

Report for 2001NH761B: Effects of Land Use on Water Quality in a Changing Landscape

- Book Chapters:
 - Schloss, J.A. 2002. GIS Watershed Mapping: Developing and implementing a watershed natural resources inventory, in R. France ed., Handbook of Water Sensitive Design and Planning, Boca Raton, FL, Lewis Publishers, 557-576.

Report Follows:

Jeff Schloss – USGS WRRRC Status Report
Problem and Research Objectives:

State: New Hampshire

Project Number: NH761

Title: Effects of Land Use on Water Quality in a Changing Landscape

Project Type: Research Project

Focus Category: Water Quality, Non Point Pollution, Nutrients

Keywords: lake, stream, water quality, nutrients, land use

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Congressional District: 1

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Objectives:

- 1- The continued collection and analysis of long-term water quality data in selected watersheds.
- 2- The dissemination of the results of the analysis to cooperating agencies, water managers, educators and the public on a local, statewide and regional basis.
- 3- To offer undergraduate and graduate students the opportunity to gain hands-on experience in water quality sampling, laboratory analysis, data management and interpretation.
- 4- To further document the changing water quality in the College Brook Watershed in the face of land use changes and management efforts.
- 5- To document the effectiveness of constructed BMPs in the Chocorua Lake Watershed
- 6- To determine the next steps for further analysis of long-term data sets.

Methodology

Ongoing sampling of College Brook has been done on a monthly basis and during storm events. Parameters measured include: dissolved oxygen, pH, temperature, specific conductivity, total suspended solids, total dissolved nitrogen, ammonium, nitrate, phosphate, sulfate, chloride, silica, dissolved organic carbon, and base cations (Ca, Mg, Na, and K).

Lake and stream monitoring through the LLMP generally involved a minimum of monthly sampling from spring runoff through lake stratification, and weekly to bi-weekly sampling from stratification until fall overturn. Water clarity, chlorophyll a, acid neutralizing capacity, color, dissolved oxygen and nutrients (total N, total P and nitrate) was the default suite of parameters measured for lakes while nutrients, turbidity, 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.

Land cover changes to study subwatersheds was documented on our established GIS data base and new management practices or conservation efforts were also documented. Particular emphasis was placed on the Squam Lakes Watershed this year.

This project was coordinated from the University of New Hampshire, which supplied the office and laboratory space (analytical and computer). The Center for Freshwater Biology Analytical Water Quality Laboratory has a Quality Assurance Project Plan for surface water analysis on file with the US Environmental Protection Agency Region 1 Office (EPA New England). Besides nutrient analysis (Total Phosphorus, Total Nitrogen, Nitrate), other water quality measurements

included chlorophyll a, dissolved oxygen, dissolved CO₂, acid neutralizing capacity, specific conductivity, pH, ORP, turbidity, water clarity, iron and E.coli. The Water Quality Analysis Laboratory of the NH WRRC uses automated flow injection analysis, ion chromatography, and high temperature combustion techniques for water quality analysis. They are also leaders in developing new analytical methods (e.g. Merriam et al. 1996; Yano et al. 1998). UNH Cooperative Extension and the Natural Resource Department provided vehicles for travel for PI's, students and interns at a cost (mileage) basis. A dedicated GIS PC NT workstation was provided for use including Arc/Info and ArcView Software, ArcView Extensions: Spatial Analyst, 3D Analyst, Image Analysis and ArcPress. This was used in addition to other data input PC stations, laser printers and a large format (36" wide) ink jet plotter that was made available for the project.

The project utilized an extensive GIS database for the study subwatersheds created through previous WRRC funding to the PI. Updated and additional GIS data including a new land cover dataset for 2000 was 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.

Principal Findings and Significance

Ongoing collection of ambient water quality data across the state continues. We added new sites for our statewide lake study. We saw an 8% increase in monitoring samples collected statewide with an over 25% increase in samples collected specifically in the Lakes region of NH: In all, we saw the addition of 3 new lakes, and the expansion of programs on 9 other lakes with the addition of 11 new or reactivated sampling sites (Table 1). We provided training for 29 new volunteer monitors!

Lake	Association/Sponsors	Town(s)
<i>New Programs Initiated:</i>		
Big Dan Hole Pond	Dan Hole Pond Watershed Assn.	Tuftonboro, Ossipee
Little Dan Hole Pond	Dan Hole Pond Watershed Assn.	Ossipee
Whitton Pond	Whitton Pond Cottage Assn.	Albany, Madison
<i>Existing Programs Expanded (new monitoring sites):</i>		
Bow Lake	Bow Lake Campowners Assn.	Strafford, Northwood
Crystal Lake	Eaton Conservation Commission	Eaton
Crystal Lake	Crystal Lake Association	Enfield
Great East Lake	Great East Lake Association	Wakefield
Goose Pond	Goose Pond Association	Canaan, Hanover
Lake Kanasatka	Lake Kanasatka Watershed Assn.	Moultonboro
Naticook Lake	Naticook Lake Assn. and Town of Merrimack	Merrimack
Newfound Lake	Newfound Lake Region Assn.	Alexandria, Bristol, Bridgewater, Hebron
Lake Winnepesaukee, Moultonboro Bay	LWA* and Tuftonboro Assn	Tuftonboro, Moultonboro
Lake Winnepesaukee, Meredith Bay	LWA and Meredith Rotary Club	Meredith
Lake Winnepesaukee, Wolfeboro Bay	LWA and Town of Wolfeboro	Wolfeboro

* LWA= Lake Winnepesaukee Association

The Lake Chocorua BMP Evaluation Study disclosed that a significant reduction in the phosphorus loading was due to the road drainage mitigation techniques. The combination of the use of plunge pools, diversions to settling areas and a large collecting swale reduced loadings during storm events by 82-94%. The P concentration range from the runoff was also reduced

significantly (pre-range of 34 to 281ppb post range of 13 to 23 ppb). Further monitoring will be done to capture spring runoff and additional storm events in the upcoming year.

Analysis of the Squam Lake Watershed nutrient budget disclosed that subwatersheds with construction activity or active agriculture were the largest contributor of phosphorous on an aerial basis. Further study will be done on analysis of the effect of riparian buffer extent and updated nutrient export coefficients will be calculated in the upcoming year.

Number of students involved or funded (#, undergrad, Masters, and PhD)

Beckie Damm -- Marine and Freshwater Biology (Senior)	Fall/Spring Employ
Renee Gannon -- Marine and Freshwater Biology (Sophomore)	Fall/Spring Employ
Todd Brackett -- Environmental Conservation (Junior)	Summer/Fall and Spring Employ
Kirsten Pulkkinen -- Environmental Conservation (Junior)	Fall/Spring Employ
Rider Foley -- Environmental Conservation (Senior)	Summer/Fall and Spring Employ
Melissa McCartney -- Forestry (Sophomore)	Summer/Fall and Spring Employ
Gregg Decelles -- Marine and Freshwater Ecology (Junior)	Fall/Spring Employ
Darla Black -- Liberal Arts	Fall and Spring Employ
Shane Brandt- - Zoology (Grad student, PhD)	
Juliette Nowak -- Zoology (Grad Student, MS)	

In addition: water quality and GIS data were used in:
 WARM 604- Watershed Hydrology -9 students
 Zoology/Botany 719/819- Field Limnology- 12 students
 Biology/Zoology 896- Multidisciplinary Lake Management- 9 students

Any publications, reports, presentations, from this work.

Publications:

Schloss, Jeffrey A. 2002. GIS Watershed Mapping: Developing and implementing a watershed natural resources inventory. In Handbook of Water Sensitive Design and Planning. R. France editor. Lewis Publishers, Boca Raton. FL. Chpt II.12 pages 557-576.

Presentations by Jeff Schloss covering all or parts of study:

New England Assoc. of Environmental Biologists	New England Water Resources Protection	March 2001 Warwick, CT	Presented:" In-situ chlorophyll fluorescence: The Good, the Bad and the Algae"
North American Lake Management Society (NALMS)	Enhancing State Lake Management Programs	April 2001 Chicago, Illinois	Presented invited session : "Lake Monitoring and NPS Partnerships Deliver: The Lake Chocorua Project."
Ohio Lake Management Society	Annual Meeting	February 2002	Presented keynote address "Watershed Stewardship Through Volunteer Water Quality Monitoring"