

# Nutrient Loading Coefficients for NH Watersheds: Development and Connectivity

## Basic Information

<b>Title:</b>	Nutrient Loading Coefficients for NH Watersheds: Development and Connectivity
<b>Project Number:</b>	2011NH148B
<b>Start Date:</b>	3/1/2011
<b>End Date:</b>	2/29/2012
<b>Funding Source:</b>	104B
<b>Congressional District:</b>	001
<b>Research Category:</b>	Water Quality
<b>Focus Category:</b>	Nutrients, Non Point Pollution, Management and Planning
<b>Descriptors:</b>	None
<b>Principal Investigators:</b>	Jeffrey Schloss

## Publications

1. 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.
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## 2011NH148B

# Nutrient Loading Coefficients for New Hampshire Watersheds: Development and Connectivity

### **Problem:**

The waters of New Hampshire represent a valuable water resource contributing to the state's economic base through recreation, tourism, and real estate revenues. Some lakes and rivers serve as current or potential water supplies. For most residents (as indicated by boating and fishing registrations and shoreline re-development) our waters help to insure a high quality of life. As documented in the 2010 Census, New Hampshire currently leads all of the New England states in the rate of new development and redevelopment. The long-term consequences of the resulting pressure and demands on the state's precious water resources remain unknown. Of particular concern is the response of our waters to increasing non-point source pollutant loadings due to watershed development and land use activities.

Through previous NIWR (USGS; NH WRRC) and EPA funded projects we have conducted volunteer assisted watershed nutrient budget studies and catalogued those studies previously undertaken 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 further analysis is needed to determine the influence of various factors such as percent imperviousness, riparian buffer extent and use of best management practices. Recent investigations have also suggested that drainage connectivity at the local (subwatershed) scale can have a large influence on these loadings.

In addition the funds will continue to support our long-term monitoring program conducted through differing weather years at both shallow and deep sites that offer the potential to cost effectively estimate the lake response to the loadings due to development over time.

### **Objectives:**

**The funds provided by the WRRC provided continued partial support of our long term citizen science participatory monitoring effort, the NH Lakes Lay Monitoring Program (LLMP).** Additional support for this effort is provided by UNH Cooperative Extension, The UNH College of Life Sciences and Agriculture, USDA National Institute of Food and Agriculture, New Hampshire Department of Environmental Services (NH DES; from US EPA section 319 funding) and from towns, municipalities and lake associations throughout the state.

- 1- To expand our investigation into land use impacts on nutrient loading by analyzing subwatershed nutrient loading data and GIS based land use/land cover data particularly looking at impervious cover, development density, riparian buffers and best management practices (where information is available) and drainage connectivity.
- 2- To refine our current land cover nutrient loading coefficient recommendations based on the project results.
- 3- The continued collection and analysis of long-term water quality data in selected watersheds.
- 4- The dissemination of the results of the analysis to cooperating agencies, water managers, educators and the public on a local, statewide and regional basis.

- 5- To offer undergraduate and graduate students the opportunity to gain hands-on experience in water quality sampling, laboratory analysis, data management and interpretation.
- 6- To further document the changing water quality in a variety of watersheds throughout the state in the face of land use changes and best management efforts.

## **Methods**

The project utilized an extensive GIS database for the study subwatersheds created through previous NIWR and EPA funding to the PI. Updated and additional GIS data (high resolution imagery) was made available through the UNH Complex Systems Research Center, which manages the NH GRANIT statewide GIS data depository. A dedicated GIS PC Windows 7 workstation provided the analysis software including ArcGIS and ArcView Software (version 10), ArcView Extensions: Spatial Analyst, 3-D Analyst, Image Analysis and ArcPress. The software was used to confirm the spatial, hydrological, land cover and land use characteristics of the various subwatersheds previously catalogued in our studies. Additional data analyses and statistics was performed using JMP statistical software (SAS institute).

Lake and stream monitoring through the LLMP generally involved a minimum of monthly sampling starting at spring runoff through to lake stratification and weekly to bi-weekly sampling through to fall mixis. Water clarity, chlorophyll a, acid neutralizing capacity, dissolved organic color, dissolved oxygen and nutrients (total N, total P and nitrate) will be the default suite of parameters measured for lakes while nutrients, turbidity, dissolved organic color and flow will be the parameters of choice for the lake tributary work. On occasion, student field teams traveled to join the volunteer monitors to perform quality assurance checks and do more in-depth analysis and lake profiling. All LLMP field sampling and laboratory analysis follows approved Quality Assurance Projects Plans and Site Specific Project Plans reviewed by NH DES and US EPA New England and are on file with both agencies.

As stated above the primary scope of this project was to maintain the long-term data collection effort of the LLMP but in addition, land cover changes to study subwatersheds will be documented on our established GIS data base and any new management practices or conservation efforts were documented

## **Principal findings and significance**

Focus of this year's efforts was on the Newfound Lake Watershed and the Squam Lakes Watershed. Emphasis of the Newfound study was on mapping road connectivity and culverts as well as investigating forestry best management practices in the headwater streams. In collaborative work with the Society for the Preservation of New Hampshire's Forests, the UNH Center for Freshwater Biology and the Newfound Lake Regional Association it was found that steep slopes combined with lack of long-term maintenance of BMPS were contributing to higher nutrient loads into the headwater streams of Newfound Lake. Significant sediment and associated nutrient loadings were also associated where under designed culverts received storm runoff from roads in the steeper areas of the watershed.

These research findings supported an innovative approach used by 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. To date 2 towns have incorporated this recommendation and additional towns are considering the measure. In addition, a summit hosted by UNH Cooperative Extension Forestry and Wildlife staff is currently planned between local consulting foresters, landowners, loggers and interested persons to discuss the need to maintain best management practices especially on steep sloped lands.

The Squam Lake Watershed work updated land use landcover and explored the relative impacts of nearshore Shoreland zone vs total subwatershed influence on water quality. This work will be reported as part of the PI's dissertation defense.

## **Publications and Presentations**

### Reports:

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.. Approved May 23, 2011 by NH DES and US EPA New England. 19pps.

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Presentations:

Schloss Jeffrey A. 2011. "An Ecological Approach to Landscaping Shoreland Properties" I- Water Quality, Water Movement and Drainage on Landscaped Sites. II- Site Assessment for Reigning in Stormwater Runoff. Invited workshop presenter Rutgers University, New Brunswick, NJ. April 13, 2011.

Schloss, Jeffrey A. 2011. Design Considerations for Rain Gardens. For Rain Garden Workshop. Urban Forestry Center, Portsmouth, NH. UNH Cooperative Extension June 1, 2011.



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, Kingston, RI June 4, 2011.

Schloss, Jeffrey A. 2011. Reigning In Runoff Through Landscaping. Invited speaker. Goose Pond Association, (Canaan and Hanover NH) June 11, 2011.

Schloss, Jeffrey A. Landscaping at the Water's Edge. Presentation and field training at the NH Lakes Congress, Windham, NH. New Hampshire Lakes Association. June 24, 2011.

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. 31<sup>st</sup> International Symposium. Spokane, Washington. October 26-28, 2011.

Craycraft, Robert. 2011. Water Quality and You. Woods, Water and Wildlife Festival. Moose Mountain Regional Greenways. August 2011.

Craycraft, Robert 2011. Roundtable Discussion: Town Implementation of Watershed Protection Measures.. NH Lakes Congress, Windham, NH. New Hampshire Lakes Association. June 24, 2011.

**Publications/Presentations from previous WRRC support not reported:**

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.

**Outreach/Information Transfer**

August 9, 2011- Presented "Cyanobacteria: What's the Worry" at the request of the Meredith NH Town manager in response to a beach closure that occurred that summer. – Over 100 citizens/decision-makers attended- Schloss

September 12, 2011- Invited to present on the importance of riparian buffers and the research behind the recommendations to the Comprehensive Shoreland Protection Act Study Commission, Concord, NH -Schloss

December 19, 2011- Met with Tuftonboro Conservation Commission and Lakes Region Planning Commission reps to discuss assessment of Wolfeboro subsurface discharge on surrounding wetlands, lakes and groundwater supply-Schloss.

February 13, 2011- Met with representatives from Moultonboro and Center Sandwich to discuss monitoring of upper Moultonboro Bay (Winnepesaukee) Watershed.-Schloss

Various Dates March 2011/February 2012- worked with Lake Wentworth Association (Craycraft, Lake Winnepesaukee Association (Schloss)) and Newfound Regional Association (Craycraft and Schloss) to plan further activities under Watershed Assistance Grants (NH DES)..

July 2011- Met with Pine River Pond Board of Directors to discuss water quality goals with emphasis on current water quality data. –Craycraft.

### **Students Supported**

While no WRRC support was provided for direct undergraduate student support, the following students were indirect beneficiaries of WRRC support to the NH LLMP:

#### Undergraduate Students

Michel Henlou	Environmental Conservation	Senior (Spring 2012 Grad)
Emma Leslie	Zoology	Senior (Spring 2012 Grad)
Ashley Lupus	Medical Science	Senior (Spring 2012 Grad)
Cara McGuire	Environmental Conservation	Senior (Spring 2012 Grad)
Emily Ramlow	Environmental Conservation	Senior (Dec. 2011 Grad)
Jessica Waller	Marine Biology	Junior

#### Graduate Students (directly supported):

Jeff Schloss	Natural Resources and Environmental Studies	PhD candidate
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### **Faculty Staff Supported**

Directly: Jeff Schloss- Extension Professor in Biological Science

Indirectly: Robert Craycraft, Educational Program Coordinator, LLMP UNH Cooperative Extension.