Water temperature study focused on the Cheticamp River and the Cheticamp reservoir

Summary report of 2018 investigation

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Background:

The Cheticamp River Salmon Association (CRSA) partnered with Parks Canada's Cape Breton Highlands National Park (CBHNP) in 2017 to inititate a water temperature analysis of the Cheticamp River and Cheticamp River reservoir. This study came on the heels of a five-year (2014-2017) instream restoration project focused on improving fish passage through critically over-widened sites along the lower Cheticamp River. Both were important and timely undertakings as climate change has been contributing to a trend of elevated water temperatures and decreased flows, conditions that are limiting factors for Atlantic salmon in the Cheticamp River.

Both the CRSA and its CBHNP collaborators agreed on the importance of continuing the water temperature investigation in 2018 in order to better understand findings from the 2017 study, including what appeared to be the presence of a small thermocline from the surface to the bottom in the Cheticamp River reservoir and a limited cooling effect from the Faribault Brook tributary, and to address a number of shortfalls of the first year of study, including an absence of data before August. This second year of data collection was made possible with funding from the Atlantic Salmon Conservation Foundation and the Nova Scotia Salmon Association's NSLC Adopt-a-Stream Program, and with RivTemp: A water temperature network for Atlantic salmon rivers in Eastern Canada as a collaborator. DFO (Cheticamp conservation/enforcement unit) and Rob LeBlanc (CRSA Director) also made generous In-kind contributions to the project, providing access to a boat and operator for multiple trips to the Cheticamp reservoir.

The remainder of this summary report provides an overview of what was accomplished in 2018.

Loggers and deployment:

The water temperature loggers used in the 2018 study were a combination of HOBO Water Temperature Pro v2 Data Loggers and HOBO 8k Pendant Data Loggers. As was the case in 2017, the water temperature loggers were programmed to record water temperature at one-hour intervals (on the hour, i.e., 1:00pm, 2:00pm, etc.) over the sampling period. The loggers were again installed in homemade protective housings made from PVC pipe with holes drilled to allow for water flow, weighted down with rocks and secured to fixtures such as trees or boulders using a combination of clothesline and rope. Deployment sheets were filled out when each logger was installed and later retrieved and included information such as depth of deployment and type of habitat (e.g., pool, riffle).

One of the goals of the 2018 water temperature study was to be able to collect data over a longer period, ideally having all loggers deployed by June 15th, 2018. This was considered important as loggers were not deployed until early August in 2017, resulting in a lack of data from the key time period of late June and July. In addition, the research team also hoped to be able to address a number of gaps in their 2017 dataset, including a lack of water temperature data from the upper river, as well as water temperature data from Aucoin Brook and Robert's Brook – two important tributaries on the lower Cheticamp River.

Having access to equipment and funding in place earlier in 2018, deployment of most of the water loggers occurred close to the target date of June 15th (see Table 1, below for dates of deployment). Between the CRSA and CBHNP, a total of sixteen water temperature loggers were deployed between June 14th, 2015 and July 4th, 2018 (12 by CRSA, 4 by CBHNP). Unfortunately, however, equipment issues resulted in water temperature data only being retrievable from thirteen loggers.

Location	Date deployed	GPS coordinates
Cheticamp Reservoir - bottom	June 18, 2018	46.65206, -060.66163
Below Dam	June 8, 2018	46.65167, -060.67353
Barrier Falls	July 4, 2018	46.624268, -060.77380
3rd Pool	July 3, 2018	46.63695, -060.87648
1st Pool	July 3, 2018	46.63301, -060.90554
Above Faribault Brook	July 3, 2018	46.63026, -060.92436
Petit Cap	July 3, 2018	46.64119, -060.94612
Above Robert's Brook	June 22, 2018	46.64345, -060.95089
Robert's Brook	June 27, 2018	46.64486, -060.94483
Warden's Station	July 14, 2018	46.64613, -060.95310
Above Aucoin's Brook	June 15th, 2018	46.65189, -060.96325
Aucoin's Brook	June 15th, 2018	46.65126, -060.96458
Terre Rouge/Tidal	June 15th, 2018	46.65845, -060.96225

Table 1. ***Locations and dates of deployment for successful water temperature loggers used in the 2018 Cheticamp River water temperature study.***

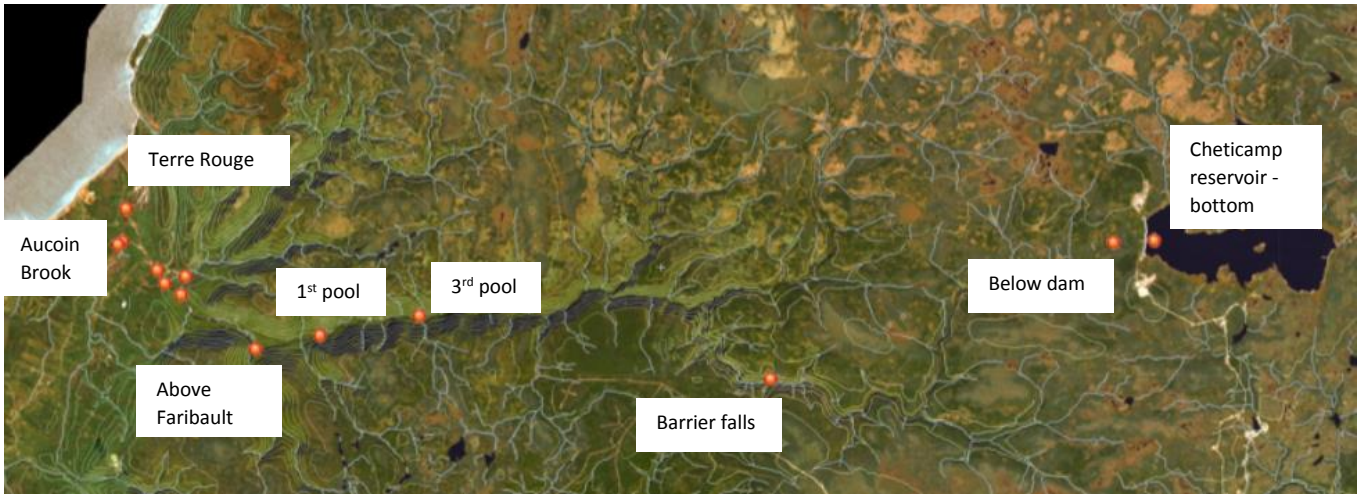

Figure 1. ***Map of Cheticamp River showing locations of water temperature loggers successfully deployed as part of the 2018 water temperature study. Image credit: James Bridgland, CBHNP.***

Results:

Water temperatures >20°C

Atlantic salmon, like other salmonids, are sensitive to water temperature and can begin experiencing stress and other negative impacts when water temperatures exceed 20 degrees Celsius. As such, the investigators used the data from the water loggers to determine the numbers of hours and locations where water temperatures exceeded 20°C.

While Table 2 allows for a comparison of logger locations, it is worth noting that, except for Robert's Brook, the water temperatures exceeded 20°C at all logger locations, including at the bottom of the Cheticamp reservoir. As expected, the highest temperatures, and most time with temperatures >20°C where at the logger locations in the lowest reaches of the river. At Terre Rouge, for example, where the river is wider and slower moving and there is a tidal influence, there were 1122 hours where temperatures exceeded 20°C in the 63-day comparison period between June 15th – September 15th (see Table 2, below). More surprising, the logger nearest to the headwaters, below Nova Scotia Power's D1 dam, recorded the second highest number of hours with temperatures above 20°C (704 hours). Unfortunately, an equipment failure involving the logger installed at the surface of the reservoir meant that no water temperature data was retrieved in 2018 for the surface of the reservoir. This lack of data meant the investigators were not able to confirm the existence of a thermocline between the surface and bottom of the reservoir. Despite the problems with the surface logger, it still appears, as was the case in 2017, that the water temperature at the outflow is closer to the surface water temperatures

than the temperatures at the bottom of the reservoir. 2019 data from the reservoir and outflow will be important to confirm and strengthen these 2018 results.

Logger	n (hrs)	n (days)	hrs T > 20	deg-hrs T > 20
Cheticamp Reservoir - bottom	1512	63	607	682
Below Dam	1512	63	704	1120
Barrier Falls	1512	63	641	979
3rd Pool	1512	63	355	336
1st Pool	1512	63	449	500
Above Faribault	1511	63	558	937
Petit Cap	1511	63	272	349
Chet River at Warden Station	1512	63	385	599
Chet River above Aucoin Brook	1512	63	651	1518
Aucoin Brook	1512	63	577	565
Terre Rouge/Tidal	1512	63	1122	3495

The 2018 data also allowed the investigators to confirm that water temperature decreases somewhat as it makes its way down to the barrier falls, likely due to the influence of the cold water being introduced by the 3 main upper tributaries (1st North East, 2nd North East and Artemise Brook). The data also reveals further cooling as it the river makes its way down the canyon to the Third Pool, before starting to warm through wider, shallower, and less shaded reaches from the Third Pool to First Pool and on to Faribault Brook. There are no tributaries of note in this section of the river.

Table 2. ***Number of hours and degree hours where water temperatures exceeded 20 degrees Celsius at logger locations where sufficient data exists to allow for comparison for period between June 15th and September 15th, 2018. Table credit: James Bridgland, CBHNP.***

Also somewhat surprising is the cooling that the data continues to reveal between Faribault Brook and Petit Cap (located 1 kilometer downstream). The research team installed water temperature loggers on the main river above Faribault Brook, on the lowest reach of the tributary, at the confluence of the Cheticamp River and Faribault Brook, and on the main river below Faribault Brook in order to try to

investigate the suspected cooling influence of Faribault Brook on the Cheticamp River. Analysis of the data from these loggers revealed, however, that at least in 2017, Faribault Brook appeared to have little, if any, significant cooling effect on the main river. If the cooling between the loggers above Faribault Brook and at Petit Cap observed in 2018 is not a result of Faribault Brook, it suggests that other cold-water sources are responsible***. Note: identifying these and other cold-water sources is part of a follow-up collaborative project between the CRSA and CBHNP planned for 2019.***

The 2018 data confirms that water temperatures continue to increase down the lower river to the estuary. Any cooling influence of Aucoin Brook is also minimal, as expected given that the lower reaches of the tributary are characterized by slow moving water through a long stretch of open marsh.

Precipitation

Given the relationship between low water conditions and water temperature, the CRSA also continued to look at rainfall amounts as part of its investigation into water temperatures on the Cheticamp River. Using monthly historical data available from Environment Canada's online database, the CRSA focused on monthly precipitation amounts for the crucial months for Atlantic salmon on the Cheticamp River – June, July, and August.

Although a complete dataset is not accessible, what data is available reveals an overall trend of decreasing monthly precipitation amounts across the summer months. While the total summer precipitation for 2018 appears high, this is due to an unusually wet June, where several big rains (e.g., 47.1mm on 19th of June and 56.3mm between June 24th - June 26th) contributed to a monthly total of 196.mm, the highest monthly total within the dataset. Beyond June, 2018 was another dry summer, with the total precipitation for July and August (141.7mm) the third lowest in the dataset (driest was 2012 with 104.4mm, followed by 2016 with 138.1mm).

	2006	2008	2010	2012	2014	2016	2017	2018
June	**92.8**	**104.3**	**174**	**23.1**	**55.6**	**63.1**	**33.6**	**196.7**
July	**142.1**	**94.2**	**79.9**	**40.7**	**58.1**	**72.8**	**26.4**	**59.7**
August	**126.6**	**146**	**72.3**	**63.7**	**105.5**	**65.3**	**122.2**	**82**
Total	**361.5**	**344.5**	**326.2**	**127.5**	**219.2**	**201.2**	**182.2**	**337.7**

Table 3. ***Total precipitation (mm) in Cheticamp, Nova Scotia during summer months. Note, some data is incomplete.***

Next steps:

The Cheticamp River Salmon Association and Cape Breton Highlands National Park are looking to continue their partnership on the Cheticamp River water temperature study in 2019. The failure of some important temperature loggers – in particular, the surface logger at the Cheticamp reservoir – left gaps in the data, and another year of data collection will allow for more confidence when identifying patterns and trends. By bringing in new partners, the CRSA and CBHNP are also looking to be able to expand the scope of their study. For example, Dr. Barret Kurylyk at Dalhousie University's Centre of Water Resource Studies has expressed interest in a collaboration in 2019, with the goal of expanding the dataset with drone and DTS temperature data collection, as well as doing some deterministic modeling and attempting to address 'what-if' scenarios of climate change and thermal management options. In addition, the CRSA will be working with the Atlantic Water Network in 2019, a partnership that will involve access to additional resources and important data sharing opportunities to allow for comparisons with other rivers in the southern Gulf of Saint Lawrence.