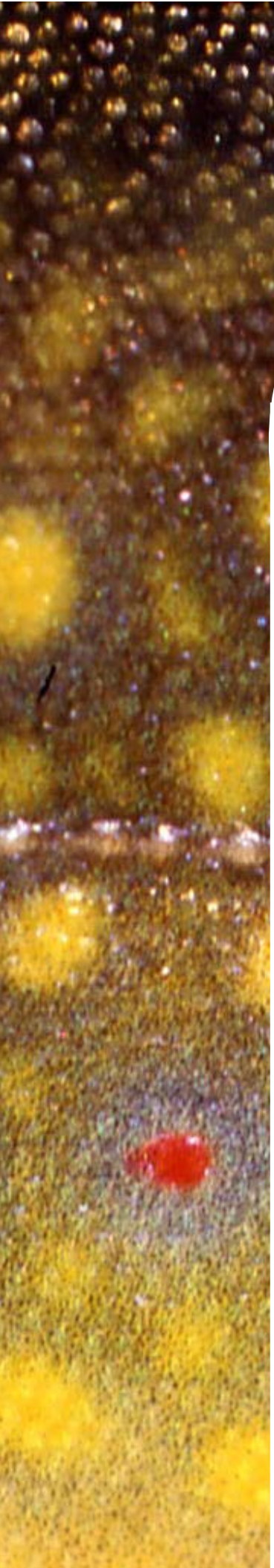

2007 Temperature Report for Cold Creek

Trout Unlimited Canada Technical Report
No. ON-028

Prepared for:
The Cold Creek Fly Fishers

Prepared by:
Silvia D'Amelio
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Table of Contents

List of Figures

Background

Cold Creek, a tributary of the Trent River, is located in Brighton. Its headwaters are considered coldwater habitat while its lower reaches transition into coolwater habitat. The portion of creek bounded by the Cold Creek Flyfishers Preserve is home to the transition point from cold to coolwater. This creek is home to natural brook trout and naturalized brown trout.

Salmonids, especially brook trout, are often considered indicators of water quality. Therefore these data will be compared to the thermal preferences of brook trout. Thermal preferences of salmonids have been well studied both in the laboratory and in the field. Although the upper thermal tolerance of brook trout is commonly known to be approximately 24°C (Ricker 1934, Power 1980, Grande and Andersen 1991), it has been well documented that their preferred range is 4-20°C (Power 1980 and references therein). In order to better understand a brook trout's ability to fully and efficiently utilize its environment it is necessary to understand that neither of these temperature ranges illustrates optimums for specific life stages. Optimal range for physical activity, growth and metabolism is 10-19°C (Baldwin 1948, Graham 1949, MacCrimmon and Campbell 1969, Power 1980 and references therein, Dwyer et al 1983), with trout selecting a preferred range of 15-17°C when provided a choice (Cherry et al 1975, Cherry et al 1977). Optimal maximum temperatures to sustain a healthy brook trout population are 18-19°C (Powers 1929, Creaser 1930, Ferguson 1958) and they actively avoid areas where temperatures approach 24°C (Meisner 1990). Critical temperatures further limit available brook trout habitat at particular life history stages. During the summer season, temperatures should not exceed 19°C and spawning maximums should not exceed 12°C with the optimum between 6-8°C. It is well documented that temperature affects swimming performance and the overall cost of swimming. As a result, increases in temperature lead to increases in critical swimming velocity (Heggenes and Traaen 1988, Tang and Boisclair 1995).

Brown trout have not been as extensively studied but are considered to have similar temperature preferences as brook trout with slightly higher tolerances (Scott and Crossman 1973). The upper lethal limit for brown trout is 24.7 - 29.2°C dependant on acclimation (Brynildson et al 1963, Needham 1969, Elliott 2000). Optimal temperatures for growth and development of brown trout range from 12° - 19°C (Frost and Brown 1967, Brown 1973, Mills 1971). Brown trout

selectively prefer waters with a maximum of 19°C, but will tolerate higher temperatures where increased oxygen is available (Elliott 2000).

This study assesses the temperature of Cold Creek within the limits of the Cold Creek Fly Fishing Club property. The results of this study will guide future monitoring and investigative efforts within the watershed. The goal of this monitoring program is to develop a geographical and temporal temperature profile aimed at monitoring and rehabilitating this system.

Methods

Temperature data loggers (Tidbits®) were launched at multiple locations within Cold Creek to gather data on longitudinal temporal variability within these waters. A total of five Tidbits were launched on June 12, 2007 and were pre-programmed to record temperature every half hour starting at midnight. The loggers were attached to a piece of substrate or large rooted plants using black UV rated cable ties. The piece of substrate utilized was dependent on the average bed load size within the tributary and therefore varied from site to site. The Tidbit was placed face down in the approximate center of the thalweg to ensure constant water flow over the unit and eliminate direct warming from sunlight and where necessary covered by other rocks. Sample sites were chosen to represent nick points in the system and/or flank significant water features.

Data were collected continuously at each site from June through October 2007. These data were compiled using Microsoft Excel to create a seamless seasonal temperature plot for each location within the tributary. Erroneous data was removed where justification existed (e.g. where the logger was exposed to air due to low water levels). Data were summarized and daily averages, maximums, minimums and temperature ranges were plotted for each sampling location and compared among sampling sites. Additionally, longitudinal trends were compared among years and stream classification was identified using a method outlined by Stoneman and Jones (1996). Trimean average and maximum temperatures were calculated weekly to identify potential sustained temperature trends. These trends account for the degree of temperature variability within the system during the course of a week and may be more indicative of the actual temperature stress felt by aquatic organisms within the system. Baldwin (1948) showed that a trimean maximum of 22°C correlates to an overall maximum of 25.6°C, well over brook and brown trout tolerances.

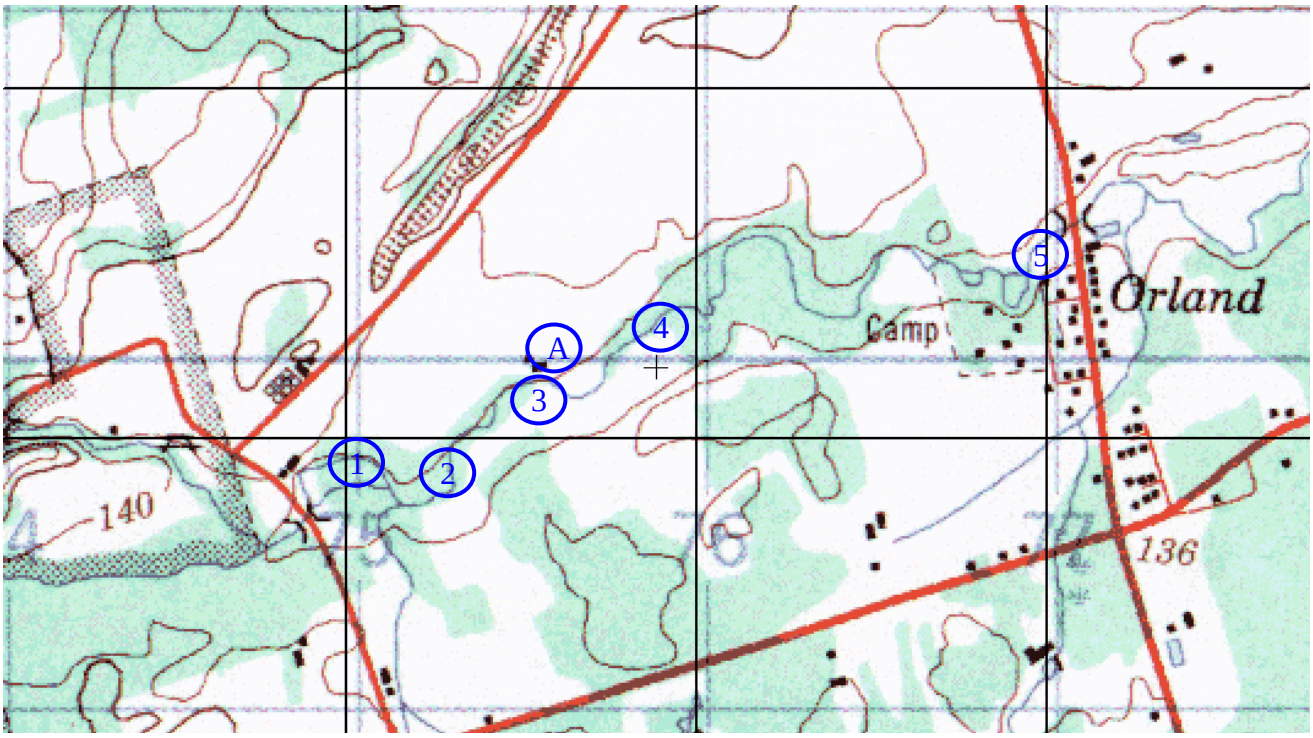


Figure 1: Study Site – Cold Creek temperature monitoring locations. 'A' represents the site where air temperature was monitored. (locations are approximate)

Data and Results

Of the five loggers launched in Cold Creek, three were retrieved and the data from each was successfully downloaded. A cursory review of the raw data files downloaded from the temperature data loggers revealed valid water temperature data.

A coarse analysis of the data indicates a negligible difference among sites and therefore no associated longitudinal trends in temperature (Figure 2). All sites display average maximum summer temperatures outside of the upper thermal maximum, above the optimal maximum for brook trout and above the optimal range for brown trout (Figure 2).

A more detailed look reveals similar trends. Daily maximums for all sites frequently fall above the upper thermal threshold for book trout and above optimums for brown trout (Figure 3). Minimum and average temperatures fall within reasonable ranges (Figures 4 and 5). Daily trends exhibit negligible temperature differences among sites (Figures 3, 4 and 5).

All sites display similar, low daily ranges and rates of change, which are reasonable for a free flowing creek (Figures 6 and 7).

Trimean average temperatures indicate that all sites fall within tolerable limits (Figure 8). Alternatively, trimean maximum temperatures indicate that all sites sustain temperatures above critical thermal temperatures for up to three weeks (Figure 9).

Thermal stream classification of these sites (Stoneman and Jones) indicate that this creek a generally cool water classification with some tendency towards warm water (Figure 10).

Summary Plots

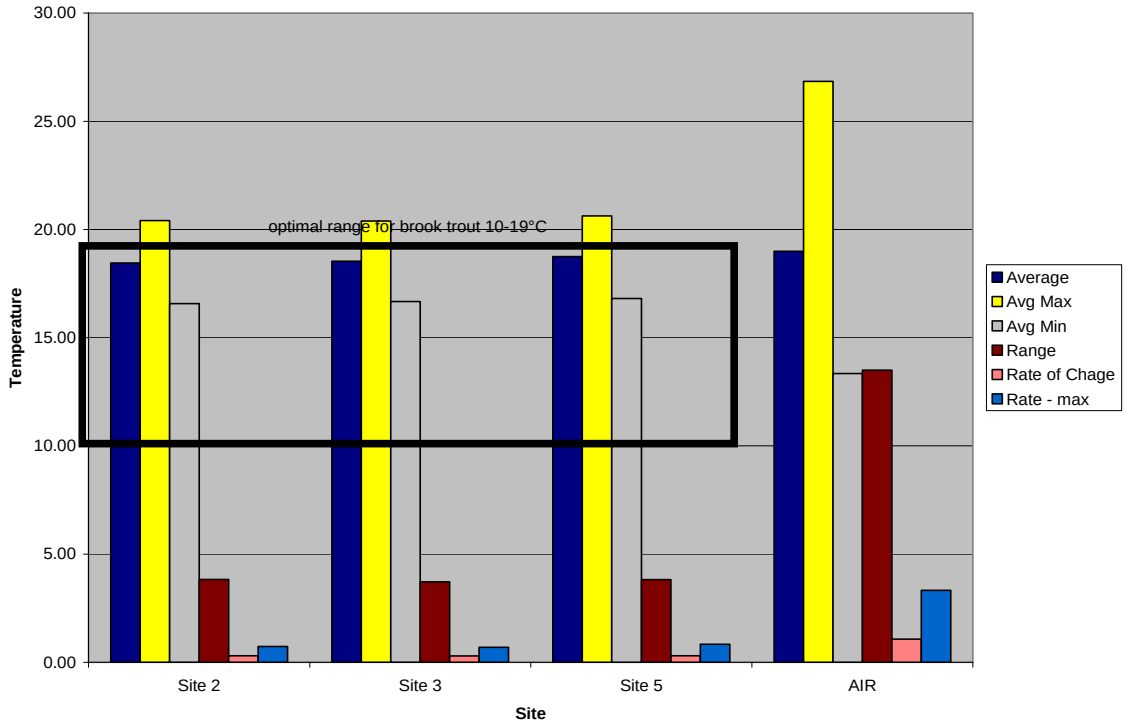


Figure 2: Summary of summer data from all sites. Average daily temperature, average maximum and minimum temperature, average daily range, average daily rate of change and absolute maximum rate of change were calculated for July and August.

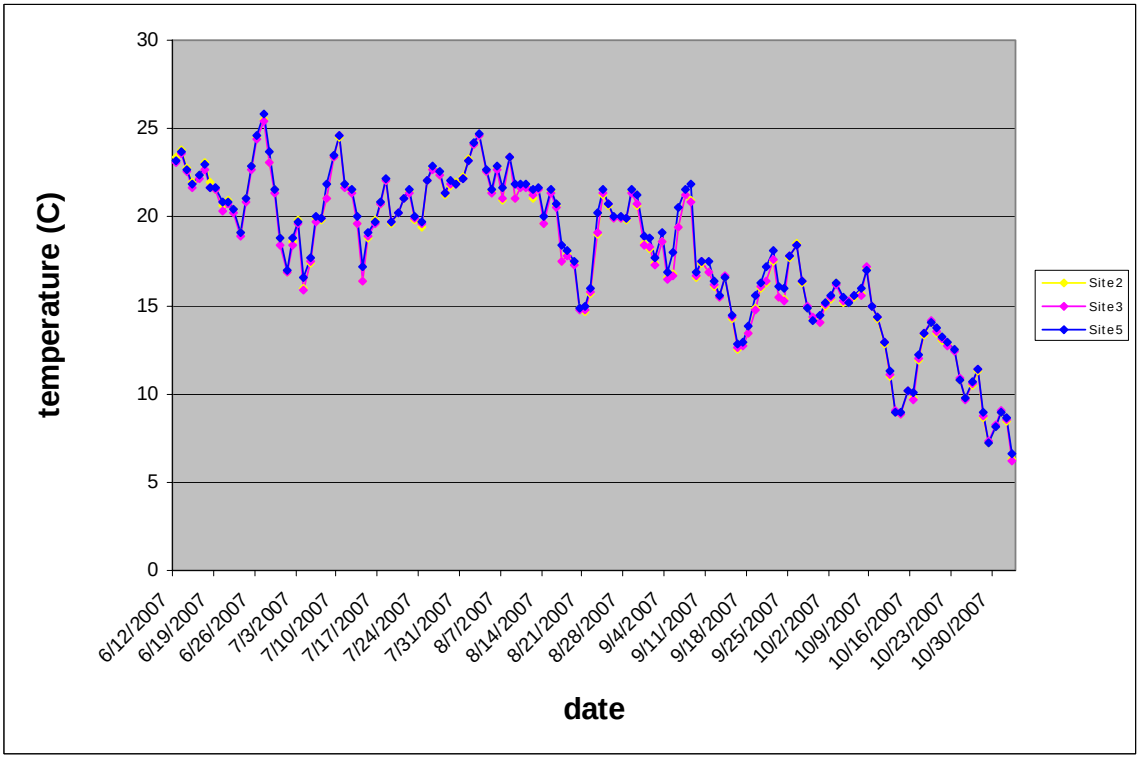


Figure 3: Maximum daily temperature. Sites are listed upstream (site 2) to downstream (site3).

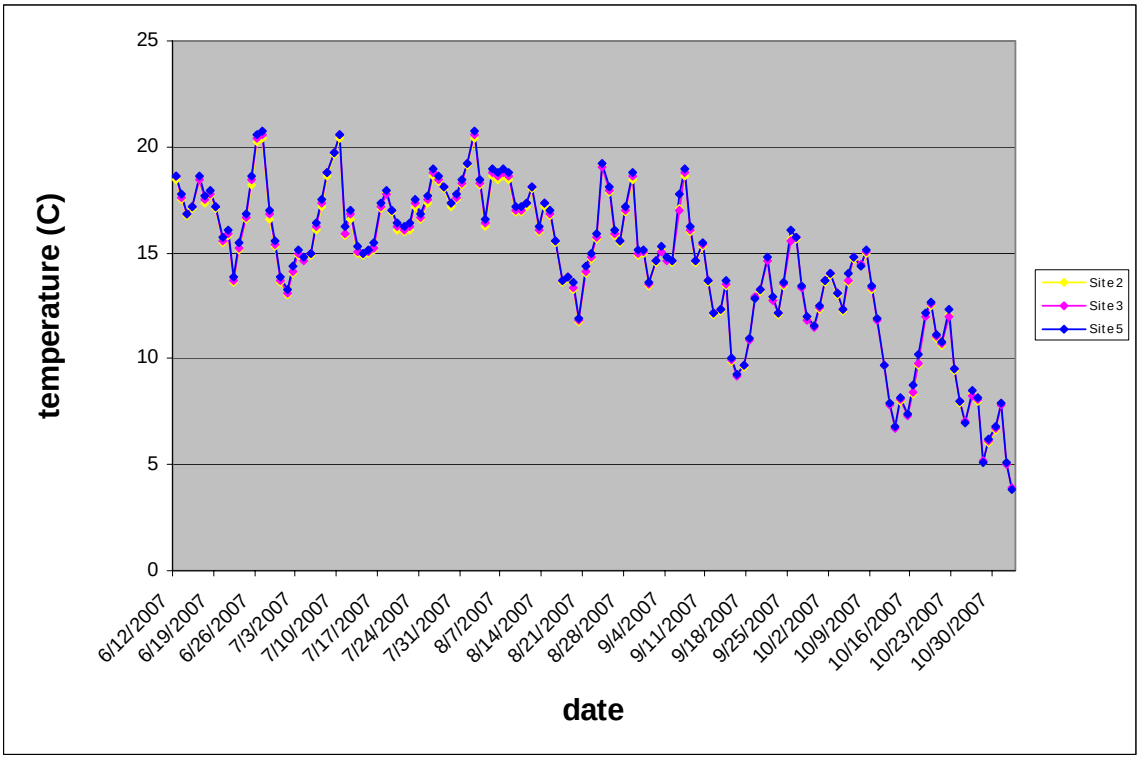


Figure 4: Minimum daily temperature. Sites are listed upstream (site 2) to downstream (site3).

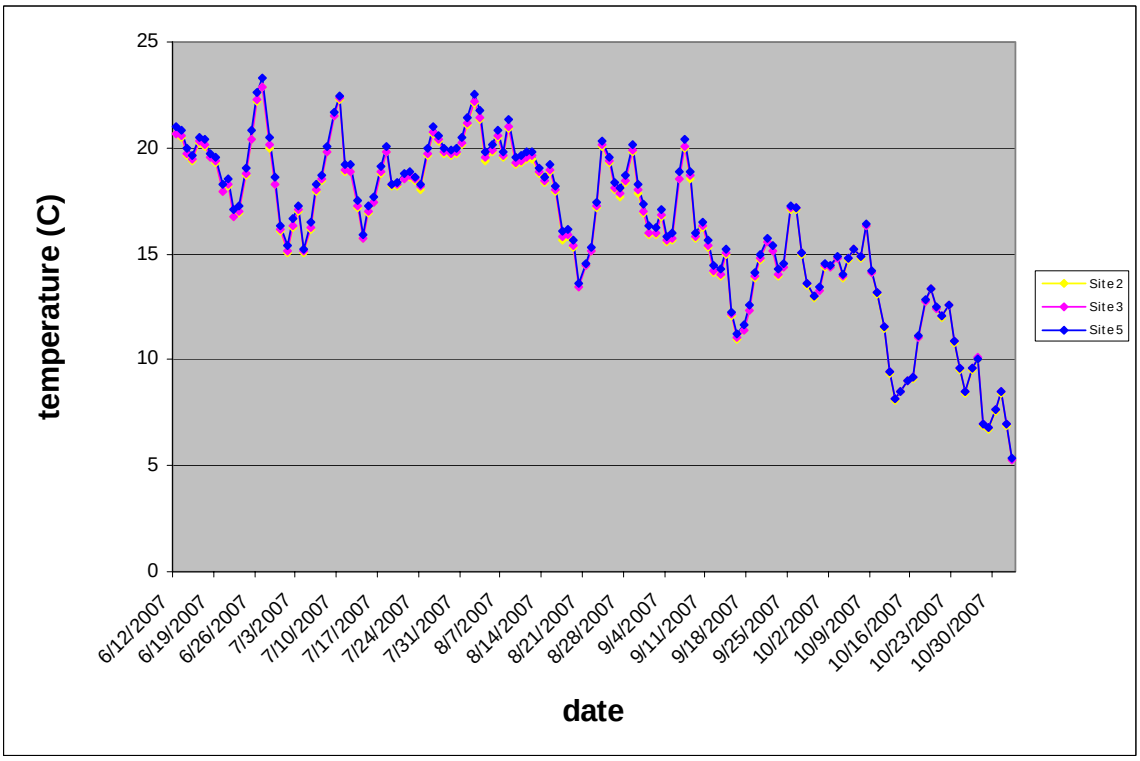


Figure 5: Average daily temperature. Sites are listed upstream (site 2) to downstream (site3).

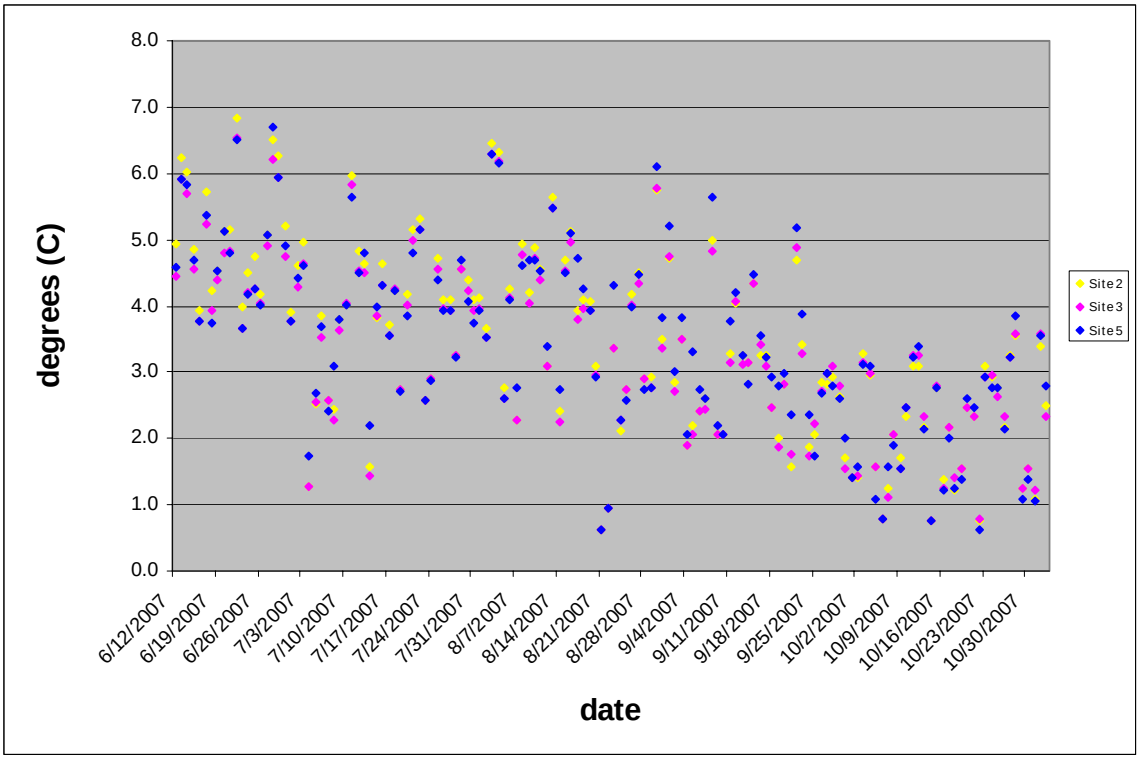


Figure 6: Daily range in temperature. Sites are listed upstream (site 2) to downstream (site3).

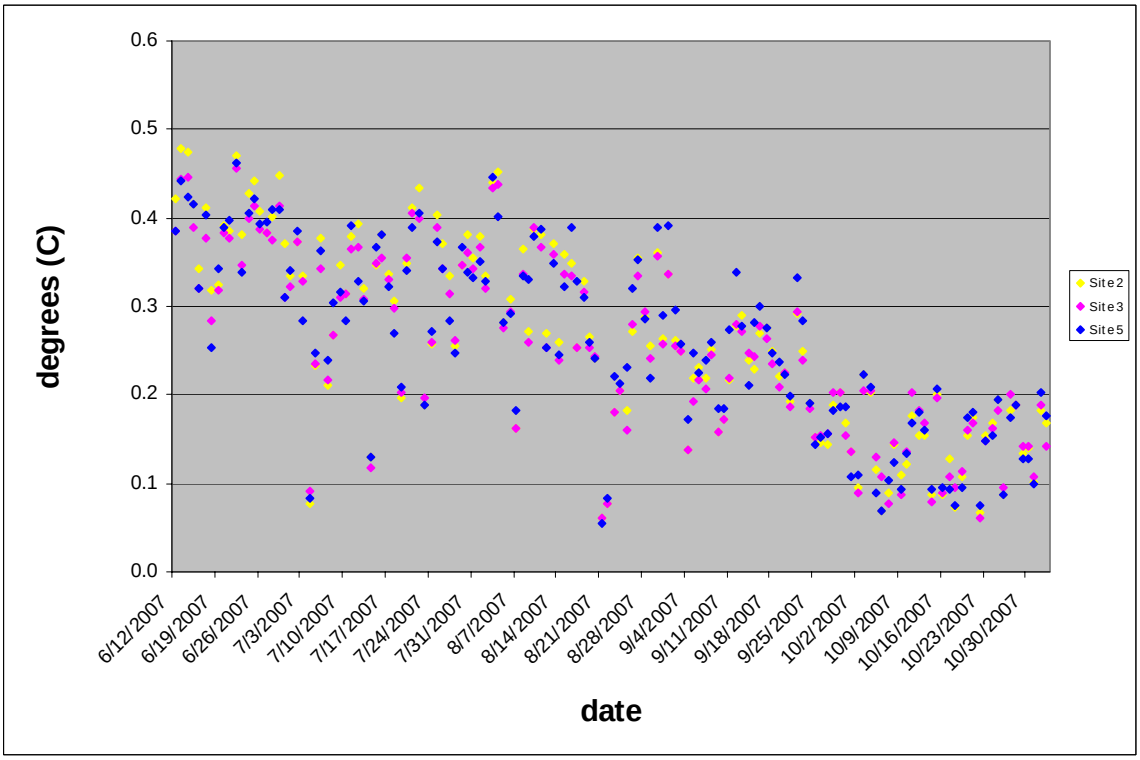


Figure 7: Daily average hourly rate of change in temperature. Sites are listed upstream (site 2) to downstream (site3).

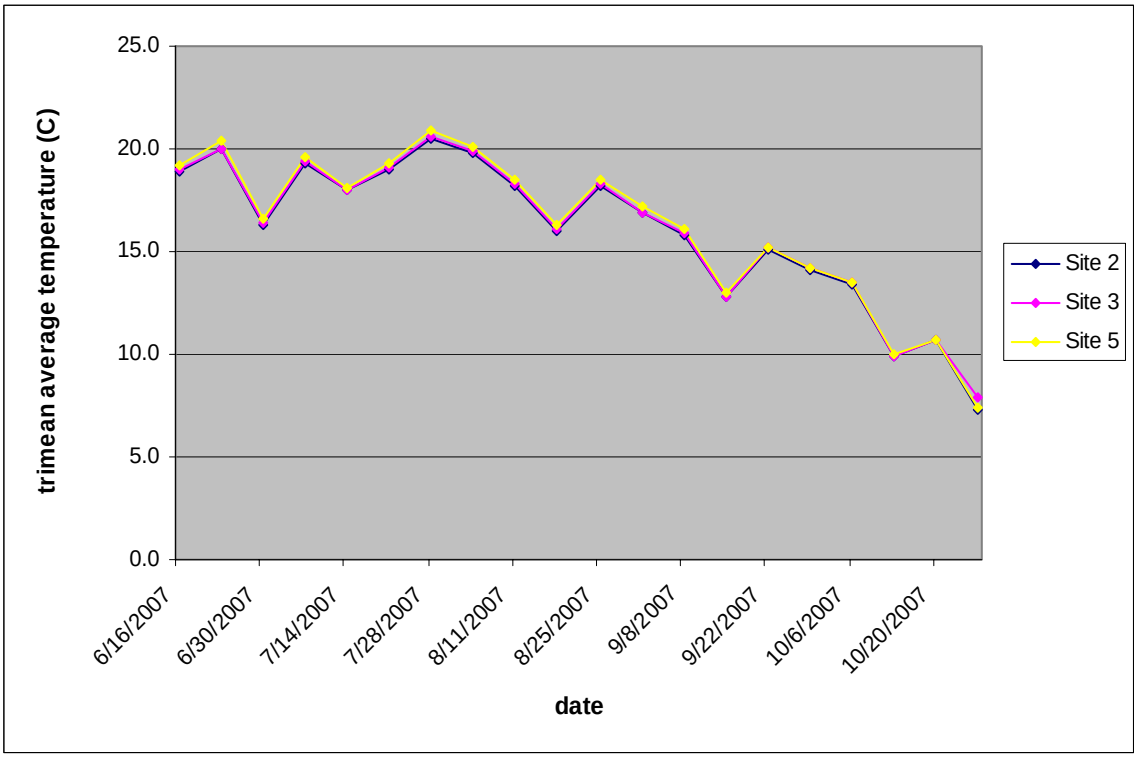


Figure 8: Trimean weekly average temperatures by site. Sites are listed upstream (site 2) to downstream (site3).

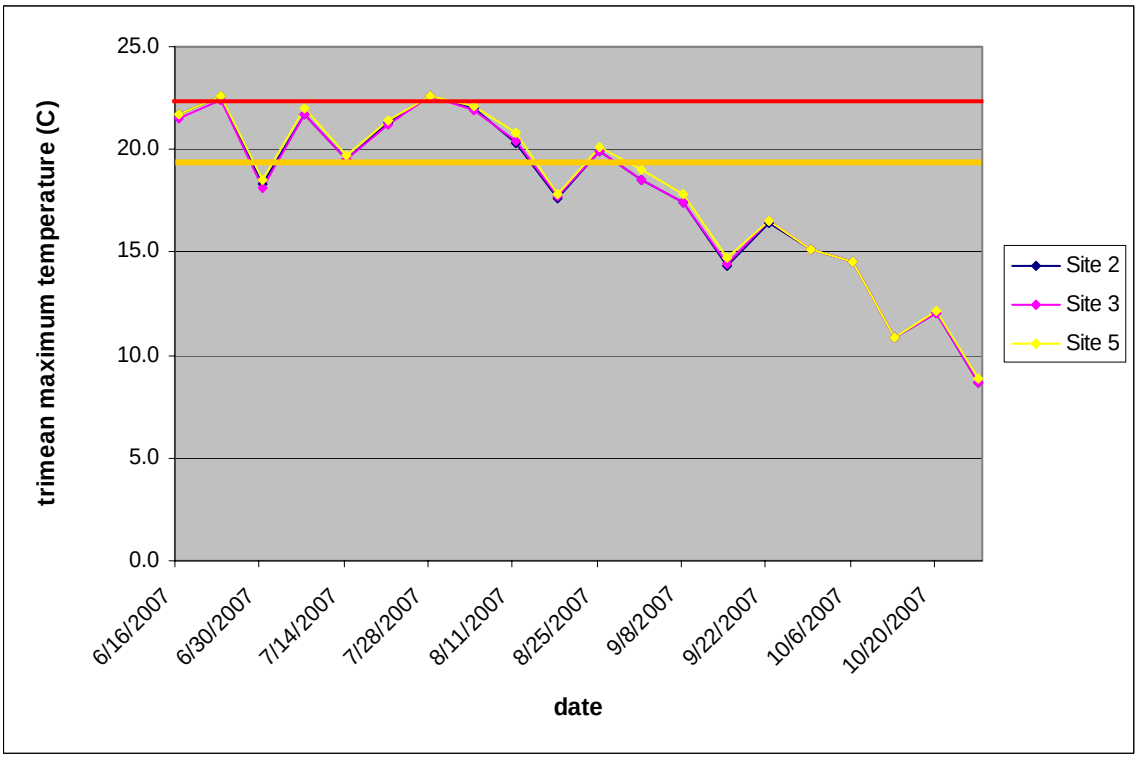


Figure 9: Trimean weekly maximum temperatures by site. The red line depicts the trimean equivalent of 22ºC, the orange line indicates the upper thermal optimum for brook trout and brown trout.

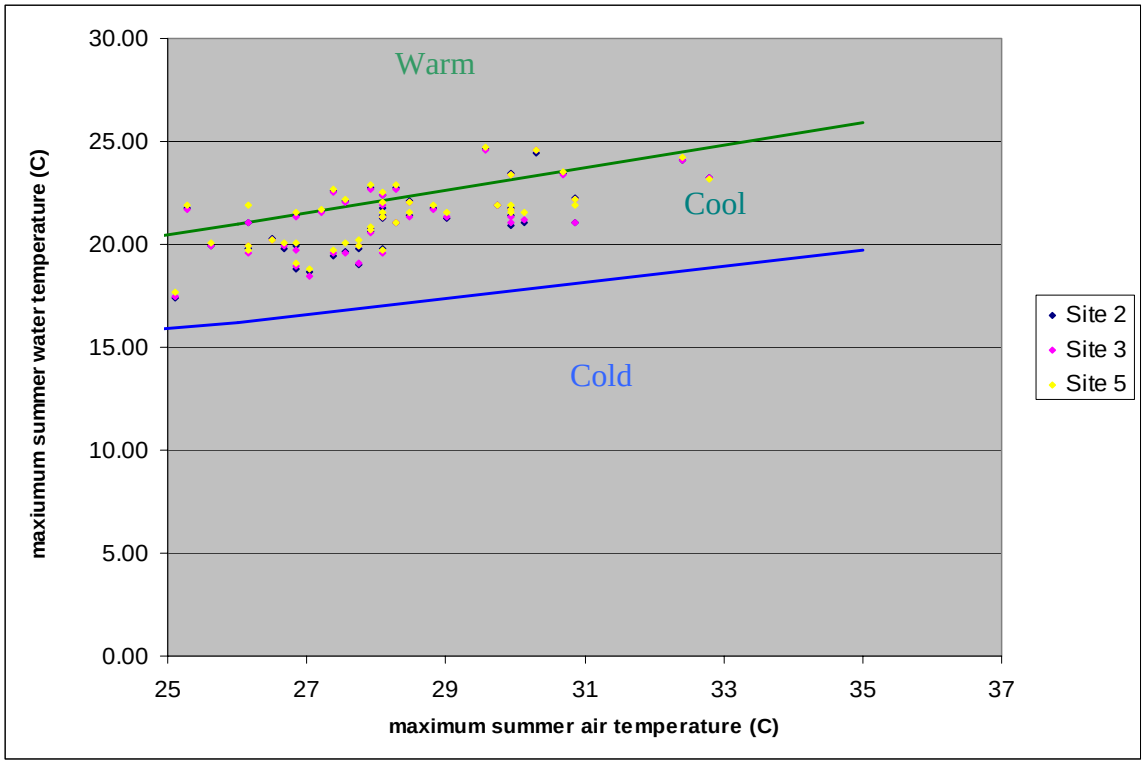


Figure 10: Stream classification of all sites (format from Stoneman and Jones 1996). Sites plotted below blue line classify as cold water, between blue and green classified as cool water and above green classified as warm water sites.

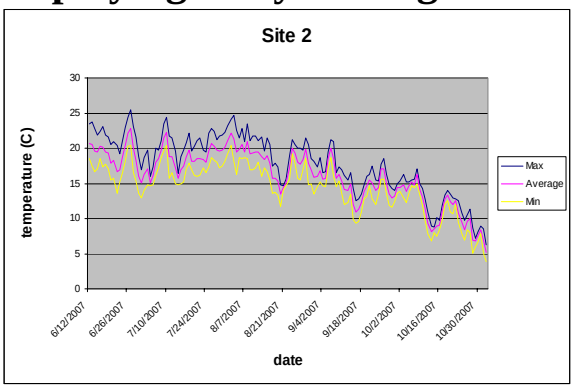
Implications

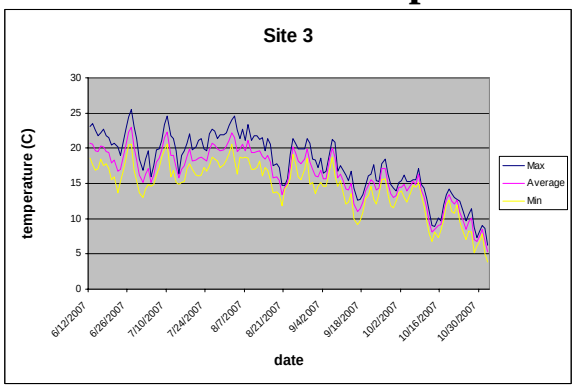
The data indicate that this system may be reaching temperatures capable of limiting the growth and production of brown trout. Additionally these temperatures would be lethal to brook trout. There is no observed variation in temperature among sites which indicates little groundwater input within the study area and also indicates no warming throughout this reach.

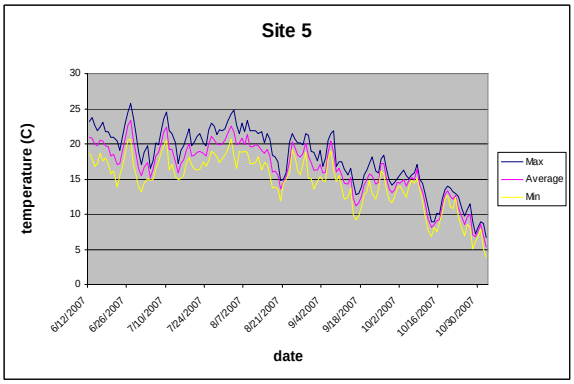
It would be prudent continue to monitor temperatures within this reach to account for the extreme weather conditions observed in 2007 (i.e. warm weather and drought conditions). In addition, to truly understand the causes of warming it is necessary to extend the monitoring upstream into the headwater sections of the creek.

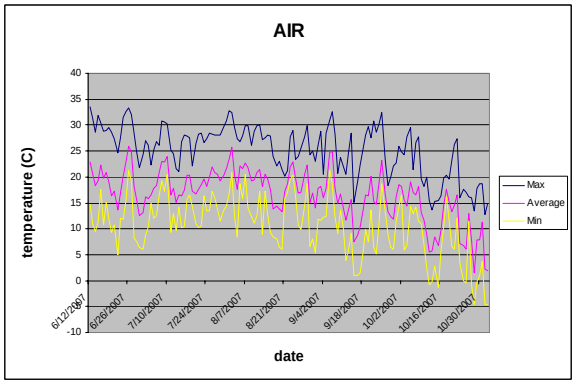
This watershed displays potential for the maintenance and enhancement of existing coldwater and cool-water communities. However, it is important to continue monitoring these sites in order to separate warming due to changes in the watershed from yearly natural fluctuations in temperature. Long term monitoring of this system will aid our understanding of the effects of the increase of braiding from surplus wood debris and resulting impoundment. In addition, long-term monitoring will aid in the identification of effectiveness of rehabilitation efforts in this system.

Appendix A Individual Site Data
Displaying Daily Average & Minimum/Maximum Temperatures









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