Allagash Wilderness Waterway Foundation
Coldwater Fishery Habitat Temperature Monitoring Project
2022-2024 Summary

Native, wild brook trout occur throughout the Allagash Wilderness Waterway (AWW) and its tributaries. Cool, clear, well-oxygenated water is essential for brook trout to thrive, and water temperature is a key factor in determining suitable habitat. Studies of brook trout thermal tolerance reveal that water temperatures less than 68^0 F provide high value habitat for brook trout, temperatures greater than 68^0 F initiate thermal stress, and temperatures above 73.4^0 F are considered unsuitable for brook trout.

Historical water temperature information recorded at the USGS Allagash River gaging station near the Town of Allagash near its confluence with the St. John River reveals that summer water temperatures in the river have increased since they were first monitored beginning in 1975.

USGS Allagash River Gage near Allagash Watershed Area 1,228 mi^2		
Time Period	July	August
1975-1980 Average	68.7^0 F	66.7^0 F
2010-2015 Average	70.5^0 F	69.6^0 F
2022	71.6^0 F	71.2^0 F
2023	74.3^0 F	66.6^0 F
2024	72.1^0 F	70.5^0 F
2022-2024 Average	72.7^0 F	69.4^0 F
Increase in 2022-24 avg. over 1975-80 avg.	***+4.0^0 F***	***+2.70 F***

With evidence of a warming climate a major concern over its effects on many native plant and animal species, information on current water temperatures throughout the AWW is necessary to assess current conditions in its tributaries, their vulnerability to temperature increases from a warming climate, and for their potential to maintain conditions that will allow AWW brook trout populations to adapt to anticipated temperature increases.

In 2022, the Allagash Wilderness Waterway Foundation (AWWF) initiated a project to document temperatures in AWW tributaries to the lakes and river that comprise the AWW. The Waterway above Allagash Falls was chosen for study as the falls constitute a barrier to several non-native fish species that are currently present downstream. Brook trout populations throughout the Allagash watershed above the falls remain intact and only minimally affected by nonnative species introductions. During the first 3 years of the project remote temperature data loggers have been deployed in 21 tributaries, from Telos Lake at the southern end of the Waterway to the Michaud Farm in the north: 10 in tributaries to the headwater lakes, 11 in

tributaries to the Allagash River north of the lakes. Water temperatures were also monitored at four locations in the Allagash River, and AWWF has provided financial support to the USGS for continued water temperature monitoring at the gaging station in the lower reaches of the river. Initial analysis of the results for this summary has focused on water temperatures during July and August, the warmest two months of the year.

The following table presents the percentage of July and August days in 2022 and 2023 with average temperatures greater than or equal to 68^0 F and 73.4^0 F recorded at four locations in the Allagash River between Churchill Dam and Allagash Falls.

	Watershed Area (mi^2)	% Days Avg. GE 68^0F	% Days Avg. GE 73.4^0F
Allagash River at Bissonnette Bridge	325	90%	45%
Allagash River at Henderson Bridge	722	97%	55%
Allagash River at Ramsay Ledge	1,020	58%	40%
Allagash River at Michaud Farm	1,025	72%	57%

The river's mid-summer water temperatures at all four sites monitored are in the range considered thermally stressful and potentially lethal for brook trout, requiring them to seek cooler areas. With its large watershed area, the Allagash is a wide river fully exposed to warming by both air temperatures and solar radiation. Its flow originates from the surface water of Churchill Lake, Long Lake, and Round Pond. Therefore, warm summer water temperatures are not surprising, and are by no means a recent phenomenon. Before the AWW was established, in a 1960 report[1] Maine Fish and Game Regional Fishery Biologist Kendall Warner wrote:

"The Allagash River and tributaries probably support one of the finest river fisheries for brook trout in the United States. Habitat conditions are superior for brook trout. Occasional deadwaters are present, but the majority of the river is a series of boulder and rubble riffles, pools, and flats. This habitat provides ideal conditions for feeding, growth and survival of brook trout during spring and early summer periods when water temperatures remain cool. During hot periods, trout migrate to areas of cooler waters to survive. A cool water supply is provided by spring holes and mouths of cold tributary brooks. The Allagash has excellent tributary systems and very good facilities for warm period carry-over of brook trout."

Sixty-Five years later Warner's description holds true. The water temperatures recorded in 2022 and 2023 at four locations in the Allagash River confirm that when summer temperatures

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[1] Kendall Warner,''Preliminary Report on the Effects of the Proposed Rankin Rapids Dam on the Fisheries of the Upper St. John River Basin," (rev.: Augusta: Maine Department of Inland Fisheries and Game, 1960), pp. 9-11 (Mimeographed.)

become too warm over extended periods of time brook trout must rely on cool water provided by its tributaries, or areas along its course influenced by springs. From 2022 - 2024, monitoring in 11 of the 19 named tributaries between Long Lake and the Michaud Farm at their confluence with the Allagash River indicates that ten are providing sources of cool water capable of sustaining brook trout during the warmest periods of the summer. The following table indicates the percentage of July and August days when Allagash River tributaries, from south to north, recorded temperatures greater than or equal to 68^0 F that begin to stress brook trout, and the percentage of days when maximum water temperatures attained levels approaching the lethal limit for brook trout.

Tributary from the East (E) or West (W)	Watershed Area (mi^2)	% Days with **Average** Temperatures GE 68^0 F	% Days with **Maximum** Temperatures GE 68^0 F	% Days with **Maximum** Temperatures GE 73.4^0 F
Sweeney Brook – E	3.7	0%	10%	0%
Harding Brook -W	14.7	0%	10%	0%
Whittaker Brook -W	15.6	1%	16%	2%
Schedule Brook – W	24.7	8%	41%	8%
Savage Brook – W	5.3	0%	5%	0%
Musquacook Stream – E	156.0	42%	58%	21%
Five Finger Brook – E	32.0	7%	45%	7%
McKinnon Brook – W	9.6	1%	7%	0%
Ben Glazier Brook – W	17.3	0%	10%	0%
Ramsay Brook – E	11.7	0%	0%	0%
Farm Brook - W	17.7	0%	2%	0%

Tributaries with larger watersheds tend to be warmer than those with smaller watersheds. Air temperatures and canopy cover providing shade play major roles in regulating stream water temperatures, and streams with larger watersheds are wider and more exposed to both air temperature and solar radiation than those with smaller watersheds. Other factors influencing stream water temperatures include their gradient, volume of flow, width to depth ratio, inputs from groundwater, and especially the presence of deadwaters and or beaver flowages that occur along their length.

Musquacook Stream, the largest tributary and the only one originating as the outlet below a series of large lakes, does not appear to provide water temperatures suitable as thermal refuge in its lower reaches, however it does provide access to smaller, likely cooler tributaries upstream in its watershed. Sweeney, Harding, Whittaker, Savage, McKinnon, Ben Glazier, Ramsay, and Farm brooks consistently provided sources of cool water when summer conditions in the river were unfavorable. Maximum daily temperatures at Schedule and Five Finger brooks exceeded the 68^0 threshold more often than in the other 8 tributaries. However, their average daily temperatures exceeded 68^0 only 7% to 8% of the time, indicating that when higher

temperatures occurred, they were not long lasting. Both brooks support trout populations throughout the summer upstream in their watersheds, and both are of a size capable of providing flows that would allow trout from the river to access their upstream areas.

It is important to note that the temperature loggers in this project were located at the lowest point in the tributaries' watersheds where they recorded temperatures as they entered the AWW. Water temperatures can vary significantly within individual streams along their lengths, and these data do not take into account any sources of cooler water that may be located higher in the watersheds.

The following table presents the percentage of July and August days with average water temperatures greater than or equal to 68^0 F in the lake tributaries monitored, and maximum water temperatures greater than or equal to 68^0 F and 73.4^0 F.

	From East (E) or West (W) a Tributary to	Watershed Area (mi^2)	% Days with Average Temperatures GE 68^0 F	% Days with Maximum Temperatures GE 68^0 F	% Days with Maximum Temperatures GE 73.4^0 F
Upper Allagash Stream	W-Allagash Lake	69.0	27%	45%	8%
Telos Stream	W-Telos Lake	16.0	23%	69%	23%
Upper Ellis Brook	W-Chamberlain Lake	15.0	65%	81%	50%
Lower Ellis Brook	W-Chamberlain Lake	24.1	52%	81%	42%
Lower Allagash Stream	W-Chamberlain Lake	96.0	81%	95%	54%
Thoroughfare Brook	W-Churchill Lake	42.7	19%	41%	5%
Churchill Brook	W-Churchill Lake	8.9	4%	23%	1%
Pleasant Stream	E-Churchill Lake	20.7	60%	92%	48%
Glazier Brook	E-Long Lake	23.2	3%	34%	0%
Grey Brook	W-Long Lake	5.2	0%	6%	0%
Shepherd Brook	E-Long Lake	15.9	0%	8%	0%

Water temperatures monitored in the AWW's headwater lake tributaries demonstrated a wide range of thermal regimes. The lake tributaries also demonstrate a relation between their watershed areas and their summer water temperatures. Allagash Stream, the tributary to Allagash Lake, was monitored only in 2023 which saw the warmest July of the 3 years, and the coolest August. Additional monitoring there would be helpful in assessing its contribution to Allagash Lake. Chamberlain Lake tributaries, Ellis Brook and Allagash Stream, commonly exceeded 68^0F for extended periods of time and therefore cannot be considered sources of cool water. Upstream ponds and a lake are the sources of water for Ellis Brook and Allagash Stream, and warm surface water flowing into these tributaries is largely responsible for their warm temperatures. Telos Brook, though not as warm, also cannot be considered a reliable source of cooler water for Telos Lake.

Churchill Lake tributaries varied in importance as cool water sources. Pleasant Stream, originating from Pleasant Lake and flowing through several deadwaters, is not a cool water source. With its large watershed, Thoroughfare Brook does not serve as a consistent cool water source. Although maximum water temperatures in Churchill Brook exceeded 68^0 for a considerable number of days, based on its average summer temperature it appears to be providing a reliable source of cool water.

In considering the AWW headwater lakes above Churchill Dam it is important to note that their brook trout populations need not rely on tributaries as summer thermal refuges. In these thermally stratified lakes cool, oxygenated water in their depths below their thermoclines provide habitat for brook trout survival during the summer. Late summer 2024 temperature and oxygen profiles taken by IF&W regional fishery biologists indicate that conditions at depths greater than 20 -25 feet in all of the headwater lakes remain suitable for supporting their brook trout populations through the summer months.

North of Churchill Dam, with a change in the topography of the land and the absence of lakes or ponds in their headwaters, the tributaries to Long Lake are considerably cooler than those south of Churchill Dam. Glazier, Grey, and Shepherd brooks are all sources of cool water.

Results of this project to date have documented the extent to which tributaries to the Allagash River are providing important sources of cool water to sustain brook trout in the river during the summer months. They indicate that due to warmer water temperatures in the headwater lakes' tributaries, in the summer their brook trout populations must rely on the cool water found in their depths as thermal refuges. With little historical information on water temperatures in AWW tributaries, any changes in their thermal regimes that have occurred over the 59 years since the AWW was established cannot be determined. The results of this project to date will contribute to establishing a baseline for each tributary from which future changes can be determined and measured. Considerable differences in both temperatures and precipitation were observed from 2022 to 2024. To consider the annual variation in northern Maine's summer weather conditions, additional years of water temperature information will provide a more accurate baseline for the thermal conditions currently provided by the tributaries that have been monitored to date. Therefore, the Allagash Wilderness Waterway Foundation plans to continue this project through 2026.