AN ANALYSIS OF STREAM TEMPERATURE PROFILES IN NORTHERN NEW HAMPSHIRE (2016)

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INTRODUCTION

Thermal stress from high water temperatures impacts the viability and distribution of coldwater fish. An analysis of stream water temperatures was used to identify the duration and extent of those periods considered lethal to sub-lethal for salmonids in New Hampshire. Coldwater fisheries are becoming increasingly vulnerable as changing thermal conditions threaten their future sustainability (Stitt et al. 2014). When adjusting management practices for these events, it is important to understand water temperature profiles for those rivers and streams sustaining or having the potential to sustain populations of salmonids. It has clearly been shown that water temperatures influence growth, behavior, survival, and distribution of trout and salmon (Cunjak and Green 1986, Ebersole et al. 2001, Selong et al. 2001, Workman et al. 2002). The objective of this study was to examine stream temperature ranges, identify present limitations, and analyze long term trends for salmonids. Understanding these temperature regimes and interpreting long range data sets may be the key in predicting the viability of trout and salmon in New Hampshire.

METHODS

During 2016*, Optic StowAway* thermographs (Onset Computer Corp©) were deployed at 23 locations in 5 different waterbodies throughout Coos County and Grafton County (Table 1).

Thermographs were deployed from June through September, and were programmed to record water temperature (°C) every hour. The units were housed in a protective case made of 1.5 in. diameter PVC pipe, capped on both ends and drilled with 1/4 in. diameter holes to allow water to flow through. The cases were attached to cement blocks with steel cable and placed in deep water behind large boulders to afford protection from heavy stream flows, as well as anthropogenic disturbance and exposure as water levels receded during the summer months.

Thirteen data loggers were deployed within the Dead and Swift Diamond Rivers, where a remote and unstocked watershed allows for a study of the relationship between temperature and Brook Trout (*Salvelinus fontinalis)* behavior (Figure 1). Within this watershed, temperatures have been monitored for over 15 seasons providing valuable data for predicting future trout abundance amid various climate scenarios.

Thirteen locations in the Saco River Watershed were monitored in 2016 to collect baseline data and determine limitations to salmonids throughout the year. This included nine sites on the Saco River, three sites on the Wildcat River, a single site on the Ellis River (Figure 2). Data was lost from three of the data loggers on the Saco due to human interference and not included in this study. Within this drainage, three sites on the Wildcat River and one on the Ellis River were sampled to evaluate current habitat conditions and explore their suitability for wild trout management.

Temperature data was checked for errors that may arise from logger malfunction, battery failure, or exposure of the unit to the air. Semi-drought conditions in 2016 resulted in subsequent low water levels and those data points deemed erroneous were not included in analysis.

RESULTS

Data collected from 21 units are summarized and mean July and August water temperatures are shown in Table 1. These months are considered the most stressful for coldwater fish and are scrutinized the most. Trends, fluctuations, and extremes are displayed in Figures 3 through 6.

Temperatures in the Dead Diamond River ranged from 12.2 to 25.3°C and averaged 19.3°C in 2016 while those in the Swift Diamond showed a larger range of 11.3 to 27.9°C but a slightly cooler average of 17.9°C. A seven-year trend within the Swift and Dead Diamond Rivers was evaluated and trends were tested for significance. Mean July and August water temperatures were compared from 2010 to 2016 and there were no statistically significant differences between annual group means as described by one-way ANOVA (p=.052) (Figure 5).

In the summer of 2016, the Saco River ranged in temperature from 11.2 to 26.1°C and averaged 19.2°C. Within the same watershed, the Wildcat River ranged from 12.3 to 24.7°C and averaged 18.0° C. Temperatures in the Ellis River ranged from 13.3 to 25.1°C and averaged 19.0°C.

DISCUSSION

Stream temperature is a common focus of study because of its importance in governing many instream processes (Johnson 2004). The information gathered in the 2016 season permitted direct comparisons among sites to illustrate differences in temperature ranges, minimums, maximums, and the extent and duration of temperatures that are stressful or lethal to various salmonids.

For many years, the New Hampshire Fish and Game Department has worked with several partners on projects related to fish habitat and water temperature. Water temperature data is a critical variable used when evaluating new management approaches or evaluating the overall health of an aquatic ecosystem. Building a long-term data set makes it possible to identify trends and fluctuations, and to quantify habitat suitability for salmonids in New Hampshire. This information will be useful when formulating trout management strategies and points out the limitations, from a temperature standpoint, to maintaining trout populations in natural environments. Although no known Brook Trout populations have been extirpated because of climate change effects (Hudy et al. 2008), studies such as this will serve as valuable data for predictive models in this area.

As a direct result of better understanding water temperatures throughout Coos County, management changes have been made on the Johns River, Carroll Stream, Nash Stream and the Swift Diamond River. The 2015 and 2016 temperature data collected in the Saco River watershed has proven to be an important factor while considering the future management of the fishery. Water temperature profiles for the Wildcat River shows no significant limitation for wild trout management and, coupled with an adequate biomass, may be a good candidate for such designation.

LITERATURE CITED

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Table 1. The Mean value of July and August Combined Water Temperature (MJAWT), Mean Value of July Water Temperatures (MJWT), and Mean Value of August Water Temperature (MAWT) and ranges observed in selected streams in Northern New Hampshire, 2016.

Stream	Town	Latitude	Longitude	MJAWT (SD) Range	MJWT (SD) Range	MAWT (SD) Range
Ellis River	Jackson	44.145079	-71.188246	19.0 (±2.3) 13.3 – 25.1	18.7 (±2.5) 13.3 – 25.1	19.3 (±2.1) 14.7 – 24.9
Wildcat dstr. Falls	Jackson	44.143725	-71.183758	19.1 (±2.3) 13.2 – 24.7	18.7 (±2.5) 13.2 – 24.6	19.4 (±2.0) 14.7 – 24.7
Wildcat River lower	Jackson	44.16199	-71.18623	18.3 (±2.2) 13.0 – 24.1	17.9 (±2.3) 13.0 – 24.1	18.7 (±1.9) 14.3 – 24.0
Wildcat River upper	Jackson	44.19461	-71.19419	16.7 (±1.7) 12.3 – 20.7	16.2 (±1.9) 12.3 – 20.6	17.1 (±1.3) 13.5 – 20.7
Saco 3 Willey House	Hart's Loc.	44.18144	-71.39847	16.1 (±1.6) 11.2 – 20.6	15.7 (±1.7) 11.2 – 20.1	16.4 (±1.5) 12.2 – 20.6
Saco 4 Sawyer	Hart's Loc.	44.07687	-71.322921	18.3 (±2.2) 12.4 – 24.5	18.0 (±2.3) 12.4 – 24.1	18.3 (±2.2) 12.4 – 24.5
Saco 5 Ellis	Bartlett	44.0955	-71.20325	19.9 (±2.3) 13.8 – 25.7	19.8 (±2.5) 13.8 – 25.7	20.1 (±2.1) 15.1 – 24.7
Saco 6 West Side Road	Bartlett	44.09616	-71.16819	20.3 (±2.1) 14.3 – 25.7	20.2 (±2.3) 14.3 – 25.7	20.4 (±1.8) 15.8 – 24.7
Saco 8 Country Club	Conway	44.04923	-71.14176	20.2 (±1.6) 15.2 – 24.3	20.0 (±1.8) 15.2 – 23.5	20.3 (±1.4) 16.7 – 24.3
Saco 9 Dahl Sanctuary	Conway	44.01000	-71.116667	20.8 (±1.9) 16.1 – 26.1	20.9 (±2.1) 16.1 – 26.1	20.8 (±1.6) 17.4 – 25.0
Dead Diamond Emerson Pool	2nd Col. Grnt	44.89431	-71.07861	19.8 (±2.2) 14.0 – 24.5	20.3 (±2.2) 14.7 – 24.4	19.4 (±2.1) 14.0 – 24.5
Dead Diamond Halfmoon	2nd Col. Grnt.	44.94295	-71.08484	19.5 (±2.3) 12.8 – 25.2	19.8 (±2.3) 13.9 – 25.0	19.1 (±2.2) 12.8 – 25.2
Dead Diamond Hellgate	Atk./Gil. Gnt.	44.97523	-71.11809	18.5 (±2.5) 12.2 – 25.5	18.8 (±2.5) 12.9 – 25.5	18.2 (±2.3) 12.2 – 24.6
Dead Diamond Management Ctr.	2nd Col. Grnt	44.88494	-71.07391	19.8 (±2.1) 14.2 – 24.5	20.3 (±2.1) 14.9 – 24.1	19.4 (±2.0) 14.2 – 24.5
Dead Diamond Monahan's	2nd Col. Grnt.	44.92418	-71.09215	19.5 (±2.3) 13.1 – 25.3	19.9 (±2.4) 14.2 – 25.3	19.1 (±2.2) 13.1 – 24.4
Dead Diamond Slewgundy	2nd Col. Grnt.	44.95994	-71.09441	18.7 (±2.1) 12.3 – 23.4	19.0 (±2.2) 13.6 – 23.4	18.4 (±2.0) 12.3 – 22.6
Swift Diamond River -upstr. conf	2nd Col. Grnt.	44.88206	-71.07272	19.7 (±3.1) 12.1 – 27.9	20.1 (±3.2) 12.3 – 27.4	19.4 (±2.9) 12.1 – 27.9
Swift Diamond River -HOR	2nd Col. Grnt.	44.88158	-71.08500	19.5 (±3.1) 12.0 – 27.6	19.8 (±3.3) 12.0 – 27.0	19.1 (±3.0) 12.0 – 27.6
Swift Diamond River 12 mile	Dix's Grant	44.91173	-71.23677	16.3 (±1.8) 11.3 – 21.4	16.2 (±1.9) 11.3 – 21.1	16.4 (±1.6) 12.2 – 21.4
Swift Diamond River below BDP	Dixville	44.94913	-71.30122	17.0 (±2.0) 11.4 – 22.3	16.2 (±1.7) 12.3 – 22.3	17.9 (±1.9) 11.4 – 21.9
Swift Diamond River Robber's R.	2nd Col. Grnt.	44.87648	-71.20943	17.0 (±2.6) 11.4 – 24.9	17.0 (±2.7) 11.4 – 24.4	17.0 (±2.4) 11.9 – 24.9

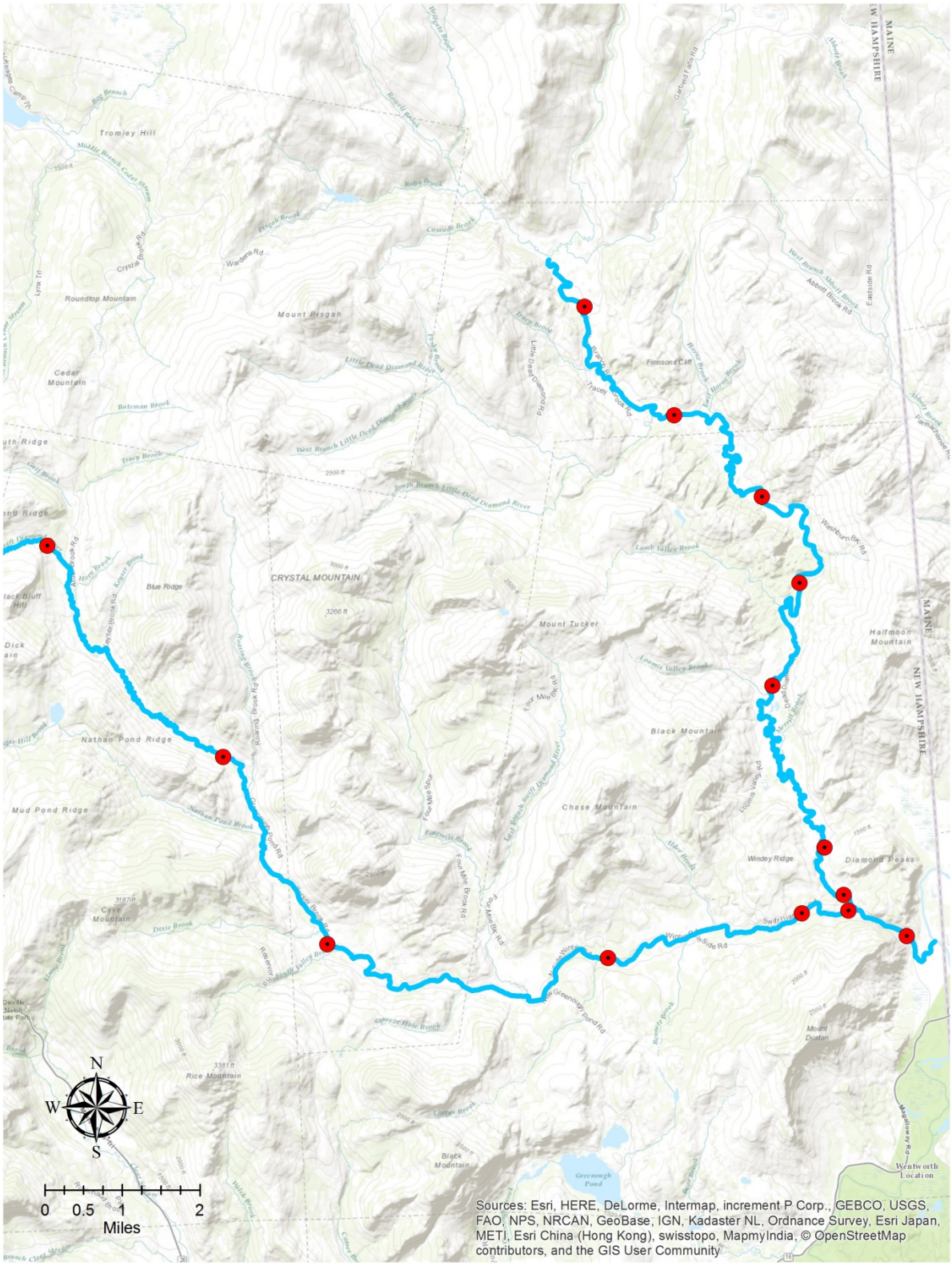

Figure 1. Temperature monitoring locations within the Dead and Swift Diamond Rivers in 2016.

Figure 2. Temperature monitoring locations within the Saco River watershed in 2016.

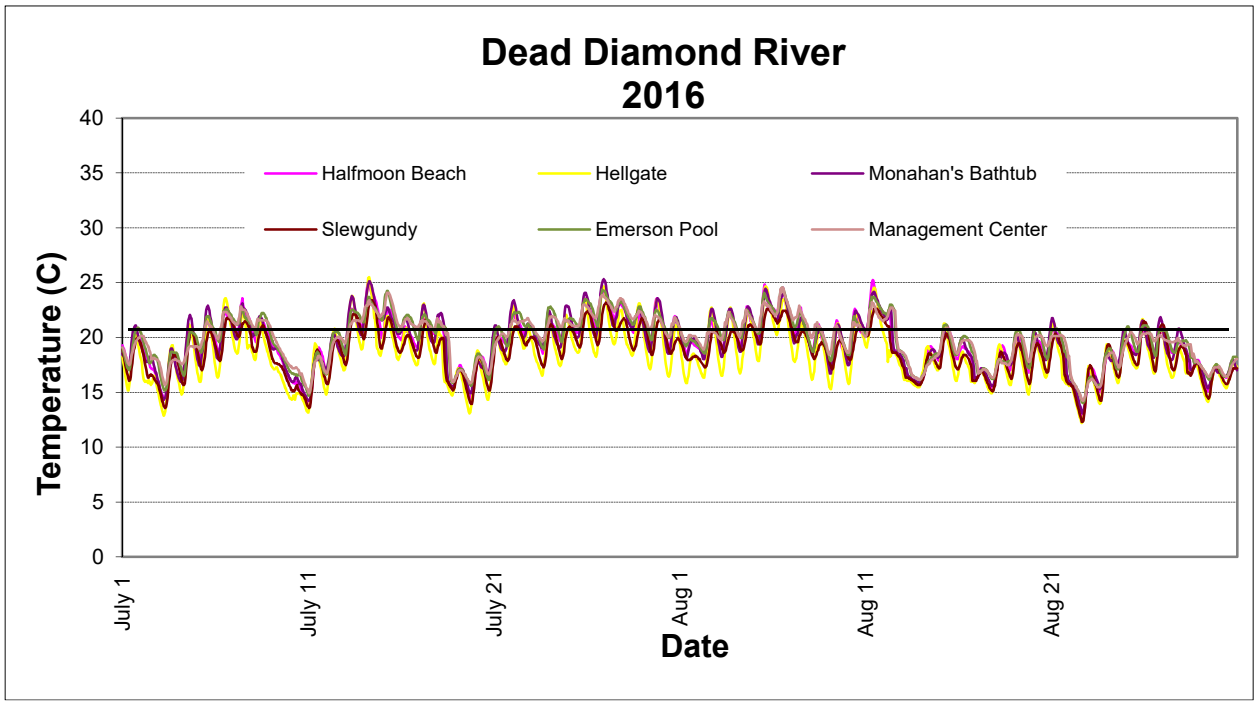

Figure 3. Stream temperature profile for the Dead Diamond River at six different sites, 2016.

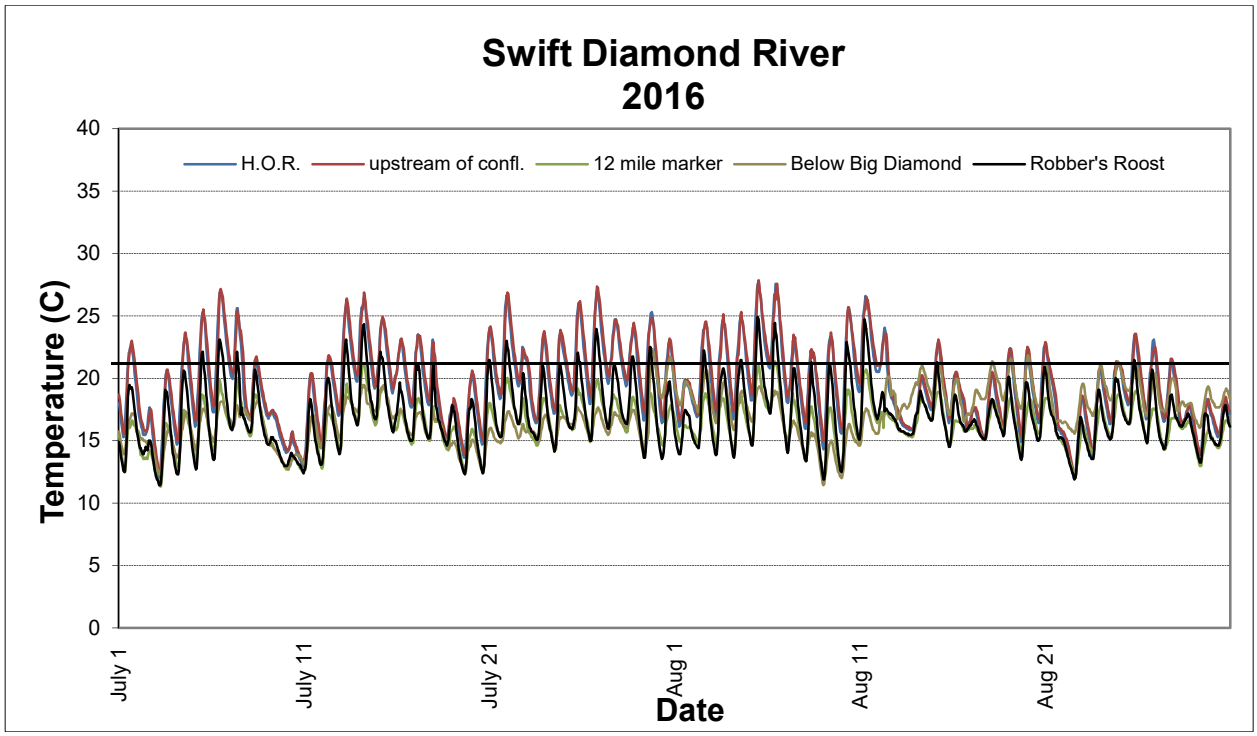

Figure 4. Stream temperature profile for the Swift Diamond River at five different sites, 2016

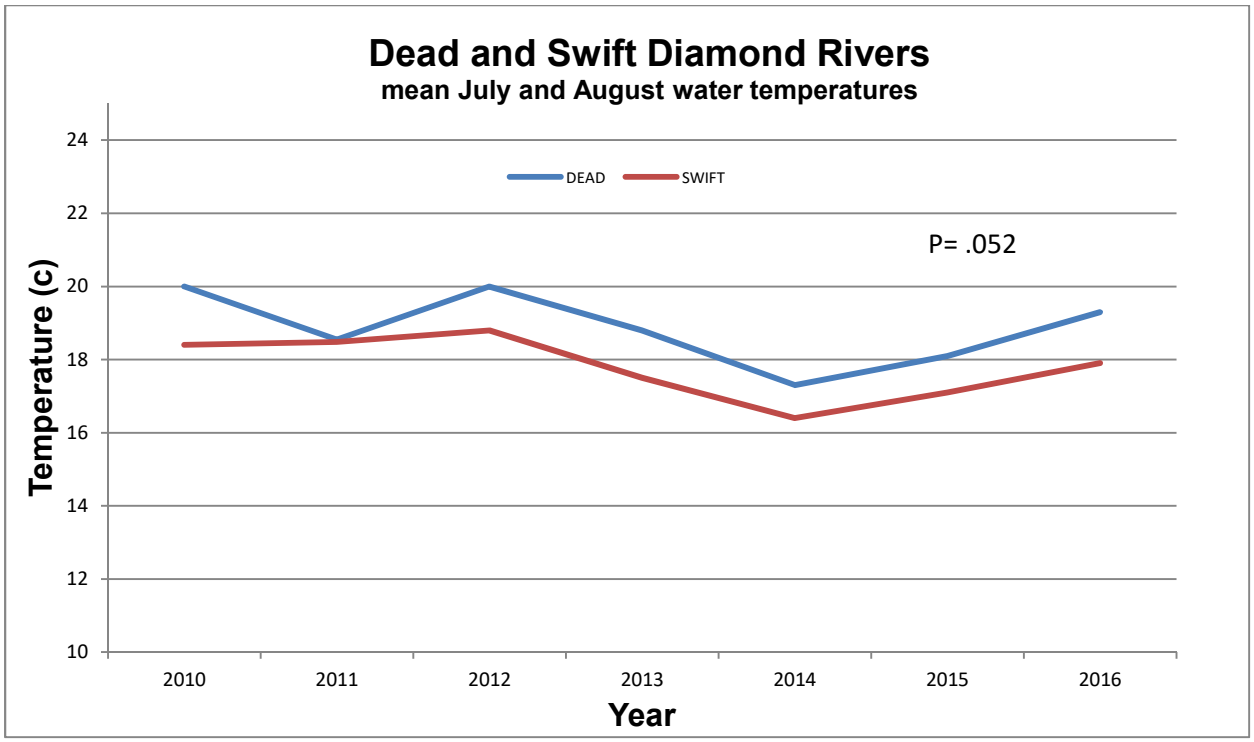

Figure 5. A seven-year trend in mean July and August water temperatures for the Dead and Swift Diamond Rivers.

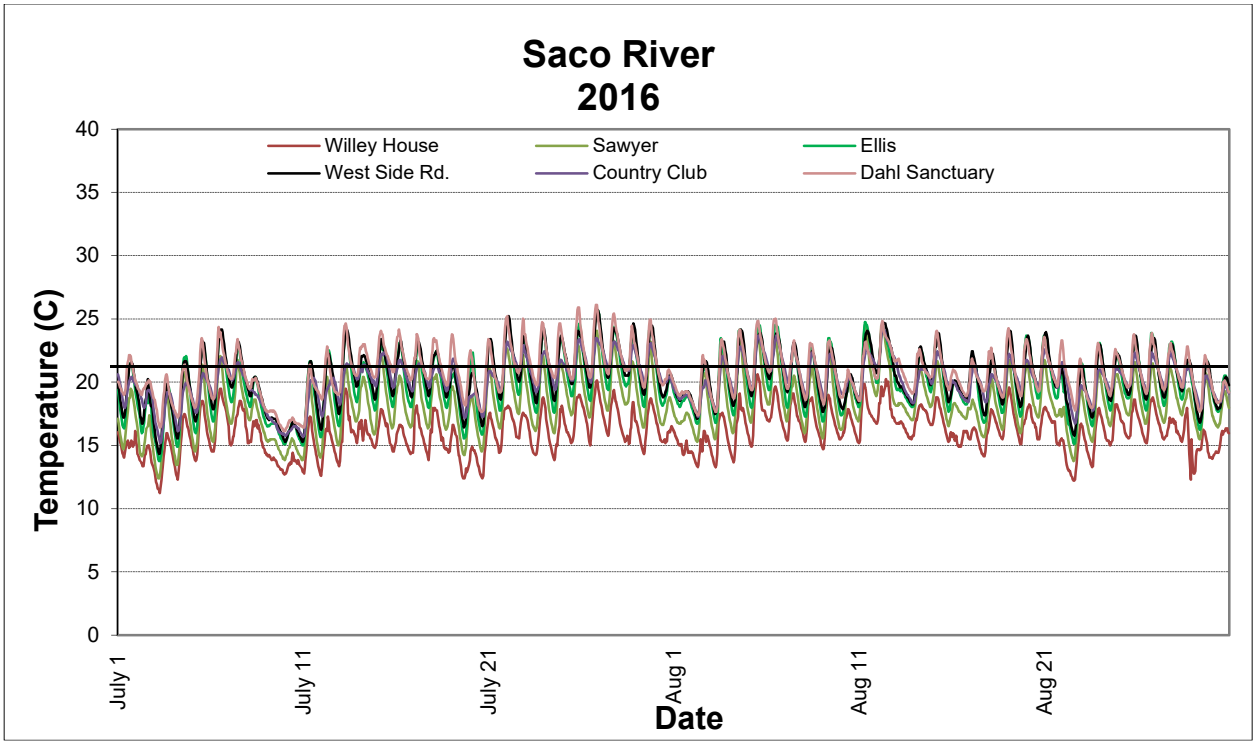

Figure 6. Stream temperature profile for the Saco and Ellis River at six different sites, 2016.

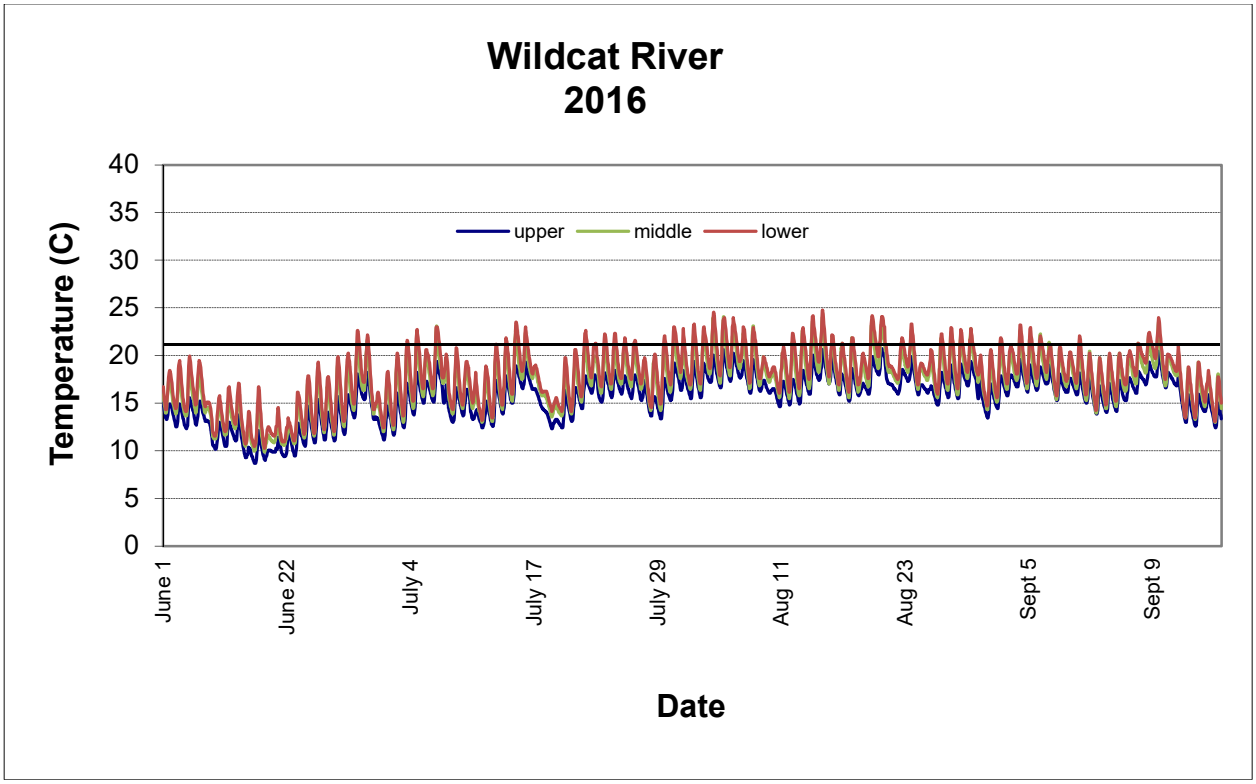

Figure 7. Stream temperature profile for the Wildcat River at three different sites, 2016