A Citizen Science Program for Monitoring Lake Stages in Northern Wisconsin
Preliminary Results

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Background

Historical data indicate that surface water levels in northern Wisconsin are fluctuating more now than they did in the recent past (see Figure 1.) In the northern highland lake district of Vilas County, Wisconsin, concern about record low lake levels in 2008 spurred local citizens and lake associations to form a lake level monitoring network comprising citizen scientists. The network is administered by the North Lakeland Discovery Center (NLDC, a local NGO) and is supported by a grant from the Citizen Science Monitoring Program of the Wisconsin Department of Natural Resources (WDNR). With technical guidance from limnologists at neighboring UW-Madison Trout Lake Research Station, citizen scientists have installed geographic benchmarks and staff gauges on 26 area lakes (Figure 2.) The project engages citizen and student science participants including homeowners, non-profit organization member-participants, and local schools. Each spring, staff gauges are installed and referenced to fixed benchmarks after ice off by NLDC and dedicated volunteers. Volunteers read and record staff gauges on a weekly basis during the ice-free season; and maintain log books recording lake levels to the nearest 0.5 cm. At the end of the season, before ice on, gauges are removed and log books are collected by the NLDC coordinator. Data is compiled and submitted to a database management system, coordinated within the Wisconsin Surface Water Integrated Monitoring System (SWIMS), a statewide information system managed by the WDNR in Madison. Furthermore, NLDC is collaborating with the SWIMS database manager to develop data entry screens based on records collected by citizen scientists.

This program is the first of its kind in Wisconsin to utilize citizen scientists to collect lake level data. The retention rate for volunteers has been 100% over the three years since inception, and the program has expanded from four lakes in 2008 to twenty-six lakes in 2011. NLDC stresses the importance of long-term monitoring and the commitment that such monitoring takes. The volunteers recognize this importance and have fulfilled their monitoring commitments on an annual basis. All participating volunteers receive a summary report at the end of the year, and, if requested, a graph that is updated monthly. Recruitment has been through lake associations, town boards, word of mouth, newspaper articles, community events, and the NLDC citizen science webpage. Local interest and participation are high, perhaps due to the value that citizens place on lakes and the concern that they have about declining water levels.

Figure 1: Provisional plot of the historic trend in lake levels, Buffalo Lake and Crystal Lake through July 2011.

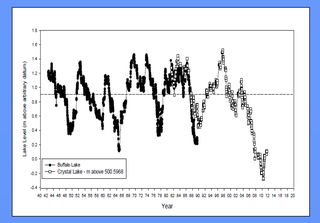


Figure 2. 2011 Lake Level Monitoring Sites in Vilas County, WI.

Study Site Lake	Hydrology	Area (acres)	Monitoring Start
Annabelle	Drainage	213	2010
Armour	Drainage	320	2010
Birch	Drainage	528	2010
Black Oak*	Drainage	564	2010
Crab	Drainage	949	2009
Horsehead	Drainage	234	2009
Inkpot*	Drainage	12	2010
Little Bateau*	Drainage	64	2010
Oxbow	Drainage	511	2010
Pardee	Drainage	206	2010
Presque Isle	Drainage	1280	2008
Rainbow	Drainage	146	2010
Van Vliet	Drainage	220	2010
Wildcat	Drainage	305	2010
Hiawatha	Drained	36	2010
Katinka	Drained	172	2008
Papoose	Drained	428	2010
Big Donahue*	Seepage	92	2010
Carlin*	Seepage	153	2008
Dewey	Seepage	48	2011
Imogene	Seepage	61	2011
Little Donahue*	Seepage	22	2010
Little Rock*	Seepage	45	2008
Rosalind	Seepage	43	2011
Statehouse	Seepage	23	2009
Dollar*	Spring	19	2010

*** Volunteer monitor calibrates gauge**

Study Area

Vilas County is located in north-central Wisconsin, bordered by the Upper Peninsula of Michigan on the north, and surrounded by Oneida, Iron, Price, and Forest Counties in Wisconsin. Vilas County is approximately 652,067 acres with approximately 93,923 acres being water (16% of area). Vilas County is in the Northern Highland Lake District, which is one of the world's highest concentration of lakes. The county's glacial history has contributed to the presence of 1,320 lakes with an area of 146.7 square miles and approximately 1,743 shoreline miles. There are twelve watersheds in the county, the major watersheds being the Lake Superior, Chippewa River, and the Wisconsin River. The main rivers that run through the county are the Deerskin River, Manitowish River, Trout River, and the Wisconsin River. Private and public forestlands including the Northern Highland American Legion State Forest and the Chequamegon-Nicolet National Forest contribute to 76.5% of the county being forest and open space. Only 5.5 % of the county is in residential land use.

Methods

- 26 volunteers recruited through the Winchester and Presque Isle Town Lakes Committees; Vilas County Lakes Association; North Lakeland Discovery Center outreach; and via word of mouth.
- One meter staff gauges mounted on metal fence posts installed in the lake beds after ice-off in the spring and removed before ice-on in the fall.
- Using surveying techniques, each staff gauge referenced to a permanent, fixed benchmark on the shoreline at the beginning and end of the monitoring season, ensuring continuity of data from year to year.
- Volunteer monitors read staff gauges to the nearest 0.5 centimeter on a weekly basis and records data in field books.
- Data are collected by monitors approximately from ice-off in the spring to ice-on in the fall.
- At the end of the monitoring season, the North Lakeland Discovery Center data collect and analyze data.
- On a monthly basis during the monitoring season, any interested volunteer monitor can submit data to the North Lakeland Discovery Center and receive a graph comparing their lake levels temporally.
- A staff gauge was installed on Statehouse Lake at the North Lakeland Discovery Center to collect data and inform visitors about lake level trends in northern Wisconsin.
- Change in depth was defined as the maximum depth minus the minimum depth for any given year. Overall variability in change of depth was defined as the maximum depth minus the minimum depth for all years combined.

Preliminary Results

- Data are gathered until ice-on in the fall and are analyzed at that time.
- Long-term lake level monitoring through the Trout Lake Research Station indicates that lake levels have risen and are currently at 2008 levels (Figure 1.)
- The 2010-2011 winter in Northern Wisconsin was relatively mild, with below average snowfall. 2011 was characterized by a relatively dry spring followed by a fairly normal summer with rainfall increasing slightly in July and then decreasing.
- Results for all lake types (Figure 3) follow a similar trend in lake depths. Actual lake levels are not comparable, only the trends between lakes.
- There was less variability among all lake types in 2011 than in 2010 (Figure 4.)
- In 2010, lake level changes among seepage lakes were the most variable and drained lakes showed the least variability. Preliminary data show that drainage lakes were the most variable in 2011 and drained lake the least variable (Figure 5.)

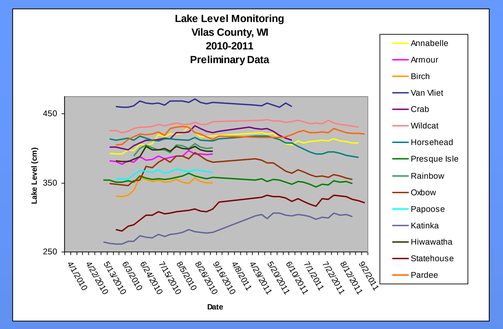
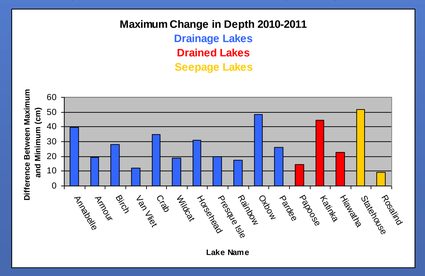


Figure 3. 2010-2011 Weekly Change in Lake Levels per Lake, Vilas County, WI.

Figure 4: 2010-2011 Change in Depth (cm) per Lake Type, Vilas County, WI.

	Drainage	Drained	Seepage
2010	23.8 *(n=17)*	19.4 *(n=3)*	41 *(n=1)*
2011	17.3 *(n=8)*	9.5 *(n=1)*	12.8 *(n=2)*

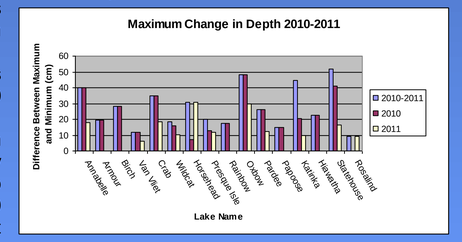
Figure 5: 2010-2011 Maximum Change in Depth



Preliminary Results Continued

- Based on preliminary data, changes in lake levels varied widely in drainage lakes from 12.0cm in Van Vliet Lake to 48.2cm in Oxbow Lake (Figure 6.)
- Presque Isle, Van Vliet, and Wildcat Lakes exhibited minimal variation in both 2010 and 2011.
- Katinka Lake's variability decreased from 2010 to 2011, however overall variability between years increased. This is due to the lake level increasing greatly in 2010 and then staying at a fairly consistent higher level in 2011.

Figure 6: 2010-2011 Maximum Change in Depth in Lake Level, Vilas County, WI.



Continuation of Project

- Lake level monitoring must be a long-term, multi-year effort to accurately and precisely discern trends and patterns.
- Volunteers have enthusiastically supported this project and have expressed the desire to continue their work. The project currently has a 100% volunteer retention rate, with additional volunteers added to the program each year.
- Communication with volunteers increased in 2011, further enhancing participants' knowledge of not only their lake, but also other lakes in the program. This ecosystem scale understanding is invaluable to the program and northern Wisconsin community.
- Established program protocols and permanent benchmarks led to consistent and accurate data collection in 2010-2011.
- 2011 coordinators worked closely with the Wisconsin Surface Water Integrated Monitoring System (SWIMS) database coordinators to develop database entry screens for lake level monitoring statewide based on Vilas County data. In addition, our established protocol was shared with the Citizen Lakes Monitoring Network coordinators to give them the tools to encourage other areas in the state to begin similar programs based on our protocol.
- Although lake levels have increased, conclusions on the severity or causes of the previous decline and current increase cannot be made until a long-term dataset is gathered.
- Incorporating wetland ground water, evapo-transpiration, and precipitation data will add to the understanding of lake level fluctuation.
- In future years, examination of factors such as a lake's position in the watershed, the size of the watershed drainage, and the role of inlets and outlets could aid in understanding fluctuations. These factors can be partially answered using Geographic Information System hydrology modeling with inputs of elevation change, soils and land use, and precipitation. Hydrologic modeling can give an accurate depiction of how water moves on the landscape and can determine how much water accumulation at any particular point in a watershed when a precipitation event occurs. This modeling could give interesting insight into why various lakes within a lake type vary in change in depth and trends.

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