W.H. McDowell. 2015 Nitrate loading and CH<sub>4</sub> and N<sub>2</sub>O Flux from headwater streams. American Geophysical Union Fall Meeting. San Francisco, California.

Snyder, L. 2015. NH EPSCoR Intensive Aquatic Sensor Network. Joint NEAEB/NH Water & Watershed Conference: Partnerships for Environmental Progress. Bartlett, New Hampshire.

Wymore, A., Rodriguez-Cardona, B. and McDowell, W.H. 2015. Patterns of dissolved organic nitrogen (DON) production and consumption with the addition of nitrate (NO<sub>3</sub>): Insights into the controls on DON cycling. Society for Freshwater Science Annual Meeting. Milwaukee, Wisconsin.

Zeglin, L., Cooper, S, Utz, R., Ardon-Sayao, M., Bixby, R., Burdett, A., Dodds, W., Griffiths, N.A., Harms, T., Johnson, L., Johnson, S., Jones, J., Kominoski, J., McDowell, W.H., Rosemond, A.D., Trentman, M., Follstad Shah, J., Van Horn, D. and Ward, A. 2015. Synthesis of stream ecosystem responses to nutrient enrichment at multiple trophic levels. Society for Freshwater Science Annual Meeting. Milwaukee, Wisconsin.

2011NH148B: Nutrient Loading Coefficients for NH Watersheds: Development and Connectivity

Conference Proceedings

Harvey, Rebecca. 2011. Pharmaceuticals and Personal Care Products in New Hampshire Water Resources; Poster presented at: Science to Inform Pharmaceutical and Personal Care Product Management, April 27-29, 2011, Holiday Inn by the Bay, Portland, Maine. New England Interstate Water Pollution Control Commission.

Schloss, Jeffrey A. 2011. Adventures in Volunteer Monitoring: Lessons learned in 30+ years with the NH Lakes Lay Monitoring Program. North American Lake Management Society. 31st International Symposium. Spokane, Washington.

Schloss, Jeffrey A. 2011. Cyanobacteria Monitoring: What Current Research Tells Us. Invited presentation. New England Chapter, North American Lake Management Society Annual New England Lakes Conference, University of Rhode Island, Kinston, Rhode Island.

#### Other Publications

Craycraft, Robert and Jeffrey A. Schloss, 2011, Site Specific Project Plan: Lake Wentworth/Crescent Lake Watershed Management Plan Implementation-Phase I, Operated Under: the University of New Hampshire Center for Freshwater Biology and Lakes Lay Monitoring Program Programmatic Quality Assurance Project Plan, UNH Center for Freshwater Biology and Cooperative Extension, Durham, NH, 19pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Baboosic Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 122 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Bow Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 65 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Conway Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 71 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Crystal Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 55 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Goose Pond Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 54 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Greay East Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 74 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Chocorua Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 66 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Kanasatka Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 76 pps.

#### Research Publications

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Wentworth and Crescent Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 108 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnepesaukee-Alton Bay Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 93 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnepesaukee-Meredith Bay Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 64 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnepesaukee-Moultonborough Bay Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 110 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnepesaukee-Tuftonboro Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 110 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnisquam Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 74 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Lovell Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 61 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Mendums Pond Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 58 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Merrymeeting Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 80 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Milton Ponds (Depot, Townhouse and Northeast) Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 80 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Mirror Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 60 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Naticook Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 60 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Nippo Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 60 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, North River Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 58 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Silver Lake (Madison) Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 98 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Squam Lakes Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 160 pps.

Craycraft, Robert and Jeffrey A.Schloss, 2011, Sunset Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 63 pps.

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2011NH164S: Determining the Effectiveness of the Clean Air Act and Amendments for the Recovery of Surface Waters in the Northeastern U.S.

#### Articles in Refereed Scientific Journals

Norton, S., Fernandez, I., Kahl, J., Rustad, L., Navratil, Tomas, Almquist, H. 2010. The evolution of the science of Bear Brook Watershed in Maine, USA, *Environmental Monitoring and Assessment*, 171(1-4): 3-21. DOI: 10.1007/s10661-010-1528-y

Kerr, J.G., M.C. Eimers, I.F. Creed, M.B. Adams, F. Beall, D. Burns, J.L. Campbell, S.F. Christopher, T.A. Clair, F. Courchesne, L. Duchesne, I. Fernandez, D. Houle, D.S. Jeffries, G.E. Likens, M.J. Mitchell, J. Shanley, H. Yao. 2011. The effects of seasonal drying on sulphate dynamics in streams across southeastern Canada and the northeastern USA, *Biogeochemistry* DOI 10.1007/s10533-011-9664-1.

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Sanclements, M., G. Oelsner, D. McKnight, S.J. Nelson, J. Stoddard, 2012. New insights into the source of decadal increases of dissolved organic matter (DOM) in acid-sensitive lakes of the northeastern U.S., *Environmental Science and Technology*, 46(6): 3212-3219, DOI: 10.1007/s11356-009-0176-7.

Strock, K., S. Nelson, J. Kahl, J. Saros, W. McDowell, 2014. Decadal trends reveal recent acceleration in the rate of recovery from acidification in the northeastern US. *Environ. Sci. Technol.* 48(9):4681-4689. DOI: 10.1021/es404772n

Boeff, K.A., K.E. Strock, J.E. Saros. 2016. Evaluating planktonic diatom response to climate change across three lakes with differing morphometry. *J Paleolimnol.* DOI 10.1007/s10933-016-9889-z

Strock, K.E., Saros, J.E., Nelson, S.J., S.D. Birkel, J.S. Kahl, W.H. McDowell. 2016. Extreme weather years drive episodic changes in lake chemistry: implications for recovery from sulfate deposition and long-term trends in dissolved organic carbon. *Biogeochemistry*, 127(2-3), 353-365.

#### Dissertations

Strock, K.E. 2013. Deciphering Climate-Mediated Changes in Boreal Lake Ecosystems. Ph.D. Dissertation, University of Maine, Orono, Maine.

Boeff, K. 2014. Evaluating the effect of a changing climate on thermocline depth in Maine's Great Ponds. M.S. Dissertation, University of Maine, Orono, Maine.

Brown, Robert E. 2014. Assessing the Ecological Effects of Increased Dissolved Organic Carbon in Maine Lakes over Recent Decades. *Electronic Theses and Dissertations.* 2162.  
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#### Conference Proceedings

Mineau, M. M., K. S. Simon, D. T. Ely; R. L. Rancatti, I. J. Fernandez, S. A. Norton, and H. M. Valett. 2011. Effects of chronic nitrogen enrichment and acidification on coupled nitrogen and phosphorus cycling in streams: Insights from multiple spiraling techniques. Annual meeting, North American Benthological Society, Providence, Rhode Island.

Nelson, S.J., C. Chen, H. Roebuck, B. Zoellick. 2011. Sensible sentinels: Preliminary mercury data for dragonfly nymphs (Odonata: anisoptera) across northern New England corroborate expected spatial pattern. The 10th International Conference on Mercury as a Global Pollutant (ICMGP), Halifax, Nova Scotia.

Boeff, K. & J.E. Saros. 2013. Evaluating the effect of a changing climate on thermocline depth in Maine's Great Ponds. Poster presentation. North American Diatom Symposium, Bar Harbor, Maine.

Brown, R.E., Saros, J.E. & S.J. Nelson. 2013. Algal community response to increases in dissolved organic carbon: Implications for drinking water utilities. Poster presentation. North American Diatom Symposium, Bar Harbor, Maine.

Nelson, S.J., C. Chen, D.P. Krabbenhoft, J.S. Kahl, 2013. Dragonfly larvae as mercury bio-sentinels: a statistical survey of northeast lakes reveals landscape-driven patterns in water and biota mercury concentrations. NERC (Northeastern Ecosystems Research Cooperative) meeting, March 19 - 20, 2013, Saratoga Springs, New York.

Nelson, S.J., C. Chen, D.P. Krabbenhoft, J.S. Kahl, B. Zoellick. 2013. Validating landscape models for mercury in northeastern US lakes using dragonfly larvae as mercury bio-sentinels. Accepted for poster presentation at the ICMGP - International Conference on Mercury as a Global Pollutant, Edinburgh, Scotland.

Strock, K.E.D., J.E. Saros, S.J. Nelson, S.D. Birkel. 2013. The effects of extreme climate events on lakewater chemistry: implications for dissolved organic carbon trends in the northeast U.S. American Society of Limnology and Oceanography Meeting. New Orleans, Louisiana, February 17-22, 2013.

Appling, A.P., W.H. McDowell, J.D. Potter, S.J. Nelson, J.S. Kahl, 2014. From the frying pan into the fire? Lake greenhouse gas responses to acid rain recovery. Joint Aquatic Sciences Meeting. Portland, Oregon.

Boeff, K. & J.E. Saros. 2014. Evaluating the effect of a changing climate on thermocline depth in Maine's Great Ponds. Poster presentation. Association for the Sciences of Limnology & Oceanography, Portland, Oregon.

Brown, R.E., Saros, J.E. & S.J. Nelson. 2014. Algal community response to increases in dissolved organic carbon over recent decades. Poster presentation. Association for the Sciences of Limnology & Oceanography, Portland, Oregon.

Strock, K.E., Saros, J.E., Nelson, S.J. & S. Birkel. 2014. Interactive effects of extreme weather and reduced sulfate deposition: accelerated recovery from acidification and increased brownification in lakes of the Northeast U.S. Association for the Sciences of Limnology & Oceanography, Portland, Oregon.

McDowell, W.G., K. Webster, S.J. Nelson, W.H. McDowell, J. Haney. 2015. Regulation and results: biotic and abiotic changes to northeastern lakes following tightening of air emission rules. Society for Freshwater Science, Milwaukee, Wisconsin.

McDowell, W.H. 2015. EPA TIME/LTM New England 2015. EPA Clean Air Act Cooperators meeting, Montpelier, Vermont.

Roy, K., H. Pembroke, S. Nelson, A. Riscassi, M. McHale, E. Boyer, G. Lampman, C. Funk, 2015. Long Term Monitoring of Acidification in Sensitive Areas of the Northern and Eastern United States: A New Generation of Research. Poster Presentation. Acid Rain 2015, Rochester, New York.

W.H. McDowell, S.J. Nelson, J.D. Potter, 2015. DOC concentrations of New England (USA) lakes: is there a response to changing atmospheric deposition? Acid Rain 2015, Rochester, New York.

Nelson, S.J., C.Y. Chen, D.P. Krabbenhoft, J.S. Kahl. 2016. Beyond "Hotspots": Dragonfly BioSentinels Describe Vulnerability (or not) of Northeastern Lakes and Their Foodwebs to Mercury Accumulation. 2016 Conference of the New England Association of Environmental Biologists (NEAEB), Rockport, Maine.

Other Publications

Vaux, P.D., S.J. Nelson, N. Rajakaruna, G. Mittelhauser, K. Bell, B. Kopp, J. Peckenham, G. Longworth, 2008. Assessment of natural resource conditions in and adjacent to Acadia National Park, Maine. Natural Resource Report NPS/NRPC/WRD/NRR-2008/069. National Park Service, Fort Collins, Colorado.

James-Pirri, M.J., S.J. Nelson, and P.D. Vaux. 2010. Natural Resource Assessment for Saugus Iron Works National Historic Site, Natural Resources Report NPS/NER/NRR-2010/XXX, National Park Service, Boston, Massachusetts.

Navrátil, T., S.A. Norton, I.J. Fernandez, S.J. Nelson, 2010, Twenty-year inter-annual trends and seasonal variations in precipitation and stream water chemistry at the Bear Brook Watershed in Maine, USA, *Environ. Monit. Assess*, 171:3-21.

James-Pirri, M. J., S. J. Nelson, and P. D. Vaux, June 2011, Natural Resource Condition Assessment for Saugus Iron Works National Historic Site. Natural Resource Report NPS/NER/NRR-2011/457, National Park Service, Fort Collins, Colorado.

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Nelson, S.J., P. Vaux, M.J. James-Pirri, and G. Giese, 2012, Natural resource condition assessment: Cape Cod National Seashore, Massachusetts, Natural Resource Report NPS/NER/NRR-2012/605, National Park Service, Fort Collins, Colorado.

Nelson, S.J., C. Chen, H. Roebuck, B. Zoellick. Sensible sentinels: Preliminary mercury data for dragonfly nymphs (Odonata: anisoptera) across northern New England corroborate expected spatial pattern. The 10th International Conference on Mercury as a Global Pollutant (ICMGP), Halifax, NS, July 24-29, 2011; and presented at the Acadia Science Symposium, October 26, 2011.

2011NH141B: Arsenic chemical dynamics in NH groundwater reservoirs: Insights from temporal variability in multi-element signatures of statewide samples

#### Articles in Refereed Scientific Journals

Andy, C.M., Fahnestock M.F., Lombard M.A., Hayes L, Bryce J. G, Ayotte, J. 2017. Assessing models of arsenic occurrence in drinking water from bedrock aquifers in New Hampshire, *Journal of Contemporary Water Research & Education*, 160, 25-41. DOI: 10.1111/j.1936-704X.2017.03238.x

#### Other Publications



Fahnestock, M.F., Lombard, M.A., Clark, J.C., Bryce, J.G., and Ayotte, J.D. 2017. Concentrations of arsenic in water from public-supply and domestic wells in New Hampshire (2004-2006): U.S. Geological Survey data release, <https://doi.org/10.5066/F7JM27R9>.

Lombard, M.A., Hayes, Laura, Andy, C.M., Fahnestock, M.F., Bryce, J.G., and Ayotte, J.D., 2017. Testing data set for independent analysis of New Hampshire arsenic model: U.S. Geological Survey data release, <https://doi.org/10.5066/F7XK8COV>.

2012NH174B: Participatory Water Quality Assessment Through the NH Lakes Lay Monitoring Program

#### Conference Proceedings

Schloss, Jeff. 2012. Landscaping at the Water's Edge Workshop. New England Chapter of the North American Lake Management Association.

Schloss, Jeff. 2012. Citizen Science: Participatory Water Resources Monitoring Supports High Tech Analyses. Canada Water Day Conference, Dalhousie University, Nova Scotia

Schloss, Jeff. 2012. Global Change and Our New England Lakes: What can we expect? New England Chapter of the North American Lake Management Association.

Schloss, Jeff. 2012. Lessons Learned from a Long-Term Participatory Water Quality Monitoring Program. Special session on Citizen Science, American Geophysical Union Annual Meeting. San Francisco, California.

Schloss, Jeff. 2012. Panel Discussion -Volunteer Monitoring- for the 2012 National Water Quality Monitoring Conference. Portland, Oregon.

#### Other Publications

Craycraft, Robert and Jeffrey A. Schloss. 2012. Baboosic Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 138 pps.

Craycraft, Robert and Jeffrey A. Schloss. 2012 Crystal Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 76 pps.

#### Research Publications

Craycraft, Robert and Jeffrey A.Schloss. 2012. Goose Pond Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 78 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2012. Bow Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 114 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2012. Conway Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH.92 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2012. Great East Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 106 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Chocorua Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 80 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Kanasatka Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 86 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Wentworth and Crescent Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 108 pps

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Alton Bay Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 93 pps

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Meredith Bay Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 64 pps

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Saunders Bay Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 110 pps

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Tuftonboro Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 110 pps

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnisquam Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 74 pps

Craycraft, Robert and Jeffrey A.Schloss. 2012. Lovell Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 86 pps.

- Craycraft, Robert and Jeffrey A.Schloss. 2012. Mendums Pond Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 80 pps.
- Craycraft, Robert and Jeffrey A.Schloss. 2012. Merrymeeting Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 86 pps.
- Craycraft, Robert and Jeffrey A.Schloss. 2012. Milton Ponds (Depot, Townhouse and Northeast) Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH..98 pps.
- Craycraft, Robert and Jeffrey A.Schloss. 2012. Mirror Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 76 pps
- Craycraft, Robert and Jeffrey A.Schloss. 2012. Naticook Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 80 pps
- Craycraft, Robert and Jeffrey A.Schloss. 2012. Nippo Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 78 pps
- Craycraft, Robert and Jeffrey A.Schloss. 2012. North River Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 72 pps
- Craycraft, Robert and Jeffrey A.Schloss. 2012. Silver Lake (Madison) Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 98 pps
- Craycraft, Robert and Jeffrey A.Schloss. 2012. Squam Lakes Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 160 pps
- Craycraft, Robert and Jeffrey A.Schloss. 2012. Sunset Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 63 pps
- Craycraft, Robert and Jeffrey A. Schloss. 2013. Baboosic Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 132 pps.
- Craycraft, Robert and Jeffrey A.Schloss. 2013 Crystal Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 82 pps.
- Craycraft, Robert and Jeffrey A.Schloss. 2013. Bow Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 108 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Conway Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH.92 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Great East Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 114 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Lake Chocorua Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 82 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Lake Kanasatka Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 94 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Lake Winnisquam Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 90 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Lovell Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 84 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Mendums Pond Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 80 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Merrymeeting Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 96 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Michawanic Pond Data Review (January 22, 2014). New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 14 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Milton Ponds (Depot, Townhouse and Northeast) Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH..96 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Naticook Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 88 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. North River Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 84 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Silver Lake (Madison) Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 102 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Squam Lakes Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 140 pps.

Craycraft, Robert and Jeffrey A.Schloss. 2013. Sunset Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 90 pps.

2012NH165B: Determining the Impact of Coal Tar Based Driveway Sealant on Polycyclic Aromatic Hydrocarbon Concentrations in NH Waterbodies

#### Articles in Refereed Scientific Journals

Mahler, B.J., P.C. Van Metre, J. Crane, A.W. Watts, M. Scoggins, E.S. Williams. 2012. Coal-Tar-Based Pavement Sealcoat and PAHs: Implications for the Environment, Human Health, and Stormwater Management. *Environmental Science and Technology*. 46: 3039-3045.  
DOI: 10.1021/es203699x

#### Other Publications

UNH Stormwater Center and NH Sea Grant. Thinking about sealcoating your driveway? Get the facts! Fact Sheet.

2014NH185B: Contribution of fluvial wetlands to nitrogen retention in urbanizing coastal watersheds in New England across multiple scales

#### Dissertations

Rosengarten, D. 2014. Spatial and temporal variability of nitrate cycling in a New England headwater wetland and stream. Department of Earth Sciences, College of Engineering and Physical Sciences, University of New Hampshire, Durham, New Hampshire, 184 pages.

Wilderotter, S. 2015. Parameterizing of transient storage and nutrient retention in coastal New England wetlands. Department of Earth Sciences, College of Engineering and Physical Sciences, University of New Hampshire, Durham, New Hampshire, 235 pages.

#### Research Publications

## Conference Proceedings

Wilderotter, S., Lightbody, A. F., Kalnejais, L. H., Wollheim, W. M., Zuidema, S. 2014. Transient Storage Parameterization of Wetland-dominated Stream Reaches. American Geophysical Union Fall Meeting.

Lightbody, A., Wilderotter, S., Wollheim, W. M., Kalnejais, L. 2015. Contribution of surface transient storage to nitrogen retention within wetland-dominated stream reaches in New England. Northeast Section Meeting of the Geological Society of America.

Lightbody, A., Wilderotter, S., Wollheim, W. M., Kalnejais, L. 2015. Contribution of surface transient storage to nitrogen retention within wetland-dominated stream reaches in New England. Northeast Section Meeting of the Geological Society of America.

Wilderotter, S., Lightbody, A., Zuidema, S., Kalnejais, L. H., Wollheim, W. M. 2015. Predicting nitrate retention in wetland-dominated stream reaches using a conservative tracer. Conference on Partnerships for Environmental Progress, New England Association of Environmental Biologists.

Wilderotter, S., Lightbody, A., Zuidema, S., Kalnejais, L. H., Wollheim, W. M. 2015. Predicting nitrate retention in wetland-dominated stream reaches using a conservative tracer. Conference on Partnerships for Environmental Progress, New England Association of Environmental Biologists.

2014NH183B: Natural dams and biogeochemistry at the river network scale: implications for water quality

## Conference Proceedings

Brehme, Christopher; Stoll, Charles. 2014. A classification and analysis of river channel conditions using aerial photos and network analysis, American Association of Geographers Annual Meeting, Paper session 3567-Remote Sensing Applications for Characterizing Wetlands, Chicago, Illinois.

Brehme, Christopher; Stoll, Charles; Burchsted, Denise, 2014. Using photo interpretation and linear referencing to quantify stream heterogeneity, NESTVAL 2014: Water in a Changing World, New England, St. Lawrence Valley Geographical Society. Durham, New Hampshire.

Burchsted D. March 24, 2016. Stream temperature demonstrates that rivers are patchy systems. New England Association of Environmental Biologists. Rockport, Maine.

2015NH191B: Improved Ecosystem Indicator Tools for Water Quality Management - Genomic Analysis of Periphyton to Identify Stressors

#### Dissertations

Wood, Allison R., 2016. Attached Algae as an Indicator of Water Quality: A Study of the Viability of Genomic Taxonomic Methods. Honors Theses and Capstones. 306. <http://scholars.unh.edu/honors/306>

#### Other Publications

Watts. 2015. Decoding the streams: Using the emerging technology of genomic analysis to improve stream monitoring. Fact Sheet.

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# Information Transfer

Project Number	Title	PI	Total budget
2008NH97B	New Hampshire WRRC Information Transfer	William McDowell	\$171,508
2012NH174B	Participatory Water Quality Assessment Through the NH Lakes Lay Monitoring Program	Jeffrey Schloss	\$45,413

## **Audio-Visual Productions**

Several PowerPoint presentations have been produced and delivered to various local watershed and lake associations, town planners, managers and conservation members and the general public using NH WRRC funding. The NH WRRC sponsors the Annual Lamprey River Symposium that focuses on water resources research in the LRHO. With permission, the symposium PowerPoint presentations are posted on the NH WRRC website (<https://wrrc.unh.edu/lamprey-river-symposium>). NH WRRC research in the LRHO was featured in the following videos produced by LRAC and posted to YouTube:

- Connecting Lives on the Lamprey River - 2011 (<https://www.lampreyriver.org/multi-media-center-connecting-lives>)
- River Story: The Lamprey River through Time – 2011 (<https://www.lampreyriver.org/media-videos-2>)
- Reflections on a River: 30 Years of Protecting the Lamprey River – 2013 (<https://www.lampreyriver.org/multi-media-videos-reflections>)

## **Newsletter**

The NH WRRC did not produce a newsletter during the 2011-2015 evaluation period. Instead we relied on our website to disseminate information and the website is updated frequently to include items of interest to the public and researchers. Key items of interest (e.g. conferences and RFPs) are sent out to our email distribution list when the information becomes available. The NH WRRC has also contributed to various press releases published in local newspapers, town newsletters and on NH Public Radio.

## **Conferences**

### **Lead Sponsor:**

The NH WRRC is the lead sponsor of the **Annual Lamprey River Symposium**. The NH WRRC Information Transfer project provided salary for the NH WRRC associate director to organize the symposium and provided support for room fees and printing materials. The goal of the Annual Lamprey River Symposium is to facilitate discussion and collaboration between scientists and students working in the LRHO and to engage state & local officials, watershed organizations, and concerned citizens with the science and its implications for Great Bay and the entire coastal watershed. Presentations typically focus on water quality, hydrology, flooding, stormwater, nitrogen cycling and future climate and land use change effects on water quality and quantity. The annual symposium attracts approximately 90 attendees, including scientists, regional leaders,



town officials, state legislators, members of state agencies, and federal agencies. The symposium is held in January on the University of New Hampshire campus. The agenda and presentations are posted on the NH WRRC website at: <http://www.wrrc.unh.edu/lamprey-river-symposium>. Feedback from participant evaluations of the symposium is used to make improvements to the annual event.

### **Cosponsor:**

The NH WRRC Information Transfer project 2008NH97B provided funding for the NH WRRC to co-sponsor the annual **NH Water and Watershed Conference** and provided salary for the NH WRRC Associate Director to serve on the planning committee and help organize the conference. The annual NH Water and Watershed Conference was held in Plymouth, NH in March of 2011-2014. This annual 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. Over the years, the conference has focused on effective strategies that address the changing environmental and societal conditions and their effects on New Hampshire's aquatic environment, enhancing capacity to understand, protect, and manage New Hampshire's water resources and the sustainability of New Hampshire's water resources. The NH WRRC co-sponsored this conference along with Plymouth State University and the Center for the Environment, NH EPSCoR, NH DES, NH Fish and Game, US Geological Survey New England Water Science Center, and a few other consulting firms, agencies and associations. The conference typically contained 5 concurrent sessions covering various water resources topics.

In 2015, the annual NH Water and Watershed Conference was held in combination with the 39<sup>th</sup> annual New England Association of Environmental Biologists (NEAB) meeting on March 18-20, 2015 in Bartlett, NH. The NEAEB conference serves as a platform for water resource experts, state and federal regulators, watershed organizations and other parties invested in environmental biology to share their first-hand experiences and knowledge as well as to discuss important issues affecting the world's waters. The NEAEB conference comes to New Hampshire only once every seven years thus this was a unique opportunity to combine these complementary events. The NH WRRC co-sponsored this conference along with Plymouth State University and the Center for the Environment, United States Environmental Protection Agency, New England Water Pollution Control Commission, and New Hampshire Department of Environmental Services. Two days of the conference were dedicated to concurrent sessions and workshops. One day was devoted to several relevant plenary presentations intermixed with a poster session and roundtable discussions. The Center's Associate Director served on the planning committee for this conference.

The NH WRRC co-sponsored a monthly **seminar series in the 2010-2011 academic year on water issues in New Hampshire** along with the USGS and the Department of Natural Resources at UNH. Seminars during March and April 2011 were held at the University of New Hampshire in Durham, NH. Brain Pellerin, USGS Scientist, presented "Seeing the Light: Applications of In Situ Optical Measurements for Understanding Organic Matter and Nutrient Dynamics in Rivers" on March 22, 2011 and Philip Harte, USGS Scientist, presented "Monitoring of In Situ Chemical Oxidation (ISCO) Treatment at a Waste Site with Time-Series Geophysical Surveys" on April 21, 2011.

### ***Internet Services***

The official Web site of the New Hampshire Water Resources Research Center, hosted by University of New Hampshire, appears at <http://www.wrrc.unh.edu>.

## Information Transfer Publications

IT Publication Type	IT Publication
Other Publications	Daley, M.L. and McDowell, W.H. 2011. "Sewer Plants in Great Bay Face Tougher Clean Water Standards" <a href="http://www.nhpr.org/sewer-plants-greatbay-face-tougher-clean-water-standards">http://www.nhpr.org/sewer-plants-greatbay-face-tougher-clean-water-standards</a> May 20, 2011.
Other Publications	McDowell, W.H. 2012. Research Profile: Bill McDowell – Protecting Water Quality for Now and the Future.
Other Publications	Forester Courtland, V. 2013. Upstream Impact: Graduate Students Inspire the Next Generation of STEMM Professionals. <a href="http://www.unh.edu/unhtoday/2013/05/upstreamimpact?utm_source=Team+Update%3A+Ecosystems">http://www.unh.edu/unhtoday/2013/05/upstreamimpact?utm_source=Team+Update%3A+Ecosystems</a> 2013.
Other Publications	Daley, M.L. 2013. Clean water: It's everyone's responsibility to reduce pollution and properly manage water resources. <a href="http://ecosystemsandsociety.blogspot.com/2013/06/clean-water-its-everyones.html">http://ecosystemsandsociety.blogspot.com/2013/06/clean-water-its-everyones.html</a>
Other Publications	Snyder, L. interviewed for article. Potter, J.D., Godbois, A., Snyder, L. 2013. Cutting edge environmental monitoring. <a href="http://ecosystemsandsociety.blogspot.com/2013/07/cutting-edge-environmentalmonitoring.html">http://ecosystemsandsociety.blogspot.com/2013/07/cutting-edge-environmentalmonitoring.html</a> .
Other Publications	McDowell, W.H. interviewed for article. Morrill, D. 2013. Dogs who really know their business: Trained to detect environmental problems. <a href="http://www.fosters.com/apps/pbcs.dll/article?AID=/20130802/GJNEWS_01/130809822">http://www.fosters.com/apps/pbcs.dll/article?AID=/20130802/GJNEWS_01/130809822</a> .
Other Publications	Daley, M.L. included in article. Nilsen, E. 2013. New Hampshire Public Radio "Statewide Project Looks at Ecosystems and Climate Change." <a href="http://nhpr.org/post/statewide-project-looksecosystems-and-climate-change">http://nhpr.org/post/statewide-project-looksecosystems-and-climate-change</a> .
Other Publications	Koenig, L. featured in article. Gillies, J. 2014. New Hampshire stream monitoring network tracks Great Bay's health. <a href="http://www.fondriest.com/news/great-baynew-hampshire-stream-monitoring.htm">http://www.fondriest.com/news/great-baynew-hampshire-stream-monitoring.htm</a> .
Other Publications	McDowell September 10, 2014. UNH Scientists Find Urban Ecosystems "Evolve," Require Sustainable Management. <a href="http://www.unh.edu/news/releases/2014/09/ds10evolve.cfm#ixzz3D10ttLHP">http://www.unh.edu/news/releases/2014/09/ds10evolve.cfm#ixzz3D10ttLHP</a> .
Other Publications	McDowell, W.H. 2014. A river runs through it: U.S. cities' waterways show consistent patterns of evolution. <a href="http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=132583&amp;org=NSF">http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=132583&amp;org=NSF</a>
Other Publications	McDowell, William H. September 23, 2014. Interviewed for the "University of Maryland professor tailors research to help protect the Chesapeake Bay." University of Maryland's Independent Student Newspaper. <a href="http://www.diamondbackonline.com/news/a/2014/09/23/university-of-maryland-professor-tailors-research-to-help-protect-the-chesapeake-bay">http://www.diamondbackonline.com/news/a/2014/09/23/university-of-maryland-professor-tailors-research-to-help-protect-the-chesapeake-bay</a>
Other Publications	Humphries, C. 2014. The city is an ecosystem, pipes and all. What scientists are finding when they treat wastewater. <a href="http://www.bostonglobe.com/ideas/2014/11/07/the-city-ecosystem-pipes-and-all/HjLVemBs9nP">http://www.bostonglobe.com/ideas/2014/11/07/the-city-ecosystem-pipes-and-all/HjLVemBs9nP</a>
Other Publications	Interviewed by Nick Reid, a reporter from the Concord Monitor, on the Suncook River avulsion in Epsom. <a href="http://www.concordmonitor.com/home/17941607-95/on-the-suncook-river-a-slow-rolling-disaster">http://www.concordmonitor.com/home/17941607-95/on-the-suncook-river-a-slow-rolling-disaster</a>
Other Publications	McDowell, W.H. 2015. On the Suncook River, a slow, rolling disaster response. Concord Monitor. August 11, 2015.
Other Publications	Daley, M.L. 2015. Understanding Nitrogen Sources in the Great Bay Watershed. Great Bay Matters. Spring 2015.

# Education

## Number of students supported by Base-level Grants

Educational Level	2011	2012	2013	2014	2015	Total
Undergraduate	10	14	15	14	19	72
Masters	4	6	6	4	2	22
Ph.D.	2	2	2	1	3	10
Post-Doc.	0	0	0	2	3	5
Total	16	22	23	21	27	109

## Number of students supported by Competitive Grants

Educational Level	2011	2012	2013	2014	2015	Total
Undergraduate	0	0	0	0	0	0
Masters	0	0	0	0	0	0
Ph.D.	0	0	0	0	0	0
Post-Doc.	0	0	0	0	0	0
Total	0	0	0	0	0	0

## Number of students supported by Internships

Educational Level	2011	2012	2013	2014	2015	Total
Undergraduate	0	0	0	0	1	1
Masters	0	0	0	0	0	0
Ph.D.	0	0	0	0	0	0
Post-Doc.	0	0	0	0	0	0
Total	0	0	0	0	1	1

## Number of students supported by Supplemental Grants

Educational Level	2011	2012	2013	2014	2015	Total
Undergraduate	1	2	4	3	5	15
Masters	1	0	3	2	4	10
Ph.D.	0	0	1	1	0	2
Post-Doc.	0	0	1	1	1	3
Total	2	2	9	7	10	30

## *Theses and Dissertations*

Number of Theses and Dissertations Resulting from Student Support: FY 2011 through FY 2015	
Master's Theses	22
Ph.D. Dissertations	10

***Student Grants-in-Aid and Summer Fellowships***

N/A

## **Additional Information for the Evaluation Panel**

N/A

# Attachments

## Attachment A: Individual Project Descriptions

### 'Arsenic chemical ...': 2011NH141B Research Description

<b>Title</b>	<u>Arsenic chemical dynamics in NH groundwater reservoirs: Insights from temporal variability in multi-element signatures of statewide samples</u>
<b>Project Number</b>	2011NH141B
<b>Start Date</b>	3/1/2011
<b>End Date</b>	2/29/2012
<b>Research Category</b>	Water Quality
<b>Focus Categories</b>	Geochemical Processes; Groundwater; Toxic Substances
<b>Principal Investigators</b>	Julia Bryce

Several studies have documented high levels of arsenic, a known human health contaminant, in New Hampshire public and private groundwater wells, well in excess of the EPA-designated maximum contaminant level. Though high levels of arsenic may be attributed to both anthropogenic and natural sources, these studies taken together identify several key factors that control arsenic abundance in New Hampshire's groundwater and suggest that the causes of high abundances across the state are generally attributable to local geological and geochemical factors. The work outlined in this proposal is designed to enhance understanding of natural controls on the presence of arsenic, a known human health contaminant, in groundwater. To elucidate the geochemical mechanisms responsible for cycling arsenic through groundwater, we will also measure aqueous abundances of iron and lead, a second regulated contaminant. Our primary targets are ~900 samples collected between 2003 and 2006 provided by J. Ayotte. We propose to complement the baseline samples for this work by resampling a subset (> 15%) of the groundwater wells to provide a perspective on how the abundance of contaminants changes over time. We will also carry out leaching experiments on two metasedimentary units found to contain a proportionately high number of groundwater wells with elevated arsenic contents (Montgomery et al., USGS fact sheet, 2003). The proposed research activities build upon earlier NH-based studies in four key ways: 1) expanding the time windows over which arsenic measurements are made in NH groundwaters; 2) expanding the geographical coverage of examining groundwater arsenic contents; 3) carrying out mineral-specific leaching experiments to enhance the role of specific mineral phases (sulfides + oxyhydroxides) in mobilizing arsenic into and adsorbing arsenic from NH groundwaters, and 4) carry out arsenic analyses in companion with other metals (namely iron and lead) to elucidate the role of natural phases in all three of these metals. The project supports two students and the development of new analytical techniques in new laboratories at the University of New Hampshire.

Funding		
Funding Period	Federal \$104 Funds	Required \$104 Matching Funds
FY2011	\$17,165	\$46,383
FY2012	\$14,969	\$33,230

Degree Level	Number of Students	Number of Dissertations/Theses
Undergraduate	1	
Masters	0	1
Ph.D.	1	0
Post-Doctoral	0	

**'New Hampshire WR ...': 2008NH97B Information Transfer Description**

<b>Title</b>	<u>New Hampshire WRRC Information Transfer</u>
<b>Project Number</b>	2008NH97B
<b>Start Date</b>	3/1/2011
<b>End Date</b>	2/29/2012
<b>Research Category</b>	Water Quality
<b>Focus Categories</b>	Management and Planning; Water Quality; Non Point Pollution
<b>Principal Investigators</b>	William McDowell

*This project will provide salary for the Center's Director and Associate Director as they meet with state representatives, local town officials, watershed groups, scientists and the general public to discuss 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.wrcc.unh.edu/>) is also used to disseminate information on water resources, and is updated and maintained by salary provided by this project.*

<b>Funding</b>		
<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2011	\$28,175	\$22,303
FY2012	\$19,235	\$18,395
FY2013	\$14,750	\$17,045
FY2014	\$9,298	\$4,417
FY2015	\$17,954	\$19,936

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate		
Masters		2
Ph.D.		0
Post-Doctoral		

<b>Publications</b>	
<b>Publication Type</b>	<b>Publication Citation</b>
Dissertations	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.
Articles in Refereed Scientific Journals	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.
Articles in Refereed Scientific Journals	Hope, A.J., W.H. McDowell, W.M. Wollheim, Submitted, Ecosystem metabolism and nutrient uptake in an urban, piped headwater stream, Biogeochemistry.

Articles in Refereed Scientific Journals	Liptzin, D., M.L. Daley, and W.H. McDowell. Accepted. A comparison of wet deposition collectors at a coastal rural site. Submitted to <i>Water, Air, &amp; Soil Pollution</i> . April 2013.
Articles in Refereed Scientific Journals	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.
Articles in Refereed Scientific Journals	Hope, A.J., W.H. McDowell, W.M. Wollheim. 2013. Ecosystem metabolism and nutrient uptake in an urban, piped headwater stream. <i>Biogeochemistry</i> . September 2013. DOI 10.1007/s10533-013-9900-y
Articles in Refereed Scientific Journals	Liptzin, D., M.L. Daley, and W.H. McDowell. 2013. A comparison of wet deposition collectors at a coastal rural site. <i>Water, Air, &amp; Soil Pollution</i> . 224(5):1558. 2013.
Articles in Refereed Scientific Journals	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. <i>Frontiers in Ecology and the Environment</i> 12: 5-14.
Articles in Refereed Scientific Journals	Kaushal, S.S., W.H. McDowell, and W.M. Wollheim. 2014. Tracking evolution of urban biogeochemical cycles: past, present, and future. <i>Biogeochemistry</i> 121:1-21.
Articles in Refereed Scientific Journals	Koenig, L.E., A.J. Baumann, and W.H. McDowell. 2014. Improving automated phosphorus measurements in freshwater: an analytical approach to eliminating silica interference. <i>Limnology and Oceanography: Methods</i> . <i>Limnology and Oceanography: Methods</i> . 12:223–231. DOI: 10.4319/lom.2014.12.223. March 2014.
Articles in Refereed Scientific Journals	McDowell, W.H. 2014. NEON and STREON: opportunities and challenges for the aquatic sciences. <i>Freshwater Science</i> 34:386-391.
Dissertations	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.
Dissertations	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.
Dissertations	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.
Articles in Refereed Scientific Journals	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 <i>Ecosphere</i> .



Articles in Refereed Scientific Journals	Appling, A.P., Leon, M.C. and McDowell, W.H. 2015. Reducing bias and quantifying uncertainty in watershed flux estimates: The R package loadflex. <i>Ecosphere</i> . 6(12): Article 269. DOI: 10.1890/ES14-00517.1 .
Articles in Refereed Scientific Journals	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. <i>Water</i> . 7:4063-4087. doi: 10.3390/w7084063.
Articles in Refereed Scientific Journals	McDowell, W.H. 2015. NEON and STREON: opportunities and challenges for the aquatic sciences. <i>Freshwater Science</i> . 34:386-391. DOI: 10.1086/679489.
Articles in Refereed Scientific Journals	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. <i>Remote Sensing of Environment</i> . 167:88-97.
Dissertations	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.
Articles in Refereed Scientific Journals	Rodriguez-Cardona, B., Wymore, A.S. and McDowell, W.H. 2016. DOC:NO3 ratios and NO3 uptake in forested headwater streams. <i>Journal of Geophysical Research: Biogeosciences</i> . 121(1):205-217. doi:10.1002/2015JG003146.
Articles in Refereed Scientific Journals	Wymore A.S., Rodriguez-Cardona B. and McDowell, W.H. 2015. Direct response of dissolved organic nitrogen to nitrate availability in headwater streams. <i>Biogeochemistry</i> . 126:1-10. DOI 10.1007/s10533-015-0153-9.
Articles in Refereed Scientific Journals	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. <i>Global Change Biology</i> . DOI: 10.1111/gcb.13517.
Articles in Refereed Scientific Journals	Hunt, C. W., Snyder, L., Salisbury, J.E., Vandemark, D., McDowell, W.H. 2017. SIPCO2: A simple, inexpensive surface water pCO2 sensor. <i>Limnology and Oceanography Methods</i> . doi: 10.1002/lom3.10157.
Articles in Refereed Scientific Journals	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 <i>Water Resources Research</i> . Special issue "Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds".
Articles in Refereed Scientific Journals	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 <i>Water Resources Research</i> . Special issue "Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds".
Articles in Refereed Scientific Journals	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. <i>Global Biogeochemical Cycles</i> , 30, doi:10.1002/2016GB005468.

Articles in Refereed Scientific Journals	Wymore, AS, B Rodríguez-Cardona, and WH McDowell. 2016. Understanding dissolved organic matter biogeochemistry through in situ nutrient manipulations in stream ecosystems. <i>Journal of Visualized Experiments</i> . 116: doi: 10.3791/54704 , <a href="http://www.jove.com/video/54704">http://www.jove.com/video/54704</a> .
Articles in Refereed Scientific Journals	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 <i>Water Resources Research</i> . Special issue “Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds”.

'Water Quality an ...': 2003NH21B Research Description

<b>Title</b>	<u>Water Quality and the Landscape: Long-term monitoring of rapidly developing suburban watersheds</u>
<b>Project Number</b>	2003NH21B
<b>Start Date</b>	3/1/2011
<b>End Date</b>	2/28/2012
<b>Research Category</b>	Water Quality
<b>Focus Categories</b>	Non Point Pollution; Surface Water; Nutrients
<b>Principal Investigators</b>	William McDowell

*New Hampshire's surface waters are a very valuable resource, contributing to the state's economic base through recreation (fishing, boating, and swimming), tourism and real estate values, and drinking water supplies. The rapid population growth that New Hampshire is experiencing threatens the state's water supplies and ecosystem health. The proposed work will continue documentation of long-term changes to water quality in response to changing land use and management practices as a result of population growth. There are several components to this project, drawing from the efforts of local watershed monitoring groups, as well as on-going research projects by UNH staff and students, all leading to long-term datasets of water quality in New Hampshire. These water quality datasets could support the development, testing and refinement of predictive models, accurately assess the impacts of watershed management practices on drinking water supplies, and be potential early warning signs of dramatic changes to surface water quality in the region resulting from rapid development.*

<b>Funding</b>		
<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2011	\$31,443	\$80,725
FY2012	\$25,000	\$69,082
FY2013	\$23,750	\$72,369
FY2014	\$24,431	\$66,648
FY2015	\$24,491	\$76,798

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	3	
Masters	4	2
Ph.D.	0	0
Post-Doctoral	0	

<b>Publications</b>	
<b>Publication Type</b>	<b>Publication Citation</b>
Dissertations	Buyofsky, Lauren A., 2006, Relationships between groundwater quality and landscape characteristics in the Lamprey River watershed, "MS Dissertation", Department of Natural Resources, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 176 pages.
Conference Proceedings	McDowell, W.H., M.L. Daley and J.D. Potter, 2011, Dissolved organic matter dynamics in a suburban basin: wetlands and people drive quantity and quality, North American

	Benthological Society Meeting, Providence, RI, May 2011.
Conference Proceedings	McDowell, W.H. and M.L. Daley, 2011, Net Manageable Nitrogen: Definition and Rationale for a new approach to nitrogen management in moderately impacted watersheds, American Geophysical Union Fall Conference, San Francisco, CA, December, 2011.
Conference Proceedings	McDowell, W.H. and M.L. Daley, 2011, Net Manageable Nitrogen: Definition and Rationale for a new approach to nitrogen management in moderately impacted watersheds, National Academy Keck Futures Initiative Ecosystem Services Conference, Irvine, CA, November, 2011.
Articles in Refereed Scientific Journals	Daley, M.L. and W.H. McDowell, In Preparation, Nitrogen saturation in highly retentive coastal urbanizing watersheds, Ecological Applications.
Dissertations	Baillio, J., 2012, Controls on variability of dissolved greenhouse gas concentration and emissions from small streams in southeastern New Hampshire, MS Dissertation, Department of Natural Resources & the Environment, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 111 pages.
Articles in Refereed Scientific Journals	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.
Articles in Refereed Scientific Journals	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.
Dissertations	Parham, L., 2012, Spatial and temporal variation in degradation of dissolved organic carbon on the main stem of the Lamprey River, MS Dissertation, Department of Natural Resources & the Environment, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 66 pages.
Articles in Refereed Scientific Journals	Hope, A.J., W.H. McDowell, W.M. Wollheim, Submitted, Ecosystem metabolism and nutrient uptake in an urban, piped headwater stream, Biogeochemistry.
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Articles in Refereed Scientific Journals	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.
Dissertations	Buyofsky, Lauren A., 2006, Relationships between groundwater quality and landscape characteristics in the Lamprey River watershed, "MS Dissertation", Department of Natural Resources, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 176 pages.

Articles in Refereed Scientific Journals	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. <i>Frontiers in Ecology and the Environment</i> 12: 5-14.
Articles in Refereed Scientific Journals	Flint, S.F. and W.H. McDowell. 2015. Effects of headwater wetlands on dissolved nitrogen and dissolved organic carbon concentrations in a suburban New Hampshire watershed. <i>Freshwater Science</i> 34:456-471.
Articles in Refereed Scientific Journals	Kaushal, S.S., W.H. McDowell, and W.M. Wollheim. 2014. Tracking evolution of urban biogeochemical cycles: past, present, and future. <i>Biogeochemistry</i> 121:1-21.
Articles in Refereed Scientific Journals	Koenig, L.E., A.J. Baumann, and W.H. McDowell. 2014. Improving automated phosphorus measurements in freshwater: an analytical approach to eliminating silica interference. <i>Limnology and Oceanography: Methods</i> . <i>Limnology and Oceanography: Methods</i> . 12:223–231. DOI: 10.4319/lom.2014.12.223. March 2014.
Articles in Refereed Scientific Journals	McDowell, W.H. 2014. NEON and STREON: opportunities and challenges for the aquatic sciences. <i>Freshwater Science</i> . 34:386-391.
Dissertations	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.
Dissertations	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.
Dissertations	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.
Articles in Refereed Scientific Journals	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 <i>Ecosphere</i> .
Articles in Refereed Scientific Journals	McDowell, W.H. 2015. NEON and STREON: opportunities and challenges for the aquatic sciences. <i>Freshwater Science</i> . 34:386-391. DOI: 10.1086/679489.
Articles in Refereed Scientific Journals	Appling, A.P., Leon, M.C. and McDowell, W.H. 2015. Reducing bias and quantifying uncertainty in watershed flux estimates: The R package loadflex. <i>Ecosphere</i> . 6(12): Article 269. DOI: 10.1890/ES14-00517.1.
Articles in Refereed Scientific Journals	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. <i>Water</i> . 7:4063-4087. doi: 10.3390/w7084063.

Dissertations	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.
Articles in Refereed Scientific Journals	Rodriguez-Cardona, B., Wymore, A.S. and McDowell, W.H. 2016. DOC:NO3 ratios and NO3 uptake in forested headwater streams. <i>Journal of Geophysical Research: Biogeosciences</i> . 121(1):205-217. doi:10.1002/2015JG003146.
Articles in Refereed Scientific Journals	Wymore A.S., Rodriguez-Cardona B. and McDowell, W.H. 2015. Direct response of dissolved organic nitrogen to nitrate availability in headwater streams. <i>Biogeochemistry</i> . 126:1-10. DOI 10.1007/s10533-015-0153-9.
Dissertations	Buyofsky, Lauren A., 2006, Relationships between groundwater quality and landscape characteristics in the Lamprey River watershed, "MS Dissertation", Department of Natural Resources, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 176 pages.
Articles in Refereed Scientific Journals	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. <i>Global Change Biology</i> . DOI: 10.1111/gcb.13517.
Articles in Refereed Scientific Journals	Hunt, C. W., Snyder, L., Salisbury, J.E., Vandemark, D., McDowell, W.H. 2017. SIPCO2: A simple, inexpensive surface water pCO2 sensor. <i>Limnology and Oceanography Methods</i> . doi: 10.1002/lom3.10157.
Articles in Refereed Scientific Journals	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 <i>Water Resources Research</i> . Special issue "Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds".
Articles in Refereed Scientific Journals	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 <i>Water Resources Research</i> . Special issue "Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds".
Articles in Refereed Scientific Journals	Wymore, AS, B Rodríguez-Cardona, and WH McDowell. 2016. Understanding dissolved organic matter biogeochemistry through in situ nutrient manipulations in stream ecosystems. <i>Journal of Visualized Experiments</i> . 116: doi: 10.3791/54704, <a href="http://www.jove.com/video/54704">http://www.jove.com/video/54704</a> .
Articles in Refereed Scientific Journals	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 <i>Water Resources Research</i> . Special issue "Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds".
Dissertations	Buyofsky, Lauren A., 2006, Relationships between groundwater quality and landscape characteristics in the Lamprey River watershed, "MS Dissertation", Department of Natural Resources, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 176 pages.
Articles in Refereed	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

Scientific Journals	marker. Environmental Monitoring and Assessment 189(8).
Articles in Refereed Scientific Journals	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. <i>Global Change Biology</i> 23(4): 1610-1625.
Articles in Refereed Scientific Journals	Hunt, C. W., L. Snyder, J. E. Salisbury, D. Vandemark and W. H. McDowell (2017). SIPCO2: A simple, inexpensive surface water pCO <sub>2</sub> sensor. <i>Limnology and Oceanography-Methods</i> 15(3): 291-301.
Articles in Refereed Scientific Journals	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. <i>Water Resources Research</i> . 53: 10,655–10,673. DOI: 10.1002/2017WR020739.
Articles in Refereed Scientific Journals	Snyder, L.E., Potter, J.D. and McDowell, W.H. 2018. An Evaluation of Nitrate, fDOM, and Turbidity Sensors in New Hampshire Streams. <i>Water Resources Research</i> . Special issue “Continuous nutrient sensing in research and management: applications and lessons learned across aquatic environments and watersheds”. DOI: 10.1002/2017WR020678
Articles in Refereed Scientific Journals	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. <i>Water Resources Research</i> . DOI: 10.1002/2017WR022168.
Dissertations	Buyofsky, Lauren A., 2006, Relationships between groundwater quality and landscape characteristics in the Lamprey River watershed, "MS Dissertation", Department of Natural Resources, College of Life Science and Agriculture, University of New Hampshire, Durham, NH, 176 pages.

**'Nutrient Loading ...': 2011NH148B Research Description**

<b>Title</b>	<u>Nutrient Loading Coefficients for NH Watersheds: Development and Connectivity</u>
<b>Project Number</b>	2011NH148B
<b>Start Date</b>	3/1/2011
<b>End Date</b>	2/29/2012
<b>Research Category</b>	Water Quality
<b>Focus Categories</b>	Nutrients; Non Point Pollution; Management and Planning

**Principal Investigators** Jeffrey Schloss

*Through previous NIWR and EPA funded projects we have conducted cost-effective volunteer assisted watershed nutrient budget studies and catalogued those studies performed by other agencies/organizations. While these investigations have allowed us to document the range of nutrient export coefficients for particular land use/land covers that occur in our state and region, further analysis is needed to determine the influence of various factors such as percent imperviousness, riparian buffer extent and use of best management practices. In addition, past work also suggests an important influence of drainage conductivity at the local (subwatershed) scale. This long-term project will update the data-base to include the most recent studies since last compiled (2001) and perform GIS aided analyses to develop loading coefficients for various land use/land covers and investigate the additional watershed characteristics that further influence the nutrient loadings. In addition, the project will continue to support our long-term monitoring program conducted through differing weather years at both shallow and deep lake and tributary sites that offer the potential to cost effectively estimate the lake response to the loadings due to increasing watershed development/use over time.*

<b>Funding</b>		
<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2011	\$5,330	\$26,554

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	6	
Masters	0	0
Ph.D.	1	0
Post-Doctoral	0	

<b>Publications</b>	
<b>Publication Type</b>	<b>Publication Citation</b>
Other Publications	Craycraft, Robert and Jeffrey A. Schloss, 2011, Site Specific Project Plan: Lake Wentworth/Crescent Lake Watershed Management Plan Implementation-Phase I, Operated Under: the University of New Hampshire Center for Freshwater Biology and Lakes Lay Monitoring Program Programmatic Quality Assurance Project Plan, UNH Center for Freshwater Biology and Cooperative Extension, Durham, NH, 19pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Baboosic Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 122 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Bow Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH



	Coooperative Extension, Durham, NH, 65 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Chocorua Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 66 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Conway Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 71 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Crystal Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 55 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Goose Pond Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 54 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Greay East Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 74 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Kanasatka Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 76 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lovell Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 61 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Mendums Pond Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 58 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Merrymeeting Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 80 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Milton Ponds (Depot, Townhouse and Northeast) Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 80 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Mirror Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 60 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Naticook Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 60 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Nippo Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 60 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, North River Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 58 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Silver Lake (Madison) Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 98 pps.

Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Squam Lakes Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 160 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Sunset Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 63 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Weston Pond Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 18 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Wentworth and Crescent Lake Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 108 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnepesaukee-Alton Bay Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 93 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnepesaukee-Meredith Bay Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 64 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnepesaukee-Moultonborough Bay Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 110 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnepesaukee-Tuftonboro Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 110 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss, 2011, Lake Winnisquam Annual Lake Report for 2010, New Hampshire Lakes Lay Monitoring Program, UNH Center for Freshwater Biology and UNH Cooperative Extension, Durham, NH, 74 pps.

**'Determining the ...': 2011NH164S Research Description**

**Title** Determining the Effectiveness of the Clean Air Act and Amendments for the Recovery of Surface Waters in the Northeastern U.S.

**Project Number** 2011NH164S

**Start Date** 3/28/2011

**End Date** 3/27/2012

**Research Category** Climate and Hydrologic Processes

**Focus Categories** Acid Deposition; Surface Water; Law, Institutions, and Policy

**Principal Investigators** William McDowell; Steve Kahl

[ 'S' projects don't yet have Abstracts ]

Funding	
Funding Period	Total 'Pass-through' Grant
FY2011	\$0

Degree Level	Number of Students	Number of Dissertations/Theses
Undergraduate	1	
Masters	1	0
Ph.D.	0	0
Post-Doctoral	0	

Publications	
Publication Type	Publication Citation
Articles in Refereed Scientific Journals	Sanclements, M., G. Oelsner, D. McKnight, S.J. Nelson, J. Stoddard, 2012, New insights into the source of decadal increases of dissolved organic matter (DOM) in acid-sensitive lakes, Environmental Science and Technology, in press.
Other Publications	Nelson, S.J., P. Vaux, M.J. James-Pirri, and G. Giese, 2011, Assessment of natural resource conditions in and adjacent to Cape Cod National Seashore, Massachusetts, Natural Resource [Technical] Report NPS/XXXX/ NRXX—20XX/XXX, National Park Service, Fort Collins, Colorado, In press.
Articles in Refereed Scientific Journals	Kerr, J.G., M.C. Eimers, I.F. Creed, M.B. Adams, F. Beall, D. Burns, J.L. Campbell, S.F. Christopher, T.A. Clair, F. Courchesne, L. Duchesne, I. Fernandez, D. Houle, D.S. Jeffries, G.E. Likens, M.J. Mitchell, J. Shanley, H. Yao, 2011, The effects of seasonal drying on sulphate dynamics in streams across southeastern Canada and the northeastern USA, Biogeochemistry DOI 10.1007/s10533-011-9664-1.
Articles in Refereed Scientific Journals	Sanclements, M., G. Oelsner, D. McKnight, S.J. Nelson, J. Stoddard, 2012, New insights into the source of decadal increases of dissolved organic matter (DOM) in acid-sensitive lakes of the northeastern U.S., Environmental Science and Technology, 46(6): 3212–3219, DOI: 10.1007/s11356-009-0176-7.
Other Publications	Nelson, S.J., P. Vaux, M.J. James-Pirri, and G. Giese, 2012, Natural resource condition assessment: Cape Cod National Seashore, Massachusetts, Natural Resource Report NPS/NER/NRR—2012/605, National Park Service, Fort Collins, Colorado.

Articles in Refereed Scientific Journals	Kerr, J.G., M.C. Eimers, I.F. Creed, M.B. Adams, F. Beall, D. Burns, J.L. Campbell, S.F. Christopher, T.A. Clair, F. Courchesne, L. Duchesne, I. Fernandez, D. Houle, D.S. Jeffries, G.E. Likens, M.J. Mitchell, J. Shanley, H. Yao, 2011, The effects of seasonal drying on sulphate dynamics in streams across southeastern Canada and the northeastern USA, 111(1-3): 393-409, Biogeochemistry, DOI 10.1007/s10533-011-9664-1.
Other Publications	James-Pirri, M. J., S. J. Nelson, and P. D. Vaux, June 2011, Natural Resource Condition Assessment for Saugus Iron Works National Historic Site. Natural Resource Report NPS/NER/NRR—2011/457, National Park Service, Fort Collins, Colorado.
Other Publications	
Articles in Refereed Scientific Journals	Sanclements, M., G. Oelsner, D. McKnight, S.J. Nelson, J. Stoddard, 2012, New insights into the source of decadal increases of dissolved organic matter (DOM) in acid-sensitive lakes of the northeastern U.S., Environmental Science and Technology, 46(6): 3212–3219, DOI: 10.1007/s11356-009-0176-7.
Other Publications	Nelson, S.J., P. Vaux, M.J. James-Pirri, and G. Giese, 2012, Natural resource condition assessment: Cape Cod National Seashore, Massachusetts, Natural Resource Report NPS/NER/NRR—2012/605, National Park Service, Fort Collins, Colorado.
Articles in Refereed Scientific Journals	Kerr, J.G., M.C. Eimers, I.F. Creed, M.B. Adams, F. Beall, D. Burns, J.L. Campbell, S.F. Christopher, T.A. Clair, F. Courchesne, L. Duchesne, I. Fernandez, D. Houle, D.S. Jeffries, G.E. Likens, M.J. Mitchell, J. Shanley, H. Yao, 2011, The effects of seasonal drying on sulphate dynamics in streams across southeastern Canada and the northeastern USA, 111(1-3): 393-409, Biogeochemistry, DOI 10.1007/s10533-011-9664-1.
Other Publications	James-Pirri, M. J., S. J. Nelson, and P. D. Vaux, June 2011, Natural Resource Condition Assessment for Saugus Iron Works National Historic Site. Natural Resource Report NPS/NER/NRR—2011/457, National Park Service, Fort Collins, Colorado.
Other Publications	
Articles in Refereed Scientific Journals	Strock, K., S. Nelson, J. Kahl, J. Saros, W. McDowell, 2014. Decadal trends reveal recent acceleration in the rate of recovery from acidification in the northeastern US. Environ. Sci. Technol. 48(9):4681-4689.
Dissertations	Strock, K.E. 2013. Deciphering Climate-Mediated Changes in Boreal Lake Ecosystems. Ph.D. Dissertation, University of Maine, Orono, Maine.
Dissertations	Boeff, K. 2014. Evaluating the effect of a changing climate on thermocline depth in Maine's Great Ponds. Master's thesis, University of Maine, Orono, Maine.
Articles in Refereed Scientific Journals	Sanclements, M., G. Oelsner, D. McKnight, S.J. Nelson, J. Stoddard, 2012, New insights into the source of decadal increases of dissolved organic matter (DOM) in acid-sensitive lakes of the northeastern U.S., Environmental Science and Technology, 46(6): 3212–3219, DOI: 10.1007/s11356-009-0176-7.
Other Publications	Nelson, S.J., P. Vaux, M.J. James-Pirri, and G. Giese, 2012, Natural resource condition assessment: Cape Cod National Seashore, Massachusetts, Natural Resource Report NPS/NER/NRR—2012/605, National Park Service, Fort Collins, Colorado.
Articles in Refereed Scientific Journals	Kerr, J.G., M.C. Eimers, I.F. Creed, M.B. Adams, F. Beall, D. Burns, J.L. Campbell, S.F. Christopher, T.A. Clair, F. Courchesne, L. Duchesne, I. Fernandez, D. Houle, D.S. Jeffries, G.E. Likens, M.J. Mitchell, J. Shanley, H. Yao, 2011, The effects of seasonal drying on sulphate dynamics in streams across southeastern Canada and the northeastern USA, 111(1-3): 393-409, Biogeochemistry, DOI 10.1007/s10533-011-9664-1.

Other Publications	James-Pirri, M. J., S. J. Nelson, and P. D. Vaux, June 2011, Natural Resource Condition Assessment for Saugus Iron Works National Historic Site. Natural Resource Report NPS/NER/NRR—2011/457, National Park Service, Fort Collins, Colorado.
Other Publications	
Articles in Refereed Scientific Journals	Strock, K., S. Nelson, J. Kahl, J. Saros, W. McDowell, 2014. Decadal trends reveal recent acceleration in the rate of recovery from acidification in the northeastern US. Environ. Sci. Technol. 48(9):4681-4689.
Dissertations	Strock, K.E. 2013. Deciphering Climate-Mediated Changes in Boreal Lake Ecosystems. Ph.D. Dissertation, University of Maine, Orono, Maine.
Dissertations	Boeff, K. 2014. Evaluating the effect of a changing climate on thermocline depth in Maine's Great Ponds. Master's thesis, University of Maine, Orono, Maine.
Dissertations	Brown, R. 2014. Assessing the ecological effects of increased dissolved organic carbon in Maine lakes over recent decades. Master's thesis, University of Maine, Orono, Maine.

**'Determining the ...': 2012NH165B Research Description**

**Title** Determining the Impact of Coal Tar Based Driveway Sealant on Polycyclic Aromatic Hydrocarbon Concentrations in NH Waterbodies.

**Project Number** 2012NH165B

**Start Date** 3/1/2012

**End Date** 2/28/2013

**Research Category** Water Quality

**Focus Categories** Non Point Pollution; Water Quality; Sediments

**Principal Investigators** Alison Watts

*Coal-tar-based pavement sealant has been identified as a source of polycyclic aromatic hydrocarbons (PAHs) to the environment. Recent studies have indicated that PAHs in lake sediments at numerous locations throughout the country are increasing. Contaminant Mass Balance (CMB) modeling indicates that the primary source of increasing concentrations may be coal-tar-based sealant. The proposed study will combine existing PAH data sets with new sample information to determine if coal-tar-sealant is contributing to increased PAH concentrations in lakes, streams and estuaries in New Hampshire. Existing data from the NH Great Bay region will be used to build a CMB model which utilizes published PAH source data to apportion source profiles in each sample data set. Existing data includes EPAs Coastal Monitoring Program, NH DES Databases, and samples previously collected and analyzed by the PIs. This information will be used to determine if sealant use is impacting PAH concentrations in Great Bay sediments. Additional samples will be collected in lakes and streams in urban and suburban regions, and the CMB source apportionment will be used to determine if sealants are impacting lakes and streams in New Hampshire, and to quantify the extent of that impact. The results of this study will be used to inform management and education decisions with regards to the use of coal-tar-based sealant.*

<b>Funding</b>		
<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2012	\$9,967	\$13,249

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	0	
Masters	0	0
Ph.D.	0	0
Post-Doctoral	0	

'James Hall Veget ...': 2012NH168B Research Description

<b>Title</b>	<u>James Hall Vegetated Roof Nutrient Removal Efficiency and Hydrologic Response</u>
<b>Project Number</b>	2012NH168B
<b>Start Date</b>	3/1/2012
<b>End Date</b>	2/28/2014
<b>Research Category</b>	Water Quality
<b>Focus Categories</b>	Nutrients; Water Quality; Treatment
<b>Principal Investigators</b>	Robert Roseen; Thomas Ballestero

*We propose to examine the comparison between water quality and hydrologic performance of a EPDM rubber flat and vegetated roof. Currently, vegetated roofs are not widely used within New England as a common stormwater Best Management Practice (BMP). However, the incorporation of vegetated roofs into a region's stormwater management plan may be an efficient method of managing flooding issues and reducing nutrient loading to already impacted surfaces waters. This information will be extrapolated to a build-out analysis for the City of Portsmouth to examine potential benefits. The information gathered will be unique for its location in a semi-humid temperate location in coastal New Hampshire. Understanding BMP effectiveness in this climate is especially important with the current need to better understand how non-point source pollution is affecting the Great Bay. The intent of this research is to explore the role that vegetated roofs can play in the mitigation of nutrient loading within a cold climate.*

<b>Funding</b>		
<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2012	\$7,000	\$17,517
FY2013	\$7,000	\$17,517

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	0	
Masters	0	
Ph.D.	0	
Post-Doctoral	0	

**'Participatory Wa ...': 2012NH174B Information Transfer Description**

<b>Title</b>	<u>Participatory Water Quality Assessment Through the NH Lakes Lay Monitoring Program</u>
<b>Project Number</b>	2012NH174B
<b>Start Date</b>	3/1/2012
<b>End Date</b>	2/28/2014
<b>Research Category</b>	Water Quality
<b>Focus Categories</b>	Water Quality; Non Point Pollution; Management and Planning
<b>Principal Investigators</b>	Jeffrey Schloss

*The fresh waters of New Hampshire represent a valuable resource contributing to the State 's economic base through recreation, tourism, real estate revenues and taxes. In addition some lakes and rivers serve as current or potential water supplies. Of particular concern in NH,(New England 's fastest growing state) is the response of our waters to increasing non-point source pollutant loading due to watershed development and land use activities. Local citizens, lake/watershed associations and local decision-makers remain in dire need of additional information required for the intelligent management of our water resources on the local level. State agencies need to be better informed on water quality changes and trends. Limited financial resources do not allow for adequate monitoring of these waters by state or federal agency personnel. This project would partially support our 30+ year, long-term participatory monitoring program: the New Hampshire Lakes Lay Monitoring Program, that has been a partnership between UNH faculty, staff and students and citizen scientists throughout the state. Citizens timely monitoring through differing weather years at both shallow and deep lake and tributary sites offers the potential to cost-effectively assess lake water quality and document the lake response to the loadings due to increasing watershed development and use over time. Participants, in turn, gain valuable knowledge to better steward and manage their resources.*

<b>Funding</b>		
<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2012	\$5,600	\$25,341
FY2013	\$2,470	\$12,002

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	7	
Masters	0	0
Ph.D.	1	0
Post-Doctoral	0	

<b>Publications</b>	
<b>Publication Type</b>	<b>Publication Citation</b>
Other Publications	Craycraft, Robert and Jeffrey A. Schloss. 2012. Baboosic Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 138 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Bow Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 114 pps.



Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Chocorua Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 80 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Conway Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH.92 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012 Crystal Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 76 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012 Goose Pond Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 78 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Great East Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 106 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Kanasatka Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 86 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lovell Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 86 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Mendums Pond Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 80 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Merrymeeting Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 86 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Milton Ponds (Depot, Townhouse and Northeast) Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH..98 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Mirror Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 76 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Naticook Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 80 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Nippo Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 78 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. North River Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 72 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Silver Lake (Madison) Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 98 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Highland Lake (Windham ME) Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for

	Freshwater Biology and UNH Cooperative Extension. Durham, NH. 106 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Squam Lakes Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 160 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Sunset Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 63 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Wentworth and Crescent Lake Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 108 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Alton Bay Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 93 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Meredith Bay Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 64 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Saunders Bay Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 110 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Saunders Bay Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 110 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnepesaukee-Tuftonboro Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 110 pps
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2012. Lake Winnisquam Annual Lake Report for 2011. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 74 pps
Other Publications	Craycraft, Robert and Jeffrey A. Schloss. 2013. Baboosic Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 132 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Bow Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 108 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Lake Chocorua Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 82 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Conway Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH.92 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013 Crystal Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 82 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Great East Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 114 pps.

Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Lake Kanasatka Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 94 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Lovell Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 84 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Mendums Pond Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 80 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Merrymeeting Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 96 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Michawanic Pond Data Review (January 22, 2014). New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 14 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Milton Ponds (Depot, Townhouse and Northeast) Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH..96 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Naticook Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 88 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. North River Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 84 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Silver Lake (Madison) Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 102 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Squam Lakes Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 140 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Sunset Lake Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 90 pps.
Other Publications	Craycraft, Robert and Jeffrey A.Schloss. 2013. Lake Winnisquam Annual Lake Report for 2012. New Hampshire Lakes Lay Monitoring Program; UNH Center for Freshwater Biology and UNH Cooperative Extension. Durham, NH. 90 pps.

## 'Natural dams and ...': 2014NH183B Research Description

<b>Title</b>	<u>Natural dams and biogeochemistry at the river network scale: implications for water quality</u>
<b>Project Number</b>	2014NH183B
<b>Start Date</b>	3/1/2014
<b>End Date</b>	2/28/2015
<b>Research Category</b>	Water Quality
<b>Focus Categories</b>	Geomorphological Processes; Wetlands; Nitrate Contamination
<b>Principal Investigators</b>	Denise Burchsted; Mark Green; Jennifer Jacobs; Wil Wollheim

*Water quality in New England rivers is dramatically affected by dams created both by humans and by other natural agents such as beavers or log jams. These dams break a critical assumption embedded in much of our infrastructure and watershed modeling, which is that rivers are continuous systems. In river systems without direct modern human management, natural dams create frequent discontinuities; they occur at frequencies up to ten per kilometer and their impoundments can extend laterally from one valley wall to the other. The impoundments created by these dams have low oxygen levels that dramatically alter biogeochemical processing such as slowing or eliminating nitrification and increasing denitrification. Given the new abundance of these features in river networks, due to the recent regrowth of riparian forests that generate large logs and the recent recolonization of river networks by beavers, it is increasingly important to understand the role of natural dams in biogeochemical state and, by extension, in the water quality of New England's rivers. The proposed research will address this need by considering the overall research question what is the difference in biogeochemical regime between free-flowing river reaches and river reaches associated with natural dams, and what is the extent of this difference at the river network scale? To address this question, we propose to both systematically collect site-scale biogeochemistry parameters along river networks that include free-flowing reaches and natural dams and to examine the landscape-scale parameters that control the presence of natural dams. The three specific research questions follow: (1) Can free-flowing river reaches and river reaches associated with natural dams be classified according to biogeochemical regime? (2) What is the nature of the transition in biogeochemical regime downstream of a natural dam? (3) Which landscape and demographic factors control their presence and frequency of natural dams? This proposal requests funding for the field research that addresses questions 1 and 2; this funding request complements the GIS investigation, addressing question 3, that would be covered partially by the request but primarily by non-federal funds. The field research will collect both high spatial resolution and high temporal resolution data. High spatial resolution data will be collected during stream walk surveys that will measure temperature, pH, dissolved oxygen, conductivity, oxidation reduction potential, stable water isotopes, and channel shape. These data will be collected at regular intervals along free-flowing channels and, where the survey encounters dams, at several points associated with the dams. High temporal resolution data will be collected by ten data logger arrays—with a temperature, stage, and conductivity sensor in each array—and by 27 additional temperature loggers; these will all be used to compare variability within and across beaver meadows, ponds and free-flowing channels. Four of the arrays will be provided by the EPSCoR LoVoTECS project and all of the data from the arrays will be incorporated into that data set. The complementary GIS research will classify reaches in a river network according to their modification by dams (e.g., free-flowing vs. impounded) and generate a predictive model of reach class based on landscape characteristics. The requested funds will primarily support a Master's student to lead field data collection. This will not only generate much-needed research but will also strengthen a nascent bond for joint student research between Keene State College and Antioch University of New England, increasing the research training of undergraduate and graduate students in New Hampshire.*

<b>Funding</b>
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<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2014	\$23,450	\$58,634
FY2015	\$21,742	\$53,250

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	4	
Masters	0	0
Ph.D.	1	0
Post-Doctoral	0	

'Contribution of ...': 2014NH185B Research Description

**Title** Contribution of fluvial wetlands to nitrogen retention in urbanizing coastal watersheds in New England across multiple scales

**Project Number** 2014NH185B

**Start Date** 3/1/2014

**End Date** 2/28/2015

**Research Category** Water Quality

**Focus Categories** Nitrate Contamination; Hydrology; Wetlands

**Principal Investigators** Anne Lightbody; Linda Kalnejais; Wil Wollheim

*Surface water quality in rapidly urbanizing coastal watersheds in New England is at risk due to excess anthropogenic nutrient inputs. We propose to use an innovative combination of hydrologic flow tracing, in-situ enrichment experiments, stable isotopes of water, and remote sensing data to determine the importance of floodplain and in-stream wetlands to nitrogen transformations, storage, and release across different seasons in the Lamprey (NH) and Ipswich (MA) watersheds. Experimental work will focus on two detailed field reaches, where we will determine the location and residence times of lentic compartments as a function of inundation and season, and quantify different biogeochemical mechanisms for nutrient removal and release as a function of season. Resulting estimates of net seasonal uptake rates will be extended to coastal watersheds throughout Massachusetts and New Hampshire and will be suitable for incorporation into existing reach-scale models of the system. This combination of approaches will greatly improve our ability to predict how these quantities may change in the future in response to changes in wetlands abundance, nitrogen inputs, and precipitation frequency.*

<b>Funding</b>		
<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2014	\$25,000	\$51,091
FY2015	\$0	\$0

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	4	
Masters	1	1
Ph.D.	0	0
Post-Doctoral	0	

<b>Publications</b>	
<b>Publication Type</b>	<b>Publication Citation</b>
Dissertations	Rosengarten, D. 2014. Spatial and temporal variability of nitrate cycling in a New England headwater wetland and stream. Department of Earth Sciences, College of Engineering and Physical Sciences, University of New Hampshire, Durham, NH, 184 pages.
Dissertations	Wilderotter, S. 2015. Parameterization of transient storage and nutrient retention in coastal New England wetlands. Department of Earth Sciences, College of Engineering and Physical Sciences, University of New Hampshire, Durham, NH, 235 pages.

**'Determining the ...': 2014NH192S Research Description**

**Title** Determining the Effectiveness of the Clean Air Act and Amendments for the Recovery of Surface Waters in the Northeastern U.S.

**Project Number** 2014NH192S

**Start Date** 7/26/2014

**End Date** 8/31/2017

**Research Category** Not Applicable

**Focus Categories**

**Principal Investigators**

<b>Funding</b>	
<b>Funding Period</b>	<b>Total 'Pass-through' Grant</b>
FY2014	\$202,226
FY2015	\$202,226

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	3	
Masters	2	0
Ph.D.	1	1
Post-Doctoral	1	

<b>Publications</b>	
<b>Publication Type</b>	<b>Publication Citation</b>
Articles in Refereed Scientific Journals	Brown, R., J. Saros S. Nelson. 2016. Using paleolimnological evidence to assess the consequences of increased dissolved organic carbon in recent decades in lakes of the Northeastern US. J Paleolimnol, in review.
Articles in Refereed Scientific Journals	Boeff, K.A., K.E. Strock, J.E. Saros. 2016. Evaluating planktonic diatom response to climate change across three lakes with differing morphometry. J Paleolimnol. DOI 10.1007/s10933-016-9889-z.
Articles in Refereed Scientific Journals	Strock, K.E., Saros, J.E., Nelson, S.J., S.D. Birkel, J.S. Kahl, W.H. McDowell. 2016. Extreme weather years drive episodic changes in lake chemistry: implications for recovery from sulfate deposition and long-term trends in dissolved organic carbon. Biogeochemistry, 127(2-3), 353-365.
Articles in Refereed Scientific Journals	Brown, R., J. Saros S. Nelson. 2016. Using paleolimnological evidence to assess the consequences of increased dissolved organic carbon in recent decades in lakes of the Northeastern US. J Paleolimnol, in review.
Articles in Refereed Scientific Journals	Boeff, K.A., K.E. Strock, J.E. Saros. 2016. Evaluating planktonic diatom response to climate change across three lakes with differing morphometry. J Paleolimnol. DOI 10.1007/s10933-016-9889-z.

Articles in Refereed Scientific Journals	Strock, K.E., Saros, J.E., Nelson, S.J., S.D. Birkel, J.S. Kahl, W.H. McDowell. 2016. Extreme weather years drive episodic changes in lake chemistry: implications for recovery from sulfate deposition and long-term trends in dissolved organic carbon. <i>Biogeochemistry</i> , 127(2-3), 353-365.
Articles in Refereed Scientific Journals	Soranno, P.A., and 79 others, including S.J. Nelson, W.H. McDowell, 2017. LAGOS-NE: A multi-scaled geospatial and temporal database of lake ecological context and water quality for thousands of U.S. lakes. Submitted, GigaScience (GIGA-D-17-00112).
Articles in Refereed Scientific Journals	Gavin, A.L., S.J. Nelson, A.J. Klemmer, I.J. Fernandez, K.E. Strock, W.H. McDowell, 2017. Climate linkages to increases of dissolved organic carbon in acid-sensitive high elevation lakes. Submitted, <i>Water Resources Research</i> (2017WR020963).
Articles in Refereed Scientific Journals	Brown, R.E., S.J. Nelson, J.E. Saros, 2016. Paleolimnological evidence of the consequences of recent increased dissolved organic carbon (DOC) in lakes of the northeastern USA. <i>Journal of Paleolimnology</i> , 57(1), 19-35.
Articles in Refereed Scientific Journals	Hunt, C. W., Snyder, L., Salisbury, J.E., Vandemark, D., McDowell, W.H. 2017. SIPCO2: A simple, inexpensive surface water pCO <sub>2</sub> sensor. <i>Limnology and Oceanography Methods</i> . doi: 10.1002/lom3.10157.
Articles in Refereed Scientific Journals	Boeff, K.A., K.E. Strock, J.E. Saros. 2016. Evaluating planktonic diatom response to climate change across three lakes with differing morphometry. <i>J Paleolimnol.</i> 56(1), 33-47.
Articles in Refereed Scientific Journals	Strock, K.E., Saros, J.E., Nelson, S.J., S.D. Birkel, J.S. Kahl, W.H. McDowell. 2016. Extreme weather years drive episodic changes in lake chemistry: implications for recovery from sulfate deposition and long-term trends in dissolved organic carbon. <i>Biogeochemistry</i> , 127(2-3), 353-365.
Articles in Refereed Scientific Journals	Brown, R., J. Saros S. Nelson. 2016. Using paleolimnological evidence to assess the consequences of increased dissolved organic carbon in recent decades in lakes of the Northeastern US. <i>J Paleolimnol</i> , in review.
Articles in Refereed Scientific Journals	Boeff, K.A., K.E. Strock, J.E. Saros. 2016. Evaluating planktonic diatom response to climate change across three lakes with differing morphometry. <i>J Paleolimnol.</i> DOI 10.1007/s10933-016-9889-z.
Articles in Refereed Scientific Journals	Strock, K.E., Saros, J.E., Nelson, S.J., S.D. Birkel, J.S. Kahl, W.H. McDowell. 2016. Extreme weather years drive episodic changes in lake chemistry: implications for recovery from sulfate deposition and long-term trends in dissolved organic carbon. <i>Biogeochemistry</i> , 127(2-3), 353-365.
Articles in Refereed Scientific Journals	Soranno, P.A., and 79 others, including S.J. Nelson, W.H. McDowell, 2017. LAGOS-NE: A multi-scaled geospatial and temporal database of lake ecological context and water quality for thousands of U.S. lakes. Submitted, GigaScience (GIGA-D-17-00112).
Articles in Refereed Scientific Journals	Gavin, A.L., S.J. Nelson, A.J. Klemmer, I.J. Fernandez, K.E. Strock, W.H. McDowell, 2017. Climate linkages to increases of dissolved organic carbon in acid-sensitive high elevation lakes. Submitted, <i>Water Resources Research</i> (2017WR020963).



Articles in Refereed Scientific Journals	Brown, R.E., S.J. Nelson, J.E. Saros, 2016. Paleolimnological evidence of the consequences of recent increased dissolved organic carbon (DOC) in lakes of the northeastern USA. <i>Journal of Paleolimnology</i> , 57(1), 19-35.
Articles in Refereed Scientific Journals	Hunt , C. W., Snyder, L., Salisbury, J.E., Vandemark, D., McDowell, W.H. 2017. SIPCO2: A simple, inexpensive surface water pCO2 sensor. <i>Limnology and Oceanography Methods</i> . doi: 10.1002/lom3.10157.
Articles in Refereed Scientific Journals	Boeff, K.A., K.E. Strock, J.E. Saros. 2016. Evaluating planktonic diatom response to climate change across three lakes with differing morphometry. <i>J Paleolimnol.</i> 56(1), 33-47.
Articles in Refereed Scientific Journals	Strock, K.E., Saros, J.E., Nelson, S.J., S.D. Birkel, J.S. Kahl, W.H. McDowell. 2016. Extreme weather years drive episodic changes in lake chemistry: implications for recovery from sulfate deposition and long-term trends in dissolved organic carbon. <i>Biogeochemistry</i> , 127(2-3), 353-365.
Articles in Refereed Scientific Journals	Gavin, A.L., S.J. Nelson, A.J. Klemmer, I.J. Fernandez, K.E. Strock, W.H. McDowell, 2017. Climate linkages to increases of dissolved organic carbon in acid-sensitive high elevation lakes. Accepted; available online. <i>Water Resources Research</i> (2017WR020963).
Articles in Refereed Scientific Journals	Soranno, P.A., and 79 others, including S.J. Nelson, W.H. McDowell, C. Funk, J. Lynch, 2017. LAGOS-NE: A multi-scaled geospatial and temporal database of lake ecological context and water quality for thousands of U.S. lakes. <i>GigaScience</i> , gix101, <a href="https://doi.org/10.1093/gigascience/gix101">https://doi.org/10.1093/gigascience/gix101</a>
Other Publications	Nelson, S.J., Capone, S.B., Dukett, J.E., Houck, N. 2017. Lake Site Assessments: US EPA TIME-Adirondack Lakes. Report to US EPA and NYSERDA.
Dissertations	Gavin, A.L. 2018 (expected). Physical & chemical response of small, north temperate lakes to recovery from acidification & climate change M.S. Thesis, University of Maine, Orono, Maine.
Dissertations	Patel, K.F. 2018 (expected). Nitrogen cycling during a period of environmental change. Ph.D. Dissertation, University of Maine, Orono, Maine.

'Improved Ecosyst ...': 2015NH191B Research Description

**Title** Improved Ecosystem Indicator Tools for Water Quality Management – Genomic Analysis of Periphyton to Identify Stressors

**Project Number** 2015NH191B

**Start Date** 3/1/2015

**End Date** 2/29/2016

**Research Category** Water Quality

**Focus Categories** Water Quality; Non Point Pollution; Nutrients

**Principal Investigators** Alison Watts; WKelley Thomas

*This proposal will build on an existing pilot study to further explore the use of attached algae as a water quality indicator, using genomic analysis to identify a wide range of species and function. The taxonomic data will be correlated to water quality stressors, including water chemistry, land use, and pollutant load to identify species classes or characteristics indicative of identifiable stresses (e.g. nutrient load). If these indicators can be established, attached algae monitoring may be an effective and economical method of enhancing existing monitoring programs. Algae monitoring has been successfully correlated to nutrient load, impervious cover and other stressors in numerous studies. Advances in genomic technology offer an opportunity to develop more extensive data sets, with high replicability at lower cost. The results of this study will directly inform an inter-municipal watershed management plan currently being developed. Specifically, we will:*

- Evaluate the effectiveness of attached algae as an indicator of ecosystem stress.
- Determine if species distribution or other characteristics (especially freshwater to saltwater transition) can be used to differentiate between probable stressors (e.g. P vs N).
- Work with municipalities to adapt the local watershed plan to address identified stresses. This will introduce three new facets to the existing regional monitoring program; the use of attached algae as a monitoring indicator; transitory community effects from stressors across a salinity gradient; and the application of innovative genomic technology to identify both the taxonomy and the function of prevalent algae. The goal of this project is to determine the value of attached algae monitoring as a biologic indicator of ecosystem health and as a method of identifying stressors which can be targeted with management actions, and to develop recommended management actions which would be triggered by specific algae conditions such as nutrient stress, or early onset of invasive species.

<b>Funding</b>		
<b>Funding Period</b>	<b>Federal \$104 Funds</b>	<b>Required \$104 Matching Funds</b>
FY2015	\$12,040	\$24,079

<b>Degree Level</b>	<b>Number of Students</b>	<b>Number of Dissertations/Theses</b>
Undergraduate	1	
Masters	0	0
Ph.D.	0	0
Post-Doctoral	0	

<b>Publications</b>	
<b>Publication Type</b>	<b>Publication Citation</b>
Articles in Refereed Scientific	Allison Wood, 2016. Attached Algae as an Indicator of Water Quality: A Study of the Viability of Genomic Taxonomic Methods. A Senior Honors Thesis Presented to the University Honors Program, University of New Hampshire, In Partial Fulfillment of the

Journals	Requirements for: Honors in Environmental Engineering. College of Engineering and Physical Sciences, Department of Civil and Environmental Engineering, University of New Hampshire. May 2016, Durham New Hampshire.
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