Volunteer Water Quality Monitoring
In Aitkin County

Summer 2010

Funding and Technical Assistance provided by:

Minnesota Pollution Control Agency,
Surface Water Assessment Program
Aitkin County SWCD

February 2011
Janet Smude, District Technician
Aitkin County SWCD
During the summer of 2010, seven lakes and four stream sites in Aitkin County were selected for monitoring through the Minnesota Pollution Control Agency's Surface Water Assessment Program. The goal of the monitoring is to complete the dataset for each lake, and provide a sufficient number of data points for water quality assessment by the MPCA. A secondary goal was to enhance and expand the ability of citizen volunteers to collect water quality data that is useful for their lake associations in managing the lakes. 2010 was the first year of this two year effort.

**Lakes monitored:**
- Glacier Lake (01-0042)
- Hickory Lake (01-0179)
- Pickerel Lake (01-0182)
- Section 10 Lake (01-0115)
- Section 12 Lake (01-0120)
- Sissabagamah Lake (01-0129)
- Vanduse Lake (01-0058)

**Stream sites monitored:**
- Rice River (S005-402; at Aitkin County Road 4, S. of McGregor)
- Rice River (S006-243; at 363rd Ln, Fishing Bridge in Rice Lake Refuge)
- Rice River (S006-242; 362nd Lane, S. of Portage Lake)
- Sandy River (S003-491; HWY 65 Crossing near Zorbaz)

A map of the sampling sites included in this effort is located in Appendix A.

Program oversight and coordination was provided by the Aitkin County Soil and Water Conservation District. Volunteer assistance was utilized to conduct the sampling. All costs associated with the monitoring were provided by a Surface Water Assessment Grant from the MPCA.

**Discussion – Lake Sampling Results:**

**Lake Methods:**
One site on each of the seven lakes was monitored. A sampling schedule for each lake was designed with a goal of completing a dataset which will be used by the MPCA for assessment of the waterbody. Lakes were sampled either 5 or 6 times from June through September. Flexibility was built into the sampling to allow for variations in each volunteer’s schedule. Dedicated volunteers ensured that the work was completed.
Lake surface samples were collected with 2m integrated samplers, at locations on the lake that coordinated with previously established sites. Laboratory analysis was provided by ERA Laboratories, Inc. in Duluth, Minnesota, using EPA-approved methods.

Each water sample was analyzed for the following parameters:
- Total Phosphorus (TP)
- Chlorophyll a, and
- Pheophytin

Secchi Disk transparency and user perception information was also recorded at each site.

**Data Summary:**
Raw data collected through this effort is located in Appendix C. Summaries of the data are given below.

The main nutrient of concern is phosphorus. Phosphorus enrichment of a water body can result in a variety of negative impacts, such as excessive plant growth, algae blooms, and lowering of oxygen levels. The average 2010 Total Phosphorus (TP) levels for each lake are shown in Chart 1.

Chlorophyll a (Chl-a) was also measured. Chlorophyll a is the main pigment in algae. The concentration of this pigment is used to estimate the quantity of algae found in the lake. Algae is a normal component of water bodies, however high concentrations can result in low levels of dissolved oxygen and reduced recreation suitability.

Secchi disk readings measure the depth of light penetration into the water. This parameter often has a direct correlation to the levels of phosphorus and chlorophyll a found in the water body.

**Table 1. Summer 2010 Mean Water Quality Parameters for Monitored Lakes.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>TP (ug/L)</th>
<th>Chl-a (ug/L)</th>
<th>Secchi (m)</th>
<th>Secchi (ft.)</th>
</tr>
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<tbody>
<tr>
<td>Glacier Lake</td>
<td>13</td>
<td>4</td>
<td>2.6</td>
<td>8.9</td>
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<td>Hickory Lake</td>
<td>13</td>
<td>3</td>
<td>3.7</td>
<td>17.2</td>
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<td>Pickerel Lake</td>
<td>61</td>
<td>34</td>
<td>1.1</td>
<td>3.5</td>
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<tr>
<td>Section 10 Lake</td>
<td>20</td>
<td>3</td>
<td>2.9</td>
<td>9.6</td>
</tr>
<tr>
<td>Section 12 Lake</td>
<td>17</td>
<td>4</td>
<td>2.8</td>
<td>9.1</td>
</tr>
<tr>
<td>Sissabagamah Lake</td>
<td>19</td>
<td>5</td>
<td>2.6</td>
<td>8.7</td>
</tr>
<tr>
<td>Vanduse Lake</td>
<td>14</td>
<td>4</td>
<td>2.6</td>
<td>8.5</td>
</tr>
<tr>
<td><strong>Ecoregion Range</strong></td>
<td><strong>14-27</strong></td>
<td><strong>&lt;10</strong></td>
<td><strong>2.4-4.6</strong></td>
<td><strong>8-15</strong></td>
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</table>
Data for each lake was used to calculate Trophic Status Index values. Carlson's Trophic State Index (TSI) is a common means for characterizing a lake's overall health. "Trophic Status" refers to the level of productivity in a lake, as measured by phosphorus and algae content, and the depth of light penetration. In general, the lower the TSI Value, the better the health of the lake. TSI’s are calculated for Phosphorus, Chlorophyll a, and Secchi Transparency. These three numbers are then averaged to result in an overall TSI value for each lake. These values are shared in the following table and chart. The figure in Appendix B shows the Carlson's Trophic State Index, with the NLF Ecoregion range indicated by a red line.

Table 2. Summary of 2010 TSI Values

<table>
<thead>
<tr>
<th></th>
<th>2010 TSIP</th>
<th>2010 TSIC</th>
<th>2010 TSIS</th>
<th>2010 Overall TSI</th>
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<td>45.0</td>
<td>46.1</td>
<td>44</td>
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<tr>
<td>Hickory Lake</td>
<td>41.5</td>
<td>41.4</td>
<td>41.1</td>
<td>41</td>
</tr>
<tr>
<td>Pickerel Lake</td>
<td>63.4</td>
<td>65.1</td>
<td>59.0</td>
<td>63</td>
</tr>
<tr>
<td>Section 10 Lake</td>
<td>47.6</td>
<td>42.4</td>
<td>44.6</td>
<td>45</td>
</tr>
<tr>
<td>Section 12 Lake</td>
<td>45.3</td>
<td>44.2</td>
<td>45.3</td>
<td>45</td>
</tr>
<tr>
<td>Sissabagamah Lake</td>
<td>46.8</td>
<td>46.7</td>
<td>46.0</td>
<td>47</td>
</tr>
<tr>
<td>Vanduse Lake</td>
<td>41.8</td>
<td>44.7</td>
<td>46.3</td>
<td>44</td>
</tr>
</tbody>
</table>
Discussion:

All of the lakes monitored for this study are located in the Northern Lakes and Forest (NLF) Ecoregion of the state. Ecoregions are grouped together based on soils, landforms, potential natural vegetation, and land use. Comparing a lake's water quality to that of reference lakes in the same ecoregion provides one basis for characterizing the condition of the lake.

The Northern Lakes and Forests Ecoregion is heavily forested and comprised of steep, rolling hills interspersed with pockets of wetlands, bogs, lakes, and ponds. Lakes are typically deep and clear, with good gamefish populations. These lakes are very sensitive to damage from atmospheric deposition of pollutants, storm water runoff from logging operations, urban and shoreland development, mining,
inadequate wastewater treatment, and failing septic systems. Agriculture is somewhat limited by the hilly terrain and lack of nutrients in the soil, though there are some beef and dairy cattle farms.

With the exception of Pickerel Lake, the monitored lakes fell within the expected ecoregion range for Total Phosphorus, Chlorophyll a, and Secchi Transparency. These results are what would be expected, and are an indicator of the good health of the lakes.

Pickerel Lake exceeded the expected eco-region range for all parameters monitored. This is of some concern, and data collected in 2011 will be critical in determining the health of the lake, and if corrective actions are necessary.

**Recommendations for Lake Sites:**
The data that was collected in 2010 was insufficient to complete the assessment dataset for these lakes. A second year of monitoring is required on each lake. Additional monitoring will allow for variations in weather conditions or land use practices that influence water quality to be taken into consideration. This data will then be used by the Minnesota Pollution Control Agency to determine what future activities are needed on each lake to keep them healthy.

Summer-mean secchi transparency generally provides a good indication of trophic status of Minnesota Lakes. It is recommended that each lake continue collecting secchi transparency data, and submitting it to the MPCA Citizen Lake Monitoring Program, for inclusion in the STORET database. Secchi transparency should continue to be a good estimator for TP and chlorophyll-a values, as well as an indicator of overall water quality.

The Aitkin County Water Planning Task Force strives to provide funding and/or technical assistance each year for lake water quality monitoring. Lake associations may consider requesting funding for chemical analysis every 5 to 10 years. This, in combination with the secchi data, will allow for tracking of water quality trends.

Each lake should continue to be vigilant about managing sources of phosphorus. Common sources of phosphorus to lakes include shoreline erosion, lawn fertilizer, runoff from impervious surfaces such as homes and roads, faulty septic systems, and agricultural practices. Many of these are sources that can be minimized through the implementation of Best Management Practices. The local Soil and Water Conservation District can provide technical assistance in this implementation, and often has cost share funds available to assist with project costs. Lakeshore landowners are encouraged to take advantage of educational opportunities that become available and learn new techniques and innovations in lake and watershed management.

Pickerel Lake in particular should look for areas to reduce phosphorus entering the lake. A goal of bringing the lake back within the eco-region range is suggested. Any new development of the shoreline should be closely monitored to ensure that the Aitkin
County Shoreland Management Ordinance is followed. In addition, review of upstream conditions and potential sources of phosphorus should be undertaken.

**Discussion – Stream Sampling Results:**

**Stream Methods:**

Four stream sites were monitored. Three Rice River sites were sampled 12 times during the open water months. A Sandy River site was sampled 11 times. The sampling schedule was designed with a goal of completing a dataset which will be used by the MPCA for assessment of the streams. Sites were monitored through a combination of field sampling and laboratory analysis. Samples were taken with a weighted bucket.

Field sampling was conducted with a SONDE 6820 water quality meter, which was available on loan from the MPCA, and a 100 cm Transparency Tube. The following parameters were monitored with the meter:

- Temperature
- Dissolved Oxygen
- Salinity
- pH
- Specific Conductance

Additional data that was collected in the field included stream height, weather conditions, user perception information, and transparency/clarity.

Laboratory analysis of water samples was provided by ERA Laboratories, Inc. in Duluth, Minnesota, using EPA-approved methods. Water samples were analyzed for the following parameters:

- Total Phosphorus (TP)
- Nitrate + Nitrite Nitrogen
- Total Kjeldahl Nitrogen
- Total Suspended Solids, and
- E.Coli

**Data Summary:** Raw data collected through this effort is included in Appendix C. Data collected can be compared to other streams/rivers in the Northern Lakes and Forests Ecoregion, just as the lake data was.

Phosphorus is a nutrient essential to the growth of organisms. This is commonly the limiting factor to plant growth in surface water bodies. Total Phosphorus measures the quantity of the nutrient in solution (reactive) and in particle form. Phosphorus also contributes to the eutrophication or greening of water bodies.

Nitrogen is another nutrient essential for plant growth, however it does not play as big a role in eutrophication of water bodies as phosphorus. Elevated levels of this nutrient may be caused by septic systems, manure, or over application of fertilizers.
pH is a measure of the acidity or alkalinity of the water. The pH scale ranges from 1 to 14, with 1 being the most acidic and 14 being the most alkaline. Pure water is neutral with a pH of 7. Typical streams in this ecoregion of Minnesota are slightly alkaline.

Total Suspended Solids is a measure of the very small particles remaining dispersed in the stream due to turbulent mixing. Cloudy conditions are a visual indicator of this parameter. High values can interfere with light penetration, and result in a buildup of sediment that will reduce the quality of the aquatic habitat.

Table 3. Summer 2010 Mean Water Quality Parameters for Monitored Streams.

<table>
<thead>
<tr>
<th>Total Phosphorus (mg/L)</th>
<th>Field pH</th>
<th>Total Suspended Solids (mg/L)</th>
<th>Nitrogen (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice River at Co Rd 4</td>
<td>0.09</td>
<td>6.65</td>
<td>5.1</td>
</tr>
<tr>
<td>Rice River at RLNWRefuge</td>
<td>0.10</td>
<td>6.79</td>
<td>4.4</td>
</tr>
<tr>
<td>Rice River S. of Portage Lk</td>
<td>0.09</td>
<td>7.00</td>
<td>2.6</td>
</tr>
<tr>
<td>Sandy River at HWY65/Zorbaz</td>
<td>0.05</td>
<td>7.34</td>
<td>2.5</td>
</tr>
<tr>
<td>Ecoregion Range</td>
<td>0.02 – 0.05</td>
<td>7.6 – 7.9</td>
<td>1.8 - 6</td>
</tr>
</tbody>
</table>

Chart 3: Total Phosphorus Ranges for Monitored Streams
Discussion: Stream conditions at all sites were generally good. Average monitored values fell within or below the expected range for Total Suspended Solids, and Nitrogen. All pH values were slightly lower than expected. Phosphorus numbers for all sites are higher than expected. The Sandy River site was at the top edge of the expected eco-region range. The three Rice River sites showed a wide range of phosphorus levels, with the average significantly higher than expected.

Six E-Coli readings were taken at each stream site. These samples, along with those planned for 2011 will complete the assessment dataset for this parameter. E. coli bacteria have been commonly found in recreational waters. Their presence is used to indicate recent fecal contamination, but this may not be indicative of human waste. E. coli are harbored in all warm-blooded animals: birds and mammals alike. Some soil types may also harbor E. coli bacteria. Bacterial contamination can result from a combination of many factors including non-point sources, transport in streams and stream water quality, and other environmental factors. Non-point sources are increasingly recognized as contributors of bacterial loads. Growth and reproduction of bacteria in stream sediments from previous human and animal inputs can be the source of outbreaks, if supported by other environmental factors. Preliminary data indicates that the Rice River sites at the National Wildlife Refuge and South of Portage Lake warrant careful investigation in 2011.

Water heights and flow volumes varied throughout the year. Higher levels were experienced in the early summer, with slightly lower stream levels later in the season. This variance in rainfall and stream flow has a definite affect on the water quality of the stream, and should be kept in mind when reviewing the data. A second year of monitoring will serve to reduce the variance in the water quality due to weather patterns.

Recommendations for Stream Sites:
The data that was collected in 2010 was insufficient to complete the assessment dataset for these stream sites. Monitoring of the sites in 2011 is needed to complete this dataset.

Tracking water transparency with a transparency tube is easy and inexpensive. Changes in transparency tell us when key water pollutants are present in the stream. Continuing monitoring through the Citizen Stream Monitoring Program is recommended. This data would be included in the MPCA STORET database.

The Aitkin County Water Planning Task Force strives to provide funding and/or technical assistance each year for water quality monitoring. Periodic chemical analysis in combination with regular transparency tube readings, would allow for tracking of trends in water quality.

Area residents should continue to be vigilant about managing sources of phosphorus. Common sources of phosphorus to streams include bank erosion, lawn fertilizer, runoff from impervious surfaces such as homes and roads, faulty septic systems, and agricultural practices. Many of these are sources that can be minimized through the implementation
of Best Management Practices. The local Soil and Water Conservation District can provide technical assistance in this implementation, and often has cost share funds available to assist with project costs. Landowners are encouraged to take advantage of educational opportunities that become available and learn new techniques and innovations in watershed management.

Expenditure Summary

Significant volunteer labor was donated to make this effort a success. Without the assistance of the volunteers, this data could not have been gathered. Expenditures related to the project in 2010 are broken out below:

| Sample Collection & Shipment                      | $ 335.00 |
| Volunteer Coordination                            | $ 129.30 |
| Equipment Maintenance                              | $ 215.76 |
| Sample Shipping to Laboratory                      | $ 2,840.00 |
| SWCD Staff Time & Travel Reimbursement             | $ 8,730.35 |
| Laboratory Analysis                                | $ 1,260.00 |
| Lake Samples                                       | $ 3,290.29 |
| Stream Samples                                     | $ 390.00 |
| Data Management                                    | $ 270.00 |
| Grant Administration & Required Reports             | $ 8,730.35 |

Impaired Waters and Total Maximum Daily Loads

The Minnesota Pollution Control Agency has been charged with assessing the waters of the State and listing any impairments. “Impaired Waters” are those waters that do not meet water-quality standards for one or more pollutants, thus they are “impaired for their designated uses”. Data collected through these efforts will be used in the next assessment process. The State is required to prepare a Total Maximum Daily Load study for each impairment on the list. A TMDL study determines the maximum amount of a pollutant that a water body can receive and still meet standards. TMDLs also set limits and reduction goals for restoring impaired waters. Further analysis of the data will occur after completion of the 2011 sampling season. It is best for lakes to maintain good water quality, and avoid being listed as impaired. It is, however, good to know that there is a process, and assistance, for dealing with sources of impairment.
Additional Sources of Information:

www.pca.state.mn.us/publications/wq-lar2-08.pdf

www.pca.state.mn.us/publication/wq-csm2-07.pdf

Minnesota Department of Natural Resources Website: www.dnr.state.mn.us

Minnesota Pollution Control Agency Website: www.pca.state.mn.us

Minnesota Waters (formerly The Minnesota Lakes Association) Website: www.mnlakes.org

Aitkin County Soil and Water Conservation District  (218) 927-6565
www.aitkincountyswcd.org

Aitkin County Planning and Zoning Office  (218) 927-7342
Appendix A: Map of 2010 Water Quality Monitoring Sites
Appendix B. Carlson’s Trophic State Index, based on a scale of 0 – 100.
(Carlson 1977)

**TSI < 30**  Classical Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.

**TSI 30 - 40**  Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.

**TSI 40 - 50**  Water moderately clear, but increasing probability of anoxia in hypolimnion during summer.

**TSI 50 - 60**  Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only.

**TSI 60 - 70**  Dominance of bluegreen algae, algal scums probable, extensive macrophyte problems.

**TSI 70 - 80**  Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypereutrophic.

**TSI > 80**  Algal scums, summer fish kills, few macrophytes, dominance of rough fish.

<table>
<thead>
<tr>
<th>TROPHIC STATE INDEX</th>
<th>OLIGOTROPHIC</th>
<th>MESOTROPHIC</th>
<th>EUTROPHIC</th>
<th>HYPEREUTROPHIC</th>
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<tr>
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<table>
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<th>2</th>
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<th>4</th>
<th>5</th>
<th>7</th>
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<td>1</td>
<td>0.5</td>
<td>0.3</td>
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<tr>
<th>CHLOROPHYLL-a (µg/l)</th>
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<th>5</th>
<th>7</th>
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<th>100</th>
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<thead>
<tr>
<th>TOTAL PHOSPHORUS (µg/l)</th>
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<th>7</th>
<th>10</th>
<th>15</th>
<th>20</th>
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NLF Ecoregion Range, 25th – 75th percentile: 

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Appendix C: Water Quality Data