Algonquin Ecosystem Headwater Study: Tyne Lake Watershed

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Abstract

*The Tyne Lake watershed is located outside the western boundary of Algonquin Provincial Park. This watershed is one of several headwaters not protected by park boundaries. The assessment of the watershed was conducted during the summer of 1998 and included a descriptive account of the shoreline regarding the flora and fauna of the area and some chemical analysis. Another important part of the research was to identify any seeps that existed within the watershed. Little is known about the importance of seeps but Brook Trout (*Salvelinus fontinalis*) hatchlings may spend the first year of their lives in the protection of a seep. Data sheets were used at each of the 20 sites that were sampled throughout the watershed to collect the descriptive data and chemical information. All chemical tests were conducted in the field using Hach kits. Chemical analysis showed that the quality of the water was good. The mean water temperature in the Tyne Lake Watershed was 24.8°C and the mean pH was 6.8. The sulphate, nitrate and nitrate nitrogen levels were low. Measuring discharge was difficult in this study as the water level in 1998 was abnormally low and many streams did not have measurable flow. The dominant tree species included White Spruce (*Picea glauca*), White Pine (*Pinus strobus*) and Black Spruce (*Picea mariana*). Labrador Tea (*Ledum groenlandicum*), grasses and sedges dominated the herbaceous vegetation in the riparian area of the watershed. The bank slope at all the sites in the watershed was slight to moderate, and the bank erosion was stable throughout the watershed except in areas that had been altered by human activity. Signs of past logging activity in the area were observed in the form of old logging roads and landings. Further investigation is necessary to determine a more specific definition of "seep", to determine Brook Trout usage and to identify ways to protect the areas from logging operations and human activity. Further investigation during spring, summer and fall over a set number of years would be useful to identify changes in the watershed over time. Careful consideration should be given to protecting the headwaters located outside the park in order to protect the Algonquin ecosystem.*

Introduction

Algonquin Provincial Park contains more than one thousand lakes that are used by boaters, canoeists and anglers. Logging operations continue within the park, but are strictly managed in order to maintain the quality of the water and the surrounding environment. Even with careful management, Algonquin Provincial Park faces many environmental challenges, including that of water quality. In some cases, the water which flows through the park is not protected by the strict guidelines that are set within the park boundaries. Several watersheds that drain into rivers which flow through the park are located outside the park boundary and may be susceptible to development, mining and logging damage. This study focuses on the Tyne Lake Watershed, located outside the northwestern corner of Algonquin Park. The primary purpose of the study is to assess the quality of the water within the watershed, by including a descriptive account of the shoreline and a chemical account of the quality of the water. A record of this information will be important to compare with future watershed studies so as to monitor changes in the watershed over time.

Study Area and Description

The Tyne Lake watershed is located in Ballantyne Township outside the northwestern corner of Algonquin Provincial Park. The watershed area is approximately 30 750 m^2. Access from Highway 11 is possible from Trout Creek and South River on a series of gravel roads. The watershed is made up of a series of both named and unnamed lakes and creeks that flow into the Amable du Fond River to the south. There are 14 lakes and three main creeks in the watershed. This is a primary headwater as the lakes are predominantly spring-fed. The watershed area lies within the Great Lakes-St. Lawrence forest region which is characterized by mixed deciduous and coniferous forests (White 1980).

Methods

The Tyne Lake watershed study was conducted between June 22 and August 20, 1998. Sample sites were selected to ensure that all significant water bodies and water courses in the watershed were represented. At each site, bank and riparian vegetation was recorded, and the stability of the bank was described. The physical characteristics, substrate composition and a description of the habitat was also recorded, taking special note of fish habitat. This information was noted at the site and was recorded onto the data sheets.

At each site three repetitions of water temperature and pH were measured using a portable pH meter, the average was calculated for each measurement and recorded. As well, six 120 mL water samples were taken for chemical analysis. The chemical analysis included testing nitrates, nitrogen and sulphates. Samples for dissolved solids were also taken. Photographs were taken to provide a visual account of each site.

Discharge was measured using a ping-pong ball, a measuring tape and a stop watch. Five depths were taken and averaged, and five widths were taken and averaged and later were used in the formula. The length of the stream was a constant interval of ten metres between where the ball was dropped and where the ball was retrieved. A constant was used in the formula to account for the composition of the stream bed. The formula used to calculate the discharge is shown in Figure 1. At the lake sites accessible by canoe, water turbidity was measured using a Secchi disk.

Nitrate tests were performed using the Low Range (0-10 mg/L) Nitrate Test Kit by the Hach Company. This test was performed in the field at the base camp to ensure that the samples were fresh. This test measures the nitrate nitrogen (N) and nitrate (NO_3) in a water sample. Sulphate tests were performed using the Sulphate Test Kit (50-200 mg/L) from the Hach Company. This test was completed in the field to ensure the freshness of the sample and was repeated twice for each site. Water samples were taken to perform the dissolved solids test. In the lab, petri dishes with filters were weighed and the values recorded. In the field the Sterifil

$$Q = \frac{WDLA}{T}$$

where:

Q = discharge
W = average width of stream
D = average depth
L = length of stream measured
T = time for float to travel length of stream
A = a constant (0.9 for sandy/muddy bottoms and 0.8 for gravel/rock bottoms).

Figure 1: Formula for calculating discharge

Asceptic System was employed to collect the solids on the filter. The filter was removed from the petri dish and placed on the sieve portion of the system between the two sample compartments.

Visual accounts of human activity in the watershed area was recorded on the data sheets. Logging activity was apparent from ground truthing the area surrounding the site. Recreational activity was recorded in terms of number of cottages, boaters, anglers and campers.

Mapping was done in this project to identify areas of change within the watershed. Areas of change included wetlands, possible seeps and logging activity that had changed the canopy cover. When traversing the area surrounding the water bodies and water courses of the watershed, evidence of groundwater springs and surface water flow was recorded. These were recorded to identify all sources of water that flow through the system.

Roads, trails and public boat launches provide easy access to many lakes in the watershed. Cottages are located on Tyne Lake, Little Tyne Lake and at the confluence of Tyne Creek and the Amable du Fond River. A trapper's cabin is situated on the south shore of Durrell Lake.

Results

Water Temperature and pH

Water surface temperature ranged from 21.5°C at Site 19 to 27.9°C at Site 13. The mean water surface temperature in the Tyne Lake Watershed was 24.8°C. Figure 2 shows the temperatures by site. The pH of the water ranged from 4.4 at Site 4 to 7.6 at Sites 2 and 12 . The mean pH in the Tyne Lake watershed was 6.8. Figure 3 shows the pH values by site.

Discharge

Discharge was calculated at Site 8 and Site 15. Stream measurements and the calculated discharge are summarized in Table 1.

Turbidity

Turbidity was tested at Sites 2, 5, 6, 12, 17 and 18. Figure 4 shows the results of the turbidity test by site.

Nitates

Nitrate nitrogen and nitrate was tested at 19 sites and in every case the test showed 0 mg/L of each in the water sample.

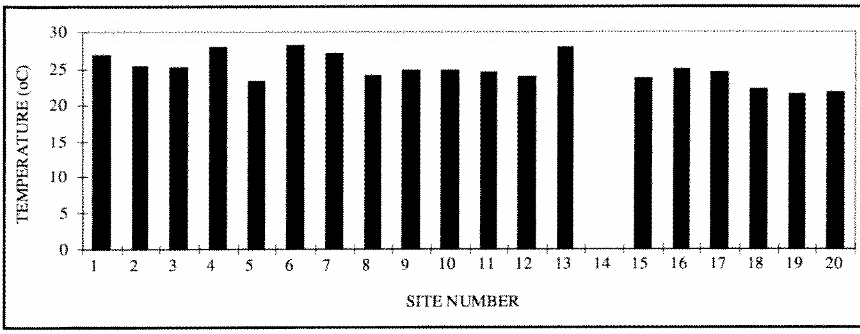

Figure 2: Water temperature by site

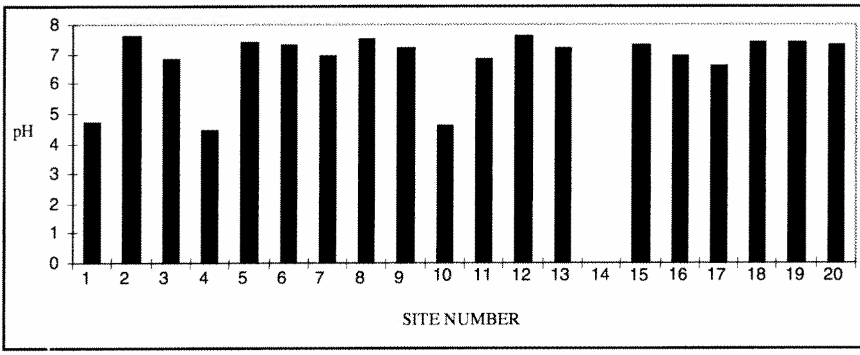

Figure 3: pH value by site

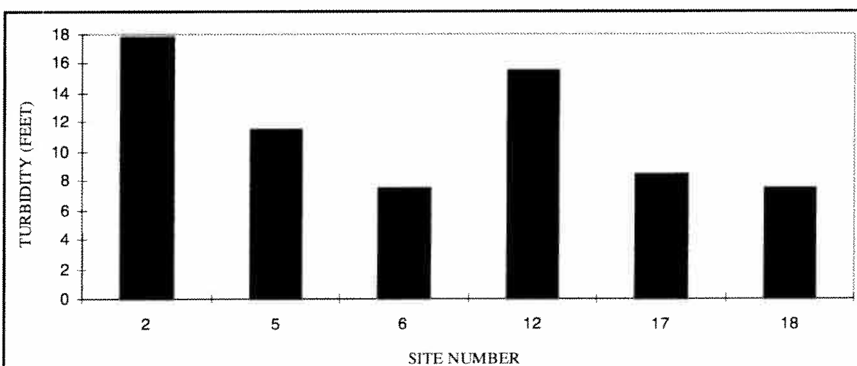

Figure 4: Turbidity by site

Site Number	Avg. Width of Stream (W)	Avg. Depth of Stream (D)	Length of Stream (L)	Time (T)	Constant (C)	Discharge (Q)
8	8.4 m	0.202 m	10 m	101 sec.	0.8	0.13 m3/sec
5	5.7 m	0.754 m	10 m	308 sec.	0.8	0.11 m3/sec

Table 1: Stream Measurements and Calculated Discharge

Sulphates
Sulphates were tested at 19 sites and in each case the test showed there was <50 mg/L of sulphate in the water sample.

Dissolved Solids
The dissolved solids test was done at 18 sites. Table 2 summarizes the results of this test. Figure 5 is a graph of the dissolved solids by site.

Brook Trout Nursery Creek and Seep Identification
Two potential brook trout nursery creeks were identified through ground truthing. The first was located adjacent to Ballantyne Lake. It consisted of a small trickle from the northeast bank of the lake. Flow was not measurable. The second was located northwest of Holtz Lake, an old logging road ran over it without a culvert. The erosion, due to the use of heavy machinery, was considerable. The temperature was not taken but was extremely cold to the touch. Flow was not measurable. This area warrants further investigation. No seeps were located.

Discussion
The vegetation found in the Tyne Lake watershed was typical of the Great Lakes-St. Lawrence forest region in Canada. The dominant vegetation included White Spruce (*Picea glauca*), White Pine (*Pinus strobus*) and Black Spruce (*Picea mariana*) with some Mixed Conifer Hardwoods and Northern Hardwoods (White 1980). Labrador Tea (*Ledum groenlandicum*), and grasses and sedges dominated the herbaceous vegetation in the riparian area of the watershed.

The bank slope at all the sites in the watershed was slight to moderate, and the bank erosion was stable throughout the watershed except in areas that had been altered by human activity, for example at site 8 where the road, culvert and public boat launch caused a moderate amount of erosion.

The watershed contained a wide variety of habitats suited for various species of wildlife. Weed beds and wetland vegetation, abundant in the Tyne Lake watershed, provide the necessary requirements for many species of animals including amphibians, reptiles, fish, birds and mammals. Rocks and log piles provide excellent structure for animals both in and out of the water. Trout in streams and lakes need sheltered areas and hiding areas in the form of stones and boulders. If any of this protection is missing as a result of damming, dredging or tree felling the fish may disappear (Mills 1971). Many animals were sighted during the study period which could indicate that the habitat has not been greatly disrupted by human activity.

Signs of past logging activity in the area were observed in the form of old logging roads and landings. No current logging operations were noted in the watershed area. According to observations, clear-cut logging was the most commonly used method in the area. Buffer strips or corridors, areas of uniform width bordering both or one side of a feature such as a stream or lake (OMNR, 1996), were left around each lake and stream for aesthetic and environmental purposes. Forest roads that, at one time, were used for access and the extraction of lumber are now used for recreation. Easier access to lakes by way of forest roads results in increased human activity. Trails are worn from the roads which do not directly ac-

Site Number	Trial Number	Weight of Petri Dish and Filter without Solids (grams)	Weight of Petri Dish and Filter with Solids (grams)	Weight of Solids (grams)
1	i	8.2781	8.2782	0.0001
	ii	8.1717	8.1715	-0.0002
2	i	8.4657	8.4669	0.0012
	ii	8.2895	8.2889	-0.0006
3	i	8.2614	8.2612	-0.0002
	ii	8.3078	8.3073	-0.0005
4	i	8.3847	8.3848	0.0001
	ii	8.3840	8.3839	-0.0001
6	i	8.1037	8.1035	-0.0002
	ii	8.2501	8.2503	0.0002
7	i	8.3900	8.3907	0.0007
	ii	8.2385	8.2375	-0.001
8	i	8.3529	8.3535	0.0006
	ii	8.4856	8.4851	-0.0005
9	i	8.4182	8.4183	0.0001
	ii	8.1966	8.1968	0.0002
10	i	8.4652	8.4648	-0.0004
	ii	8.1176	8.1174	-0.0002
11	i	8.3244	8.3242	-0.0002
	ii	8.4647	8.4643	-0.0004
12	i	8.2373	8.2363	-0.001
	ii	8.1293	8.1287	-0.0006
13	i	8.3029	8.3163	0.0134
	ii	8.3662	8.4880	0.1218
15	i	8.1561	8.2441	0.088
	ii	8.2914	8.3217	0.0303
16	i	8.4712	8.5237	0.0525
	ii	8.3481	8.3762	0.0281
17	i	8.4862	8.5118	0.0256
	ii	8.3290	8.4001	0.0711
18	i	8.1233	8.1696	0.0463
	ii	8.4225	8.4747	0.0522
19	i	8.2624	8.2966	0.0342
	ii	8.2007	8.2426	0.0419
20	i	8.2197	8.3647	0.145
	ii	8.1927	8.3397	0.147

Table 2: Dissolved solids results by site.

cess the lake or stream. Increased use of the trail can cause soil compaction and the loss of vegetation. The desire to access seemingly untouched lakes is usually motivated by consumptive recreation such as hunting and fishing. Cottages and hunt camps located in the Tyne Lake watershed were primarily accessed by road.

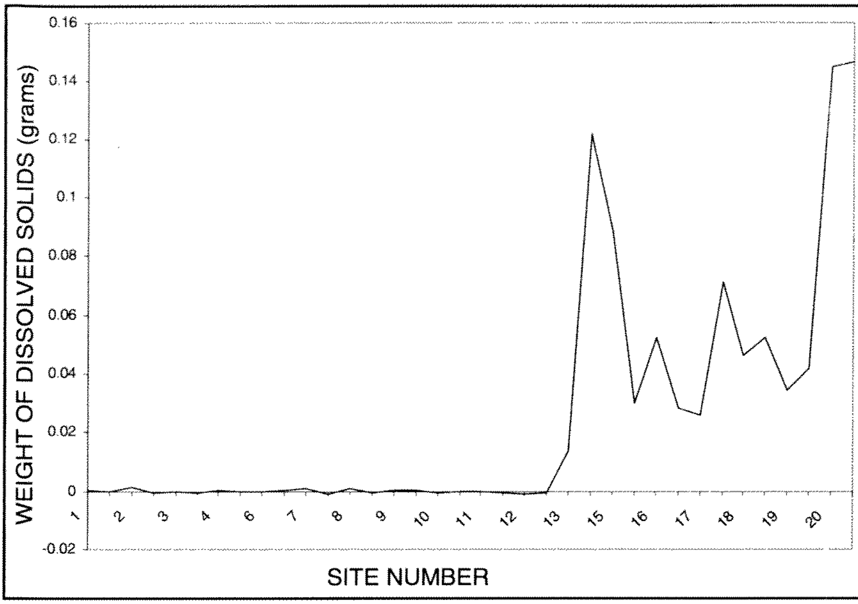

Figure 5: Weight of Dissolved Solids by Site

Surface water temperature ranged from 21.5°C to 27.9°C. The mean surface water temperature in the Tyne Lake Watershed was 24.8°C. The mean water temperature of the surface water in the watershed was too warm for Brook Trout (*Salvelinus fontinalis*). Brook Trout have difficulty surviving in water that is warmer than 20°C (OMNR, 1978). Brook Trout, if present, would be located further down into the thermocline where the water temperature would be colder. In natural Brook Trout lakes the volume of 'trout water'—the transition zone between the upper and lower lakes in a volume of water—averages about 43% of the lake's total volume, and extends from about three metres to about 12 metres below the surface (OMNR 1978).

The pH of the water in the watershed ranged from 4.4 to 7.6 and the mean pH was 6.8. Changes in the pH value of water are important to many organisms. Most organisms have adapted to life in water of a specific pH and may die if it changes even slightly. This has happened to Brook Trout in some streams in the Northeastern United States (Mitchell and Stapp 1996). The water bodies with lower pH values tended to be wetlands, while the more neutral values (around 7.0) were in the lakes and streams of the Tyne Lake watershed. Brook Trout prefer these areas due to the neutral pH. The best water for trout is that which possesses a slightly alkaline reaction, or in other words, a pH of between 7.0 and 8.0. Trout can tolerate acid or alkaline pH levels but the limits should be between 5.0 and 9.5 (Mills 1971).

Measuring discharge was difficult in this study as the water level in 1998 was abnormally low and many streams did not have measurable flow. Discharge was calculated at Sites 8 and 15. At both sites a moderately high amount of water was flowing out of the stream, 0.13 m3/sec at Site 8 and 0.11 m3/sec at Site 15. The velocity of both streams was slow but the channels were deep and wide, accounting for the volume of flow. The constant used in each case was 0.8 indicating gravel bottom.

Turbidity is a measure of the relative clarity of water: the greater the turbidity the murkier the water. Turbidity increases as a result of suspended solids in the water that reduce the transmission of light (Mitchell and Stapp 1996). The lowest turbidity results in the watershed took place at Site 2 (Tyne Lake) and Site 12 (Holtz Lake). The most turbid sites were Site 6 (Stove Lake) and Site 18 (Pat Lake). High turbidity may be caused by soil erosion, waste discharge, urban run-off, abundant bottom feeders, such as carp, that stir up bottom sediments, or algal growth (Mitchell and Stapp 1996). The dissolved solids results at Sites 2 and 12 were very low indicating low suspended solids, accounting for the low turbidity. The results for Site 18 showed much higher dissolved solids in the sample and therefore greater turbidity. Negative numbers shown in Figure 4 indicate that there was not sufficient dissolved solids in the water to weigh. The varying humidity on the days that the original weights (filter and petri dish) were measured and the day the final weights (filter, petri dish and solids) were weighed may also account for the negative numbers.

Throughout the watershed tests showed that nitrate and nitrate nitrogen was not an issue in the water. The number of cottages on the lakes and rivers did not contribute to nitrate build up in the water, as sewage is the main source of nitrates, added by humans, to rivers and lakes (Mitchell and Stapp 1996).

Sulphate tests in the Tyne Lake watershed showed less than 50 mg/L per 25 mL sample. Atmospheric sources of sulphates have increased since the onset of human industrial activities, although volcanic emissions have added sulpher compounds to the air for eons. Humans now contribute about 2.4 times more sulphates than the annual contribution from volcanoes to the atmospheric load of this gas. Coal combustion is notorious, and copper smelting and paper manufacturing also produce gases and run-off rich in sulpher (Cole 1983).

Seeps, or groundwater upwellings, may be crucial to the successful spawning of Brook Trout. Brook Trout fry may spend up to the first year of their lives in the protection of tiny cold water nursery creeks. Further investigation is necessary to determine ways of protecting the seep areas from logging damage and other human activity, such as mining and shoreline cottaging.

Conclusions and Recommendations

The observations made throughout this study indicate no serious threats to the health of this watershed. Recommendations for future studies and management considerations are as follows:

1. Further investigation during spring, summer and fall over a set number of years would be useful to identify changes in the watershed over time.
2. Creel census data would be useful to understand the fish populations in the Tyne Lake watershed area, and would provide valuable baseline data for future comparisons.
3. More information regarding seeps and brook trout nursery creeks in headwater

areas is needed as well as identifying ways to protect them from damage by logging operations and other human activity, such as mining and shoreline cottage development.

4. Careful consideration should be given to extending the boundary of Algonquin Park to incorporate all inflowing headwater drainages, such as the Tyne Lake Watershed. Considerations on this matter would include: future logging and mining activity; the current amount and type of recreation versus the future amount; and, type of recreation and development if it became a new segment of the park.

At least 20 watersheds that drain into rivers which flow through the park are located outside the park boundary and may be more susceptible to development and logging damage. These areas should be carefully monitored in the same manner as the Tyne Lake Watershed. Finally, the number of roads and the amount recreational activity may, in the future, compromise the water quality of the Tyne Lake watershed which could, in turn, affect the water quality in Algonquin Provincial Park.

Acknowledgements

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References

Cole, G.A. 1983. *Textbook of Limnology. Prospect Heights*: St. Louis: Mosby.

Mills, D. 1971. *Salmon and Trout: a resource, its ecology, conservation and management.* New York: St. Martin's Press.

Mitchell, M. K. and W. B. Stapp. 1996. *Field Manual for Water Quality Motoring.* Dexter: Thompson- Shore, Inc.

OMNR. 1978. *Fishing in Algonquin Provincial Park.*

OMNR. 1996. *Forest Management Planning Manual for Ontario's Crown Forests.* Toronto: Queen's Printer for Ontario.

White, J.H. 1980. *Forest Trees of Ontario.* Toronto: Ministry of Natural Resourses.