

Participatory Water Quality Assessment Through the NH Lakes Lay Monitoring Program

Basic Information

Title:	Participatory Water Quality Assessment Through the NH Lakes Lay Monitoring Program
Project Number:	2012NH174B
Start Date:	3/1/2013
End Date:	2/28/2014
Funding Source:	104B
Congressional District:	001
Research Category:	Water Quality
Focus Category:	Water Quality, Non Point Pollution, Management and Planning
Descriptors:	None
Principal Investigators:	Jeffrey Schloss

Publications

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.

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10. 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.
11. 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.
12. 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.
13. 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
14. 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
15. 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
16. 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
17. 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
18. 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
19. 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
20. 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
21. 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
22. 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
23. 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
24. 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
25. 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
26. 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

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27. 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
28. 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.
29. 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.
30. 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.
31. 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.
32. 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.
33. 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.
34. 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.
35. 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.
36. 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.
37. 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.
38. 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.
39. 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.
40. 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.
41. 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.
42. 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.
43. 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.

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44. 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.
45. 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.

2013NH174B

Participatory Water Quality Assessment Through the NH Lakes Lay Monitoring Program

Problem:

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 drinking water reservoirs/supplies. For most residents our generally pristine waters help to insure a high quality of life. However, New Hampshire currently leads all of the New England states in the rate of new development and redevelopment (Society for the Preservation of New Hampshire Forests, Governor's Office of Energy and Planning). 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 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,

The recent increase of infestations of invasive species such as variable water milfoil as well as the proliferation of blue green bacteria blooms, which can leach dangerous toxins impacting humans and wildlife, has threatened the water quality and has limited or restricted use of NH waters at an increasing rate. There is still no mechanism for successful eradication of milfoil and we are just beginning to understand the conditions that favor blue green bacteria blooms and their ecological impacts through cutting edge research by UNH faculty and students.

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- 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 a variety of watersheds throughout the state in the face of land use changes and best management efforts.

Methods

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 and support information transfer for informed local decision making regarding water resources.

Principal findings and significance

Focus of this year's efforts was on the Newfound Lake Watershed, Wentworth Lake and the Ossipee Lake watershed.

These research findings continued to support 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. Volunteer data were used to help calibrate a watershed land use nutrient loading model as well as a lake response model for the resulting phosphorous nutrient loading.

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. A second phase of the project is currently underway 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.

Publications and Presentations

Reports:

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. 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. 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. 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 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. 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 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. 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.

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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.

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.

Presentations:

Craycraft, Robert. 2013. Lake Winnepesaukee Mount Washington Cruise water quality talk. Water quality and economic value. May 22, 2013 Attendance: 22.

Craycraft, Robert. 2013. Lake Kanasatka Watershed Association Annual Meeting: Lake Kanasatka water quality, past, present and future. June 13, 2013. Attendance: 50.

Craycraft, Robert. 2013. Lake Winnepesaukee Mount Washington Cruise water quality talk: Lake Winnepesaukee water quality overview and water quality threats. August 7, 2013. Attendance: 13.

Craycraft, Robert 2013. New Hampshire Coverts Program lecture: Water quality overview and threats to New Hampshire lakes. September 20, 2013. Attendance: 22.

Craycraft, Robert 2013. University of New Hampshire Thompson School Forest Technology class lecture: Macroinvertebrates and their interrelationship with the forested landscape. September 30, 2013. Attendance: 18.

Outreach/Information Transfer

July 25, 2013. Guest of the New Hampshire Lakes Management Advisory Committee. Discussed water quality monitoring in the Newfound Lake watershed as part of a watershed management planning effort. (Craycraft)

October 30, 2013- Guest lecture-for Marine Ecology and Freshman Biology (MEFB) class. Introduction to Water Resources through the Lakes lay Monitoring Program and NH Lakes. (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

Amy Arsenault	Environmental Conservation	Senior (Spring 2014 Grad)
Casey Chalmers	Environmental Conservation	Senior (Spring 2014 Grad)
Hannah Johnson	Environmental Conservation	Senior (Spring 2013 Grad)
Ryan Ross	Microbiology	Junior
Will Taveras	Civil Engineering	Junior
Jessica Waller	Marine Biology	Senior (Spring 2013 Grad)

Graduate Students Supported

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

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

Indirectly: Jeff Schloss- Extension Professor in Biological Science