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Water Quality Change: Effects of Development on Nutrient Loading in Selected Watersheds

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Jeff Schloss-

Water Resources Research Center Project Update Report March 2007-February 2008:

Water Quality Change: Effects of Development on Nutrient Loading in Selected Watersheds

Problem:

The waters of New Hampshire represent a valuable 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 2005 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.

Of all the in-depth watershed nutrient budget measurements and modeling efforts that have been attempted in NH none have primarily focused on change detection due to development as they were either base-line studies on relatively pristine lakes or focused on specific problems such as internal nutrient loading from past sewage outfalls, or septic systems in the water table of a seepage lake. In addition nitrogen species were only monitored for less than a handful of studies and the measurement technologies at the time were not sensitive enough to provide much usable data. The opportunity to add nitrogen monitoring and support GIS land change analysis to co-occurring externally funded phosphorus watershed nutrient budget studies on two lakes that had previous budgets done in the past provides a true cost-effective project that directly addresses Statewide concerns.

Alone, these watershed nutrient budgets represent only short-term examinations of non-point source pollution nutrient loadings to the lake. A longer-term monitoring program conducted through differing weather years at both shallow and deep sites is required to best estimate the lake response to the loadings due to development over time.

Objectives:

1- To complete phosphorus and nitrogen analysis of collected seepage water samples as a research add-on to an already funded project developing a water and total phosphorus budget for a small lake watershed that has experienced land cover change since a previous study was undertaken over a decade ago. (Mendums Pond, NH) and complete a water /phosphorus budget for a large multijurisdictional watershed that also had a previous study undertaken (Newfound Lake, NH) .

2- 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.

3- The continued collection and analysis of long-term water quality data in selected watersheds through the NH Lakes Lay Monitoring Program (NH LLMP).

- 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 determine next steps for further analysis of long-term data sets and GIS spatial data on land cover.

Methods:

An EPA approved QAPP (Schloss 2006) for the watershed water/nutrient budget was followed that included volunteer sample collection and gage readings and student technicians sampling and conducting stream flow measurements using a Doppler water velocity meter (SonTek/YSI).

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) were the default suite of parameters measured for lakes while nutrients, turbidity, dissolved organic color and flow were 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.

The project utilized an extensive GIS database for the study subwatersheds created through previous WRRC funding to the PI. Updated and additional GIS data were made available through the UNH Complex Systems Research Center, which manages the NH GRANIT statewide GIS data depository. The extensive data directory contains statewide GIS data layers (usually at 1:24,000 scale) including hydrology, geology, soils, National Wetlands Inventory, land-use, land cover, and digital elevation models. Also available are Landsat Thematic Mapper, SPOT Panchromatic and digital orthophoto imagery.

As stated above the primary scope of this project was to maintain the long-term data collection effort but in addition, land cover changes to study subwatersheds were documented on our established GIS data base and any new management practices or conservation efforts were also documented. USGS WRRC support was used to enhance the two ongoing water nutrient budget studies, especially the Mendum's Pond project, as the majority of the costs for these projects were underwritten by US EPA Nonpoint Source Project funds passed through by the NH Department of Environmental Services to the respective watershed associations.

Major findings and significance:

We expect completion of the Newfound Lake water nutrient budget in the early spring of 2008 and the Mendum's Pond water nutrient budget in the summer of 2008. However, work on both lakes already documented the deleterious impacts of development projects with poorly managed erosion controls and a cease and desist order was written by NH DES to close down further work in the Mendum's Pond case. Data from both studies was supplied to ENSR Incorporated who had been contracted by EPA New

England to develop Total Maximum Daily Loading models for nutrient impaired and blue green bacteria toxin impaired lakes in NH. Specific nutrient loading coefficients measured for the studies as well as from data analyzed in a previous NH WRRC funded project (Schloss 2001: Development of Statewide Nutrient Loading Coefficients Through Geographic Information System Aided Analysis) were employed in their model estimates. In addition, water flow and nutrient data from the two projects as well as other UNH Center for Freshwater Biology efforts were used to develop daily loading conversions from annualized loading from the model results.

The NH LLMP long-term data base analysis of the phosphorus to chlorophyll relationships in NH lakes indicates a more sensitive chlorophyll response to the nutrient than studies from other states and regions and that the slope of the relationship increases at a point somewhere near 10 ppb total phosphorus. These findings are informing current efforts underway by NH DES to set nutrient criteria and water quality standards for NH lakes.

Publications, presentations, awards:

Schloss, J. 2007. REALISTIC EXPECTATIONS AND OUTCOMES FROM THE SURVEY OF THE NATION'S LAKES. Invited presentation for: 20th Annual National Conference Enhancing the States' Lake Management Programs: *Interpreting Lake Quality Data for Diverse Audiences*. May 24-27, 2007. Chicago IL.

Craycraft, R. and J. Schloss 2007. NH LAKES LAY MONITORING PROGRAM: 2006 WATER QUALITY MONITORING REPORT SERIES. 31 lake/watershed specific reports for participants. UNH Center for Freshwater Biology, UNH Cooperative Extension.

Outreach or Information Transferred:

See above for information transfer to ENSR and NH DES; the nutrient data and phosphorus chlorophyll analyses are being used by the state's Water Quality Standards Advisory Committee (WQSAC) as well as the WQSAC Nutrient Criteria Subcommittee. In addition, we uploaded our long-term database into the NH DES Data Exchange System which is the state's warehouse of water quality data that is also shared with the US EPA Water Quality Data Exchange Network .

The reports listed above were supplied to our participants and their lake/watershed associations and their communities. Non-technical summaries provided were published in local papers and association newsletters. Over a dozen presentations were provided to lake associations across the state.

Number of students supported (and degree level, undergrad, Master, PhD):

Six undergraduate students and one PhD student were partially supported and the nitrogen analyses funded were a major component of a Masters graduate student's study.