Water quality monitoring of five major tributaries in the Otsego Lake watershed, summer 2012

Kayla Mehigan

INTRODUCTION

Otsego Lake’s northern watershed has been monitored since 1995 to determine water quality and nutrient concentrations. Historically, Otsego Lake was classified as mesotrophic with characteristics of an oligotrophic lake (Iannuzzi 1991). However, in recent years there has been a trend towards eutrophication (Harman et. al 1997; Albright 1998; 1999; 2000; 2001; 2002). Increases in nutrients, which contribute to eutrophication, can partly be attributed to agricultural runoff; 44 percent of the northern Otsego watershed is classified as agricultural land (Harman et. al 1997).

The municipalities within the Otsego Lake watershed adopted a watershed management plan which focuses on this addition of nutrients from five tributaries that feed the Lake in the northern portion of the watershed (Anonymous 2007). USDA’s Natural Resource Conservation Service (NRCS) developed programs designed to reduce nutrient loading into lakes from agriculture. These programs are called best management practices (BMPs). In 1996 the Farm Bill included funding for the USDA’s Environmental Quality Incentive Program (EQIP), which provided farms with funds to implement BMPs (Denby 2009). As of 2012, 22 farms utilize NRCS-funded BMPs.

Monitoring the tributaries for changes in nutrients more accurately assess the nutrient loading into the Lake. The illegal introduction of alewife, Alosa pseudoharengus, into Otsego Lake in 1986 made assessments of BMP benefits on water quality more difficult because the effects of alewife mimic those of nutrient loading (Harman et. al 1997). The introduction of zebra mussels, Dreissena polymorpha, in 2007 also affects observed lake water quality. Increased water clarity and decreased phytoplankton abundance have been attributed to zebra mussel colonization in studies of other lakes (Fahnenstiel et. al 1995). Stream monitoring provides information on nutrient concentrations and sources upstream of the lake, allowing for the assessment of BMP effectiveness without the additional confounding factors present within the lake proper.

METHODS

The study was continued using methods employed in previous years (Zaengle 2011). The five major tributaries monitored included White Creek, Cripple Creek, Hayden Creek, Shadow Brook, and a stream that flows from Mount Wellington. There are 23 sites in total; three along White Creek, five on Cripple Creek, eight on Hayden Creek, five on Shadow Brook, and three on Mount Wellington. Table 1 provides site names, coordinates, and a brief description of each site. Figure 1 illustrates the locations of each site and BMP farms. These sites were chosen based on road access and their proximity to farms that utilize BMPs. The seventh site along Hayden

Creek was incorrectly located and recorded for the first six weeks; as a result only the last three weeks of data are included. Water samples were collected weekly at each site from 23 May to 26 July in 125 mL acid washed bottles. Samples were preserved with sulfuric acid to a pH <1. Samples were analyzed for concentrations of total nitrogen (TN), nitrate+nitrite, and total phosphorus (TP) using a Lachat® QuikChem FIA+ Water Analyzer. The cadmium reduction method (Pritzlaff 2003) was used to assess total nitrogen and nitrate+nitrite and ascorbic acid followed by persulfate digestion (Liao and Martin 2001) to assess total phosphorus. For graphing purposes, nitrate+nitrite samples below detection level (bd) were included as 0 mg/L.

Physiochemical parameters were measured at each site using a YSI (6820 V2) Multiparameter probe that was calibrated according to manufacturer’s specifications. Measurements included temperature, specific conductance, pH, oxidation reduction potential (ORP), percent dissolved oxygen (DO), DO concentration (mg/L), and turbidity. Specific conductance data were discarded due to data collection errors.

Figure 1. Map of five tributaries in northern watershed of Otsego Lake. Sampling sites are numbered; agricultural BMPs are marked with an asterisk.
Table 1. Physical descriptions and GPS coordinates of sampling sites (modified from Zaengle 2011). Sites are displayed in Figure 1.

**White Creek 1**: N 42º 49.646’ W 74º 56.986’
South side of Allen Lake on County Route 26 near outlet to White Creek.

**White Creek 2**: N 42º 48.93’ W 74º 55.303’
North side of culvert on County Route 27 (Allen Lake Road) where there is a large dip in the road.

**White Creek 3**: N 42º 48.355’ W 74º 54.210’
West side of large stone culvert on Route 80.

**Cripple Creek 1**: N 42º 48.919’ W 74º 55.666’
Weaver Lake accessed from the north side of Route 20 just past outflow of beaver dam. Water here is slow moving and there is an abundance of organic matter.

**Cripple Creek 2**: N 42º 50.597’ W 74º 54.933’
Young Lake accessed from the west side of Hoke Road. The water at this side is shallow; some distance from shore is required for sampling.

**Cripple Creek 3**: N 42º 49.437’ W 74º 53.991’
North side of culvert on Bartlett Road. The water at this location is cold and swift.

**Cripple Creek 4**: N 42º 48.836’ W 74º 54.037’
Large culvert on west side of Route 80. The stream widens and slows at this point; this is the inlet to Clarke Pond.

**Cripple Creek 5**: N 42º 48.822’ W 74º 53.779’
Dam just south of Clarke Pond accessed from the Otsego Golf Club road.

**Hayden Creek 1**: N 42º 51.658’ W 74º 51.010’
Summit Lake accessed from the east side of Route 80, north of the Route 20 and Route 80 intersection.

**Hayden Creek 2**: N 42º 51.324’ W 74º 51.294’
North side of culvert on Dominion Road.

**Hayden Creek 3**: N 42º 50.890’ W 74º 51.796’
Culvert on the east side of Route 80 north of the intersection of Route 20 and Route 80.

**Hayden Creek 4**: N 42º 50.258’ W 74º 52.144’
North side of large culvert at the intersection of Route 20 and Route 80.

**Hayden Creek 5**: N 42º 49.997’ W 74º 52.533’
Immediately below the Shipman Pond spillway on Route 80.

**Hayden Creek 6**: N 42º 49.669’ W 74º 52.760’
East side of the culvert on Route 80 in the village of Springfield Center.

**Hayden Creek 7**: N 42º 49.258’ W 74º 53.010’
Large culvert on the south side of County Route 53.

**Hayden Creek 8**: N 42º 48.874’ W 74º 53.255’
Otsego Golf Club, above the white bridge adjacent to the clubhouse. The water here is slow moving and murky.
Table 1 (cont.). Physical descriptions and GPS coordinates of sampling sites (modified from Zaengle 2011). Sites are displayed in Figure 1.

- **Shadow Brook 1:** N 42º 51.831’ W 74º 47.731’
  Small culvert on County Route 30 south of Swamp Road.

- **Shadow Brook 2:** N 42º 49.882’ W 74º 49.058’
  Large culvert on the north side of Route 20, west of County Route 31.

- **Shadow Brook 3:** N 42º 48.788’ W 74º 49.852’
  Private driveway on County Rte 31 (Box 2075) leading to a small wooden bridge on a dairy farm.

- **Shadow Brook 4:** N 42º 48.333’ W 74º 50.605’
  One lane bridge on Rathburn Road. This site is located on an active dairy farm. The stream bed consists of exposed limestone bedrock.

- **Shadow Brook 5:** N 42º 47.436’ W 74º 51.506’
  North side of large culvert on Mill Road behind Glimmerglass State Park.

- **Mount Wellington 1:** N 42º 48.864’ W 74º 52.594’
  Stone bridge on Public Landing Road adjacent to an active dairy farm.

- **Mount Wellington 2:** N 42º 48.875’ W 74º 52.987’
  Small stone bridge is accessible from a private road off Public Landing Road; at the end of the private road near a white house there is a mowed path which leads to the bridge. Water here is generally stagnant and murky.

**RESULTS & DISCUSSION**

**Temperature**

Summer 2012 mean site temperatures, displayed in Figure 2, ranged from 15.44°C at MW1 to 22.56°C at HC1. In 2011, the lowest and highest mean temperatures were 16.41°C at CC3 and 24.42°C at HC1, respectively (Zaengle 2011). The mean temperatures have decreased in 2012 compared to previous years. Changes in water temperature can be an indicator of stream health, especially related to the condition of the riparian zone. Many aquatic organisms are sensitive to temperature fluctuations because temperature affects oxygen availability; colder water holds more DO (Senese 1997). Best management practices that protect riparian zones with woody vegetation can increase shading of the stream and result in lower, more stable summer temperatures.

**pH**

Mean site pH values are displayed in Figure 3. The mean pH ranged from 7.82 at CC1 to 8.28 at HC4 in 2012. In 2011, the pH range was larger with a low pH of 7.69 at HC1 and a high pH of 8.45 at HC7 (Zaengle 2011). pH is a measure of hydrogen ions and can be an indicator for water quality because it affects the availability of DO, nutrients, and heavy metals. The values in 2012 are near neutral or slightly basic, which decreases the ability of heavy metals to leach into the streams.
Figure 2. Mean temperatures (°C) for sampling sites along five tributaries of the northern Otsego Lake watershed, summer 2012. Points on the left side of the graph represent stream mouths while the points on the right are head waters. Vertical bars indicate standard error.

Figure 3. Mean pH for sampling sites along five tributaries of the northern Otsego Lake watershed, summer 2012. Points on the left side of the graph represent stream mouths while the points on the right are head waters.
Dissolved Oxygen

Mean site DO concentrations ranged from 5.04 mg/L at CC1 to 11.16 mg/L at SB4; all mean site concentrations are displayed in Figure 4. In 2011, the range was from 5.80 mg/L at HC1 to 10.16 mg/L at SB4 which is similar to 2012 values (Zaengle 2011). Dissolved oxygen concentration is fundamental to indicating water quality because it reflects the availability of oxygen for aquatic organisms and decomposition. Sensitive species may be impacted by DO levels less than 6 mg/L. Site CC1 fell below that level at 5.04 mg/L.

![Figure 4. Mean dissolved oxygen (mg/L) for sampling sites along five tributaries of the northern Otsego Lake watershed, summer 2012. Points on the left side of the graph represent stream mouths while the points on the right are head waters. Vertical bars indicate standard error.](image-url)

Turbidity

Turbidity causes water to look cloudy and results from suspended particles in water that interfere with the passage of light. Higher values indicate a greater number of suspended particles (APHA 1992). In 2012, turbidity ranged from 3.68 NTU at CC3 to 26.03 NTU at MW2 (Figure 5). These values reflect the difference in site characteristics; site CC3 is a fast moving portion of Cripple Creek and MW2 is an area where the water is muddy and calm. This is the first year turbidity data has been collected.
Nitrogen

Total nitrogen comprises all forms of nitrogen found in the streams including nitrates, nitrites, ammonia, and nitrogenous organic compounds. In 2012, mean total nitrogen values ranged from 0.37 mg/L at WC1 to 2.3 mg/L at HC8. All total nitrogen values are displayed in Figure 6. The mean site concentrations of nitrate+nitrite in 2012 ranged from 0.16 mg/L at CC2 to 1.14 mg/L at HC8. In 2011, the values ranged from below detection (0.02 mg/L) to 1.57 mg/L at CC2 and SB2, respectively (Zaengle 2011). Nitrite+nitrate values from stream outlet sites are displayed in Figure 7. Nitrogen is an essential nutrient for all organisms and can be a limiting factor in lakes and streams. A spike in nitrogen levels can increase the productivity of a water system. The main focus of the best management practices is to limit the amount of nutrients entering Lake Otsego via the tributaries. Mean nitrate concentrations have increased from previous years at sites near the source of each tributary; Hayden Creek and Cripple Creek concentrations increase as the stream sites reach the outlets. The other tributaries display a trend that decreases in nitrate concentrations near the stream outlets. Figure 8 and Table 2 compare mean nitrate concentrations of the five tributaries since 1991.
Figure 6. Mean total nitrogen (mg/L) for sampling sites along five tributaries of the northern Otsego Lake watershed, summer 2012. Points on the left side of the graph represent stream mouths while the points on the right are head waters. Vertical bars indicate standard error.

Figure 7. Mean nitrate (mg/L) for sampling sites along five tributaries of the northern Otsego Lake watershed, summer 2012. Points on the left side of the graph represent stream mouths while the points on the right are head waters. Vertical bars indicate standard error.
Phosphorus is an essential nutrient to aquatic organisms and is a limiting factor of productivity in Otsego Lake. Total phosphorus comprises all forms of phosphorus found in the streams. In 2012, mean total phosphorus values ranged from 20 µg/L at HC4 to 71 µg/L at MW2. The concentration of phosphorus has remained similar to previous years. In 2011, the lowest value was 20 µg/L at HC2 and the highest value was 53 µg/L at HC1 (Zaengle 2011). All total phosphorus values are displayed in Figure 9. Mean stream outlet phosphorus concentrations are displayed in Figure 10. A comparison of mean phosphorus concentrations from 2000 to 2012 is displayed in Table 3.
Table 2. Comparison of mean nitrate (mg/L) concentrations at each sampling location 1991, 1998-2012.

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- - - stream flow was too low for sample collection; no nutrient data exists for Site SB1 in 2012
Figure 9. Mean total phosphorus (µg/L) for sampling sites along five tributaries of the northern Otsego Lake watershed, summer 2012. Points on the left side of the graph represent stream mouths while the points on the right are head waters.

Figure 10. A comparison of mean phosphorus (µg/L) concentrations at each stream mouth from 1996-2012.
Table 3. Comparison of mean phosphorus (μg/L) concentrations at each sampling location from 2000-2012.

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* - stream flow was too low for sample collection; no nutrient data exists for Site SB1 in 2012

**CONCLUSION**

Water quality of the five tributaries has remained similar to previous years with some slight variation. The overall effectiveness of the best management practices that were implemented in 1995 has remained the same since 2000. The nutrient concentrations fluctuate yearly related to changes in weather, human activities, etc. In 2012, there was a drought that decreased water flow of each tributary; Shadow Brook site 1 was dry the entire summer and White Creek site 1 decreased in flow in mid-July to the point where measurements could not be taken. Determining changes in water quality resulting from land management practices requires long term sampling; natural variation in climate and other factors that influence physical parameters in streams can create fluctuations in the data values, making it difficult to relate the results to best management practice success.
REFERENCES


Zaengle, O. 2011. Water quality monitoring of five major tributaries in the Otsego Lake
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