Water temperature-related fishery closures for Atlantic Salmon

Literature review and recommendations for the Restigouche River



September 2025

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Conseil de Gestion du Bassin-Versant de la Rivière Restigouche Inc
Restigouche River Watershed Management Council Inc

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INSTITUTE OF NATURAL UNDERSTANDING

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1. Introduction

Water temperature is increasing in many rivers in Eastern Canada, leading to more frequent periods of warm water events during the Atlantic salmon (*Salmo salar)* angling season (Breau 2013; Van Leeuwen et al. 2020). During these warm periods, salmon concentrate around cold-water refuges and in pools (e.g., O'Sullivan et al., 2021). With the decline of salmon abundance in the last decades, catch-and-release angling has become more prevalent in Eastern Canada rivers, allowing recreational fisheries to remain while preserving salmon populations (DFO, 2022). However, recent evidence suggests that catch-and-release fishing can result in post-angling mortality, especially during warm water periods. This led to the development of water temperature-related fishery closures (or warm water protocols) and their application in some rivers where population abundance is not meeting conservation requirements (DFO, 2012), with the challenge to optimize trade-offs between socio-economic benefits of angling and salmon conservation.

In this context, the objective of this study is to summarize up-to-date science regarding the following issues:

- The biological requirements for Atlantic salmons in terms of thermoregulation: temperature thresholds, delay of recovery, cumulative effects of thermal stress
- The impacts of catch-and-release on Atlantic salmons during warm periods
- The effects, pros, and cons of water temperature-related fishery closure scenarios

Finally, and based on this information, the goal is to propose specific recommendations for the case of the Restigouche River.

2. Tolerance of Atlantic salmon during high water temperatures periods

2.1. General thermal sensitivity

This limited range of temperature for cold-water fish is species- and population-specific. Salmonids (trout, salmon, charr) have generally the lowest thermal tolerance of many fish groups, and of the salmonids, the Atlantic salmon has the highest temperature tolerance (Elliott & Elliott, 2010). However, this thermal tolerance (or inversely, thermal sensitivity) is also life stage-specific whereby adult salmonids prefer lower temperatures than juveniles (McCauley & Huggins, 1975) and are less tolerant to high temperatures (Fowler et al., 2009).

The relative thermal tolerance for different life stages of Atlantic Salmon as determined based on a literature review of field studies and controlled laboratory studies (Gillis et al., 2023), is depicted on Figure 1.

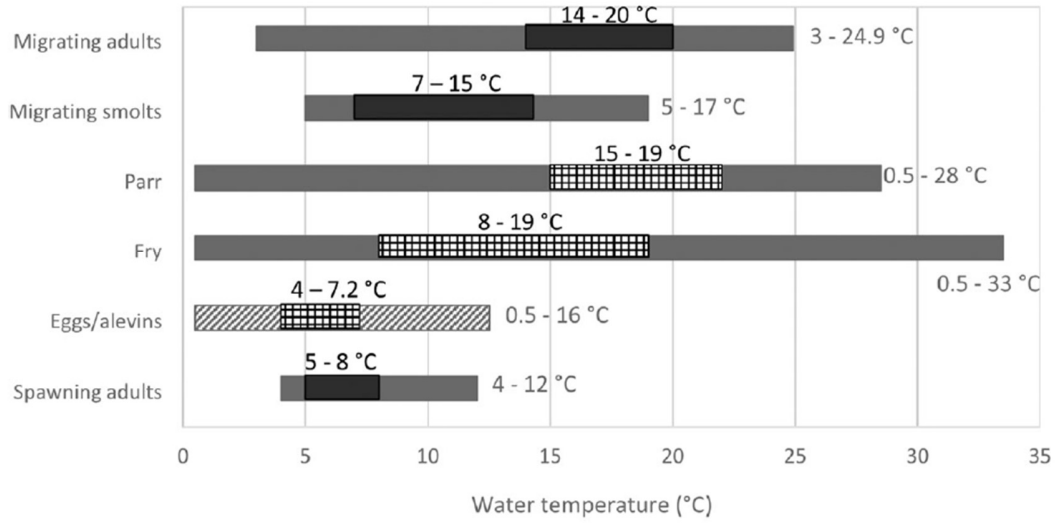


Figure 1: Relative thermal tolerance of Atlantic salmon by life stage, as collated from literature. Data were predominantly from field studies (solid bars); findings from controlled experiments are denoted by dashed bars. Black bars (solid and checkered) represent the optimal water temperature range for activity; grey bars (solid and dashed) represent the lower and upper water temperature boundaries. Source: Gillis et al. (2023).

Several temperature thresholds have been defined to identify these thermal windows. These thresholds are based on observed changes in behaviour of Atlantic salmon both in the wild and in experiments with measured physiological responses of adult salmon exposed to exercise at high water temperatures (DFO, 2012; Breau, 2013).

- The optimal temperature (T_{opt}): the temperature that provides the greatest aerobic scope and as a result the highest level of energy available for metabolism.
- The critical temperature (T_{crit}): the temperature corresponding to the complete collapse of the aerobic scope, all metabolism becoming anaerobic which is energetically costly and leads to the production of potentially damaging cellular metabolic byproducts such as lactic acid.

  Between T_{opt} and T_{crit}, metabolism transitions from aerobic to anaerobic, the latter being energetically costly and leading to the production of potentially damaging cellular metabolic byproducts such as lactic acid.
- The incipient lethal temperature (ILT): the temperature which the fish can tolerate for a long period (usually taken as seven days)
- The ultimate lethal temperature (ULT): the temperature which the fish cannot tolerate even for short periods of time (usually taken as 10 minutes)

After exposition to thermal stress, salmons can recover if returning to cooler conditions (temperature less or close to T_{opt}) for few hours, allowing aerobic scope and breakdown of the anaerobic metabolism byproducts (DFO, 2012).

General values of these thresholds for adult Atlantic salmon were first defined in 2012 by DFO (2012). Based on laboratory studies, T_{crit} was set to 24 °C. For T_{opt}, the process was based on the observations done for Pacific salmon for which T_{opt} corresponds to the range of water temperatures experienced during upriver migration, which means that T_{opt} was river specific. Thus, according to water temperature data in Miramichi River and the Restigouche River, T_{opt} was set to 17 °C and 19 °C for these two rivers, respectively. In a standardization will, these values were revised in 2013 to 18 °C and 25 °C respectively (Breau, 2013), then T_{crit} was reduced to 23 °C in official warm water protocols, while ILT was set to 25 °C and ULT in the range 30°C to 33 °C (e.g., DFO, 2015).

However, thermal sensitivity has been shown to be highly variable at the population, family, and individual levels with a significant genetic component, suggesting thermal history, genetics and behavior influence thermal tolerance and some capacity to adapt to environmental changes (Anttila *et al*., 2013; Corey et al., 2020; Debes et al., 2021). Recent research has focused on temperature thresholds associated with in-river behavioural changes such as abandonment of feeding areas and aggregation in cold-water refuges in a specific geometric shape (peloton) to minimize energetic costs (e.g., Dugdale et al., 2016; O'Sullivan et al., 2022; 2023). Aggregation onset temperatures were found to be variable, differing from one study to another, and, in the same studies, from one river to another (Table 1). The observed tendency is that salmons (adults and juveniles) in cooler river reaches initiate behavioral thermoregulation at cooler temperatures than fish in a warmer river (Corey *et al.,* 2020; Frechette *et al*., 2018) which suggests a long-term acclimation of salmons to temperatures.

Table 1: Temperature thresholds for aggregation in cold-water refuges of Atlantic salmon

River	Temperature threshold for aggregation in cold-water refuge (°C)		Reference
	Adult	**Juvenile**	
Penobscot River (Maine, USA)	23 °C	-	Shepard (1995)
Rivière Sainte-Marguerite Nord-Est (QC)	17 – 19 °C	-	Frechette et al. (2018)
Rivière Ouelle (QC)	-	28 °C	Dugdale et al. (2016); Corey et al. (2020)
Restigouche River (NB)	-	19-20 °C	Collet (2025)
Miramichi River system (NB)	-	22 °C	Cunjak et al. (1993; 2005)
	-	27 °C	Corey et al. (2020, 2025); O'Sullivan et al. (2025); Wilbur et al. (2020)

Moreover, aggregation behaviour in the afternoon also depends on the water temperature in the morning: in the Southwest Miramichi River, the sustained aggregation of juvenile salmon over consecutive days occurred when the average daily temperature exceeded 23°C and the minimum water temperature remained above 18°C (Breau, 2011, 2013).

2.2. The effect of cumulative thermal stress (thermal fatigue) on thermal sensitivity

In addition to the variability at the fish and spatial levels, recent research shows that physiological thresholds would be dynamic rather than static and vary with exposure and time due to thermal fatigue (e.g., Wilbur et al., 2020). O'Sullivan et al. (2023) introduced the concept of thermal hysteresis to describe the effect of the repeated thermal stress on the temperature thresholds that induce behavioural thermoregulation in salmonids. They followed juvenile salmon aggregation behaviour using underwater cameras in two known thermal refuges of the Little Southwest Miramichi (New Brunswick). Aggregation onset temperatures were relatively consistent in early summer but decreased across the summer from 27.1°C to 24.2°C as the frequency of events increased. Conversely, the thermal threshold increases again with time since a behavioural thermoregulation event, taking ~ 11 days to return to initial threshold value. A hysteresis model was also used on the Restigouche River by Collet (2025) to explain temporal variation of aggregation onset temperature. This new concept is very important for fishery management, especially in the context of climate change and the increasing frequency of extreme heat events.

3. Effect of catch-and-release during warm water periods on salmons

3.1. Lethal effects

Reviews on catch and release fisheries in relation to water temperature showed that post-angling mortality of fish increase as a function of increasing water temperature but is highly variable according to study methodology, mortality assessment period, fishing technique and life-stage (Gale *et al*., 2013; Van Leeuwen *et al*., 2020).

Van Leeuwen et al. (2020) conducted a meta-analysis of 32 published studies on the effect of river temperature and other factors on post-angling mortality and estimated a probability of mortality as a function of water temperature (Table 2).

Keefe et al. (2022) estimated post-release mortality at various water temperatures (Table 2) based on a comprehensive three-year study conducted in the Western Arm Brook, NL, comparing long-term survival of Atlantic salmon that were either angled, radio-tagged and released (n = 119), or trapped, radio-tagged and released (control; n = 164) at water temperatures ranging from 10 °C to 22 °C, representing the added mortality that could be attributed to catch and release.

Table 2: Probability of post-release mortality as a function of temperature at time of capture (Keefe et al., 2022)

Water temperature (°C)	Mean mortality probability
15	0.02
16	0.03
17	0.05
18	0.08
19	0.10
20	0.14
21	0.20
22	0.25
23	0.31

These results come from studies where best angling practices were used which are known to reduce post-angling mortality. Best practices include limiting gear to barbless, single-hooked artificial flies, instruction on use of appropriate strength of fly rod, reel, and leader, use of knotless rubber nets, handling of fish with bare wet hands only (no gloves), and minimizing the handling time and exposure to air of fish (Cooke & Suski,

2005; Keefe et al., 2022). Thus, these results may be overestimated since such practices are not used by all anglers.

The thermal history of salmons and the time in the freshwater migration period have no significant influence on post-release mortality as compared to the water temperature at time of the catch-and-release event, which remains the most suitable predictor of post-release survival when fish can recover in cooling water (Thorstad et al., 2007; Gargan et al., 2015; Van Leeuwen et al., 2023, 2024).

However, other factors influence post-release survivability of salmon such as run duration, freshwater acclimation (freshwater residents, grilse, multi-sea-winter salmon), starvation and naivety (Wilkie et al., 1996; Van Leeuwen et al., 2020, 2023), as well as fishery characteristics (retention limits, gear usage, angler motivation and behavior, monitoring capacity; Van Leeuwen et al., 2023).

3.2. Post-release physiological recovery

On a physiological point of view, post-release recovery of adult salmon can take several hours depending on water temperature and on physiological indicators: ATP restoration takes 1 h at 18 °C and 4 h at 23 °C (Wilkie et al., 1996, 1997) while glycogen level levels remain significantly lower than control values until 12-hours recovery (Brobbel et al., 1996).

3.3. Long term effects

When salmons survive and physiologically recover from angling, it has been shown that catch-and-release still have long term sub-lethal impacts on spawning and reproductive success (Richard et al., 2013; Bouchard et al., 2022), migration distances (Lennox et al., 2016) as well as the incidence of disease (Papatheodoulou et al., 2022), especially when angling is done in warm water and close to the fall spawning season.

3.4. Effect of temperature on salmon catchability

A common argument against water temperature-related fishery closures is that catches would be lower at water temperature over 20°C, making such protocol ineffective for salmon conservation.

Some studies show that catchability (or catch per unit effort) decreases during high water temperature events (≥ 20 °C; Mowbray & Locke, 1999; Van Leeuwen et al., 2021), making it difficult to collect data on a representative number of released individuals. However, it is still possible for a substantial number of salmons to be caught in these conditions, due to the high level of effort, which can still lead to unacceptable mortality (DFO, 2012; Mowbray & Locke, 1999; Van Leeuwen et al., 2023).

4. Water temperature-related fishery closures in Eastern Canada

4.1. Comparison of current water temperature-related fishery closures

In Canada, fisheries harvest decisions are based on the Precautionary Approach Framework (DFO, 2006) to prevent stocks from declining into the Critical Zone (DFO, 2019) where serious harm could occur.

Water temperature-related fishery closures for Atlantic salmon have been conducted in some regions since the mid-1970s especially in New Brunswick and Newfoundland and Labrador (Dempson et al., 2001), but the first protocols based on fish physiology were developed in 2013 in DFO Gulf Region (Breau 2013; Breau & Caissie 2013; DFO 2012). DFO chose to base fishing closure decision on daily minimal water temperature (T_{min}) rather than maximum temperature (T_{max}), considering that T_{min} would be a better indicator of physiological recovery and survival after thermal stress and angling exhaustion.

Due to a lack of data regarding adult salmons, and since the protocol was first defined for the Miramichi River, the threshold value was based on observations on juvenile salmons in the Little Southwest Miramichi River and set to 20 °C.

Moreover, for operational purpose and to avoid frequent decisions and one-day closures, a 2-days approach was adopted (Breau & Caissie, 2013), which means that T_{min} must be higher than 20 °C during two consecutive days to trigger angling closure.

This first warm water protocol was applied to the Miramichi River and progressively adapted to different provinces and different rivers over the years. The dates and temperatures thresholds of the current protocols are given in

Table 3. Some protocols apply on a whole river (e.g., in Newfoundland and Labrador), some on river reaches (e.g., Restigouche River) and some others only on pre-determined pools (e.g., Miramichi River). A partial closure ("morning angling only") was introduced in 2019 as a trade-off between total closure and no-closure. It was applied in Newfoundland and Labrador, as well as on the Restigouche River in New Brunswick.

In New Brunswick, the protocol is different in the Miramichi River than in the Restigouche River and the Nepisiguit River to account for differences in temperature patterns: for a same temperature threshold of 20 °C, the closure is total in pools of the Miramichi River, while restricted to morning angling in the two other rivers because nighttime water temperatures are presumed to allow for fish recovery.

In all cases, the decision process is based on two days with minimal temperature above the threshold temperature, except in Quebec where it is only one day.

Table 3: Temperature thresholds used in temperature-related fishery closures in Eastern Canada

	Temperature threshold for partial closure	Temperature threshold for total closure	Year of application	Reference
Newfoundland and Labrador [1]				
Class 0 rivers (catch and release only angling)	18 °C	-	2019	DFO (2020)
All other rivers	20 °C	-		
Nova Scotia				
Margaree River	-	20 °C for two river sections 23 °C for other river sections	2018	DFO (2018, 2023a)
Quebec [2]				
Rivière Petit-Saguenay and Rivière-Saint-Jean-Saguenay	-	23 °C (1 day)	2020	Gouvernement du Québec (2025)
New Brunswick				
Miramichi River	23 °C	20 °C in predetermined pools	2013	Breau (2013), DFO (2012, 2023b), Dolson et al. (2024)
Nepisiguit River	20 °C	23 °C	2019	DFO (2022), Dolson et al. (2024)
Restigouche River	20 °C	23 °C	2020	CGBVRR (2020), DFO (2023c)

1. In Newfoundland and Labrador, temporary angling closures were imposed between 1975 and 1988, and a first formal threshold was established at 22 °C in 1989 (Dempson et al., 2001).
2. In Quebec, the application is still experimental. The river is closed as soon as water temperature reaches 23 °C or even as of 22 °C depending on meteorological forecasts. Partial closure (morning only fishing) is not allowed by provincial regulation.
3. In the Miramichi River, the total closure protocol applies only on 29 predetermined pools while the partial closure protocol applies on all the river systems.

4.2. Efficiency of temperature-related fishery closures

Van Leeuwen et al. (2023) compared the effect of different temperature-related fishery closures on angling opportunities and salmon mortality in rivers from Newfoundland and Labrador, Nova Scotia, and New Brunswick, and showed that:

- In 2021, morning angling only resulted in an average reduction in angling water temperatures over the salmon season of 1.7 °C for the Miramichi River and 1.3 °C for the Restigouche River. The number of days in which angling water temperatures were >20.0 °C was reduced by 47% (45 days to 24 days), and 54% (39 days to 18 days) respectively over the salmon season.
- The 20 °C and 18 °C morning angling only protocols resulted in a 50% and 16% increase in angling opportunity over the summer when compared to the 20 °C and 18 °C full river closure protocols, respectively.
- Complete river closure resulted in less catch and release mortality than no closure or morning angling only protocol. The estimated catch and release mortality in the Exploits River (NL) over the 2016–2020 fishing seasons was 6.4% without any closure and decreased to 5.0% and 3.8% with morning angling only protocol and full closure respectively when using a 20 °C temperature threshold. This corresponds to a save of 104 and 188 salmon respectively. Mortality decreased to 3.5% and 1.7% respectively when using an 18 °C temperature threshold.

This confirms that morning angling only protocol is a good trade-off between no closure and full closure to decrease post-release mortality while maintaining angling opportunities. However, it still raises some issues regarding salmon recovery: when catch and release is done in the morning at water temperatures over 20 °C (common trigger for partial closure), salmons recover in increasingly warm water that can reach more than 25 °C in the end of the afternoon, which probably greatly affects fish recovery unless fish recover in a nearby cold-water-refuge.

Complementary to temperature-related fishery closures, another fishery management measure is applied in Newfoundland and Labrador: the number of fish that one can catch and release in a single day was limited to 4 in 1986 and reduced to 3 in 2018. It has been shown that limiting this number to 1 catch/day would reduce by approximately 40% the population post-release mortality (Van Leeuwen et al., 2023).

5. The warm water protocol in the Restigouche River

5.1. General conditions

The warm water protocol has been applied on the Restigouche River system since 2020 and concerns the two warmer rivers of the watershed: the Restigouche River and the Upsalquitch River (Figure 2).

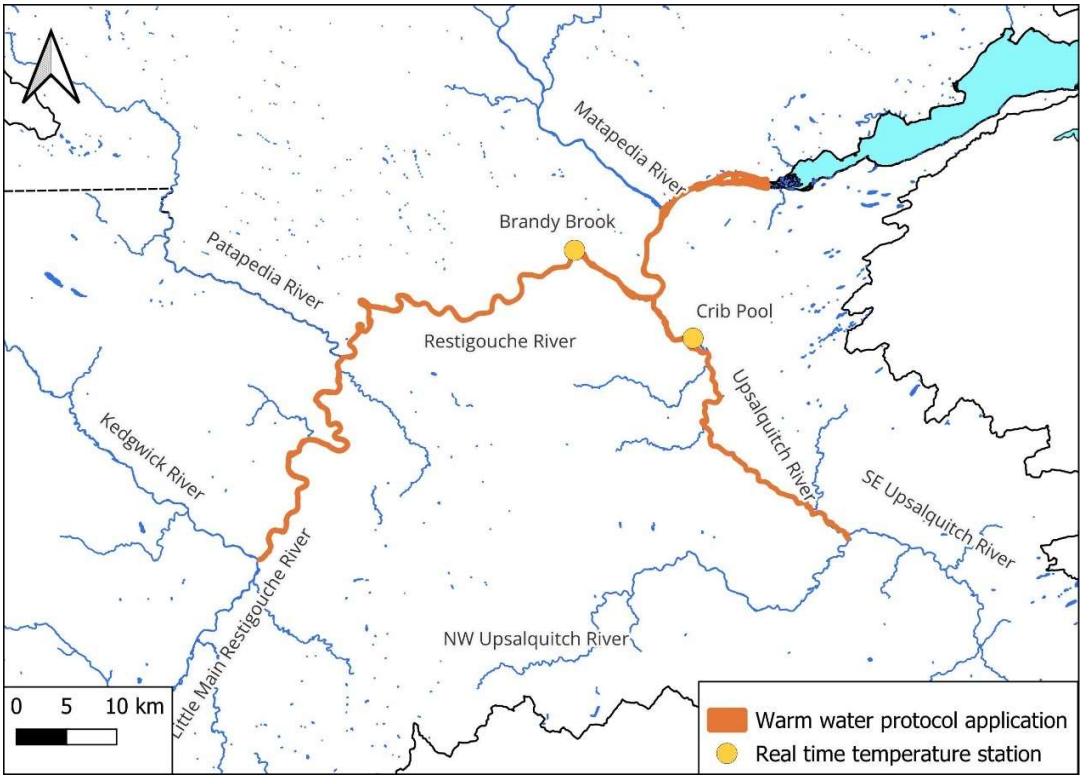


Figure 2: Rivers where the warm water protocol is applied and corresponding water temperature stations in the Restigouche River watershed

The protocol includes morning angling and full closure with temperature thresholds (T_{min}) of 20 °C and 23 °C respectively (see details in Appendix A).

DFO is responsible to monitor the water conditions (water temperatures, levels & weather forecast). When thresholds are met, DFO schedules a call with the partners of this protocol (RRWMC, GINU and DNRED) to discuss potential management actions (closure or opening). Ideally, that conference takes place when the situation evolves towards reaching thresholds, i.e., after one period of 24h over 20 °C, if the threshold is believed to be reached again in the following 24 h period. The final decision to implement any management action resides with DFO (DFO, 2023).

5.2. Application, results, and main issues (2020-2025)

Between 2020 and 2024, only partial closure has been applied. The annual number of days with morning angling only ranged from 2 to 24 in the Restigouche River and from 0 to 12 in the Upsalquitch River (Table 2). Note that the trigger for decision process always led to partial closure, i.e., meteorological forecasts have never changed the decision based on measured temperature.

Table 4: Number of days with angling closure since 2020

Year	Restigouche River		Upsalquitch River	
	Full closure	Partial closure	Full closure	Partial closure
2020	0	20	0	8
2021	0	18	0	0 [a]
2022	0	2	0	0
2023	0	5	0	0
2024	0	24	0	12
2025	15	0	15	0

a: no temperature data was available from early July to late August due to technical problem

The case of summer 2024, among the warmest ones over the last two decades, is detailed on Figure 3 for the Restigouche River. Partial closure was applied during three distinct periods in June (3 days), July (13 days) and early August (8 days) for a total of 24 days.

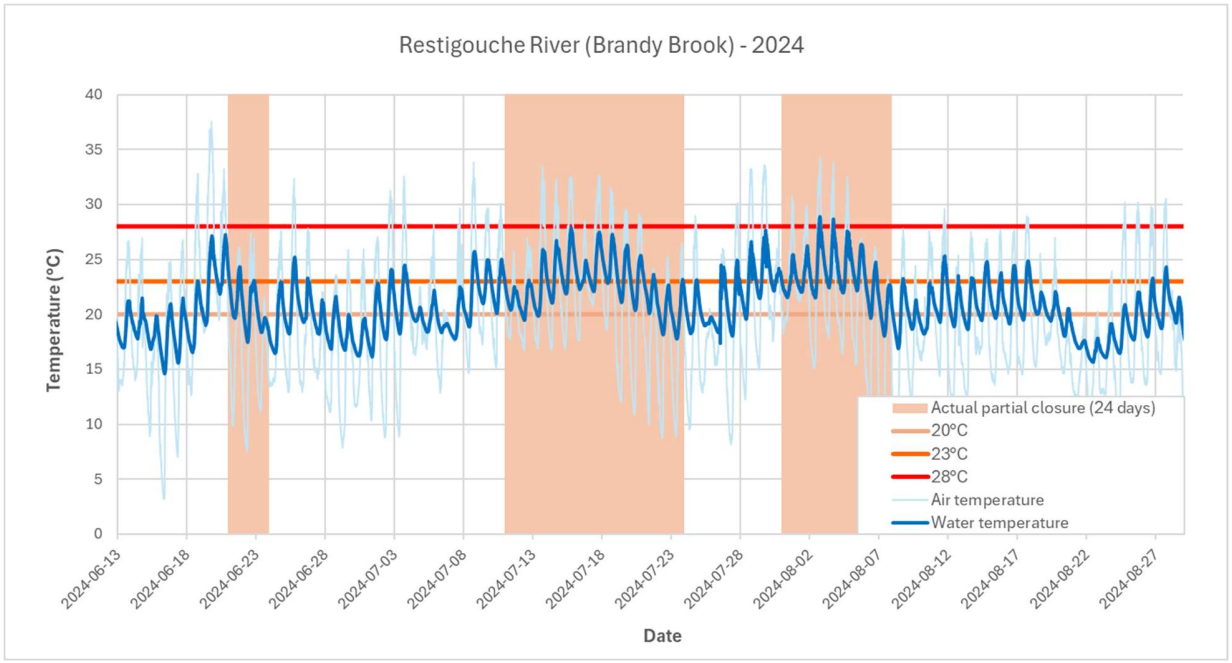


Figure 3: Application of the warm water protocol on the Restigouche River in 2024

2025 was a particular year with a very rapid warming from August 11 to August 15, leading to T_{min} higher than 23°C and a full angling closure in both rivers that started on August 11 (Figure 4). This closure lasted until August 26, even if water temperature had decreased lower than triggers, because of the occurrence of several forest fires that led to the closure of Crown Lands anyway.

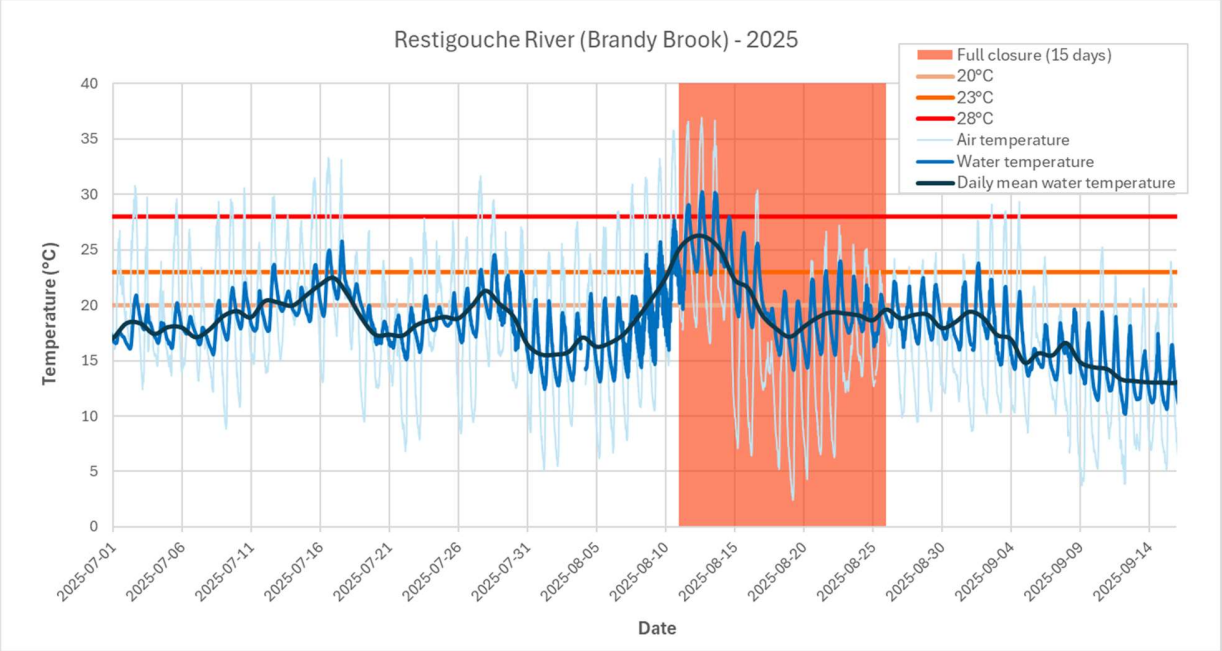


Figure 4: Application of the warm water protocol on the Restigouche River in 2025

The following observations can be made from these data.

- **Time lag between warm stressful conditions and protocol application timing**

Each closure period beginning, and end well illustrate the decision process delay and its consequences regarding temperature conditions for angling:

- On June 19, a very hot day, water temperature sharply increased from 19.0 °C in the morning to 27.1°C in the end of the afternoon. Water temperature remained high on June 20 (T_{min} = 21.8 °C, T_{max} = 27.3 °C) and started to decrease on June 21st (T_{min} = 19.7 °C, T_{max} = 24.4 °C). Meanwhile, the morning angling only protocol started to be effective only on June 21, which means that angling was still going on during these two warm days, leading probably to high post-release mortality of caught salmons. Ironically, the protocol remained effective during the following 3 days until June 24, while temperature rapidly decreased with T_{max} even lower than 20 °C on June 24, which means that afternoon angling was closed this day even if fish were not experimenting high thermal stress anymore.
- The same situation occurred on the second and the third period of protocol application. For instance, between July 28 and July 31, water temperature rapidly increased to stressful conditions with T_{min}

over 19.6 °C (reaching 22.1 °C on July 30th) and T_{max} over 26.6 °C (reaching 27.7 °C on July 30th), and the protocol was only effective on July 31.

This shows that the current decision process is not proactive enough, which leads to "miss" a significant number of days all along the summer, especially in the case of frequent and fast warming events.

- **T_{max} over 25 °C during angling periods**

During periods without any partial closure, there was 18 days with a T_{max} value over 24 °C, including 9 days with a value over 25 °C. This was due to the decision process lag (see previous point) but also to a daily water temperature range that is often higher than 5 °C and even 6 °C. Post-release mortality at such temperature is probably high (see section 3.1).

- **T_{max} over 28 °C during partial closure periods**

In late July and early August, during the third morning angling only period, the daily water temperature range was high during warmest days (reaching 7.4 °C) and T_{max} reached values over 27 °C on 7 days, and even over 28 °C on 2 consecutive days (August 2 and 3), reaching 28.9 °C on August 2. However, during this period, T_{min} never reached 23 °C to trigger full closure protocol, which means that morning angling was still possible in water that remained over 22 °C and was rapidly warming to extreme values after the catch and release period (8-11h). In these conditions, caught salmons had probably no chance to recover from release unless they reach cold-water refuges.

On a managing point of view, the following issues have been raised by partners regarding the current warm water protocol:

- **Difficulty to reach everyone**

When the threshold temperature for closure is met, the time to reach every partner of the decision process and to decide can take one or two days, and even more if the threshold is met on Friday.

- **Data accessibility**

The real time temperature stations are managed by two different organizations in different ways: GINU for the Restigouche River station and Environment Canada for the Upsalquitch River station. The data from the latter are not as rapidly available for all partners than for the former.

6. Recommendations

Catch and release can affect a high proportion of salmon population during warm water periods. Water temperature-related fishery closures are thus necessary, especially when population abundance is not meeting conservation requirements as it is the case in the Restigouche River. Since such closures have economic and social impacts, they must be based on decision protocols that are optimized according to specific river thermal regime and salmon population thermal sensitivity.

The following recommendations go in this way to improve the efficiency of current warm water protocols, especially in the Restigouche River but may be generalized to other rivers.

6.1. Conduct research to determine river-specific temperature thresholds for adult salmon in the Restigouche River

Current temperature thresholds are mostly based on data acquired on juvenile salmons in the Miramichi River and its tributaries. However, temperature thresholds for aggregation behaviour are known to be lower for adult salmons than for juvenile salmons and lower in cooler rivers such as the Restigouche River as compared to the Miramichi River (see section 2.1). Thus, river specific data on adult salmon aggregation behaviour and post-release mortality would be needed to determine if the current temperature thresholds of the protocol (20 °C and 23°C) are adequate or should be revised. Lower thresholds would have a drastic impact on angling opportunities: with a partial closure threshold of 19 °C instead of 20 °C, the number of days with morning angling only would have been 36 days (instead of 24) in 2024 in the Restigouche River. With a threshold of 18 °C, it would have reached 66 days with morning angling only. If required, such change would need to be justified to angling community by solid arguments and river-specific data.

6.2. Assess the effect of the warm water protocol on salmon mortality in the Restigouche River

The efficiency of temperature-related fishery closures on salmon mortality has been assessed on a river in Newfoundland (see section 4.2), but the same kind of study applied to the Restigouche River would enable to get specific information that would be useful in outreach and communication with partners to justify the use and/or the improvement of the warm water protocol. This would require gathering and analysing pluri-annual fish populations estimates, angling reports and water temperature data. Different scenarios could also be tested (for instance different temperature thresholds or full closure vs. partial closure) to compare their effects on salmon mortality.

6.3. Initiate closure decision process at lower temperature

To improve proactivity in the decision process and better anticipate warm water events, especially when water temperature increases rapidly, the temperature trigger for decision process may be lower (for closure) than the target temperature threshold for salmons. This would also give more importance to meteorological forecasts in the decision.

A trigger of 19 °C is proposed for partial closure, which means that as a call is scheduled after one period of 24h over 19 °C if the threshold of 20 °C is believed to be reached in the following 24 h period. If this approach had been applied in 2024, it would have allowed to apply morning angling only one day sooner at first and third closure period each and thus during critical warm water conditions.

In the same way, a trigger of 22 °C could be used to initiate full closure decision process to increase chances to apply closure as soon as T_{min} reaches 23 °C.

6.4. Develop and apply water temperature forecasting models

A better proactivity in the decision process would need a better predictability in water temperature and protocol thresholds exceedance. To do so, the development and application of water temperature forecasting models is a promising approach. Such approach is already used in hydrology to forecast streamflow and flood risks over a horizon of several days (MELCCFP, 2025). Research works have been done in this way by INRS-ETE with promising results on some rivers in Quebec and British Columbia, either

with process-based model or statistical models (Ouellet-Proulx et al., 2017, 2023). Further research is needed with specific application on the Restigouche River to see if reliable water temperature forecasts can be achieved on a horizon of 1 to 3 days. Such approach would also enable to spatialize water temperature forecasts and to determine in which river reaches the thresholds are the most likely to be reached. The forecasting model results could be shared in real time on a website, which would facilitate and accelerate the decision process for river closure.

The implementation of such tools in the decision process would require outreach, information and consultation of partners and angling community. A better predictability in angling closures would also benefit fishing camps, enabling to improve communication to their customers.

6.5. Add a T_{max} threshold for total closure

Warm water protocol is currently based on T_{min} only. However, in the warmest days of the summer, the temperature daily range often reaches 6 °C or even 7 °C leading to temperatures over 28 °C in the afternoon under morning angling only conditions. To avoid such situations where salmons caught in the morning have to recover in extremely warming water in the afternoon, it is proposed to apply a second threshold for full closure on T_{max}, with a proposed value of 28 °C. However, as for the use of T_{min} thresholds, decision process has to be proactive enough to make sure that full closure applies on the first day with $T_{max} \geq 28$ °C and goes back to partial closure as soon as $T_{max} < 28$ °C.

Applied to the 2024 data of the Restigouche River, it would have led to a 2-day full closure in August.

6.6. Consider thermal fatigue in the decision process

The current warm water protocols assume that water temperature thresholds for thermal stress are static through time. However, physiological thresholds have been shown to be dynamic, decreasing with exposure and time (see section 2.2). Moreover, sub-lethal effects have been shown to be more important in late summer than in early summer.

This issue could be accounted for in the decision process at the short term, for example in the way meteorological forecasts are considered: the decision to close angling could be made in a more conservative way in August than in June, even if no dramatic water temperature increase is expected.

At the longer term, the development of real-time, river specific, thermal stress indices as proposed by O'Sullivan et al. (2023) would be avenue to explore to account for thermal stress thresholds variations.

6.7. Expand the protocol to the Northwest Upsalquitch River

The thermal regime in the Northwest Upsalquitch River is very close to the one in the Upsalquitch River. According to data from DFO stations, the mean summer temperature (July-August) between 2003 and 2024 was 17.6 °C and 18.0 °C, respectively. In 2024, it was even higher in the former than in the latter (20.3 °C and 19.9 °C respectively). However, the daily range is larger in the Northwest Upsalquitch River with higher T_{max} and lower T_{min}, making it one of the hottest spots among the whole Restigouche River watershed. For instance, T_{max} reached 28.0 °C in early August 2024.

Since the lower part of the Northwest Upsalquitch River is used for angling as Crown Reserve, currently without any restriction during warm temperature events, it is proposed to include it in the warm water protocol of the Upsalquitch River, eventually based on the DFO water temperature station located at the 10 Mile Pool. Ultimately, if water temperature continues to increase, all fishing reaches of the Restigouche River network could be included in the protocol.

6.8. Continue to promote best angling practices

Most research data on post release mortality are based on angling best practices conditions, and post-release mortality is probably higher than expected when angling practices are not optimal. In the Restigouche River watershed, outreach is still needed to inform fishing camps and guides and to promote best angling practices.

6.9. Close angling in specific pools

During warm water periods, fish aggregate in cold-water refuges and pools. In the Miramichi River, the first step of the warm water protocol it to close angling in 29 predetermined pools as soon as water temperature reaches 20 °C (DFO, 2023b). These pools have been identified as areas where Atlantic salmon are known to congregate in large numbers during high water temperatures. The same approach could be applied in the Restigouche River to improve salmon resilience during warm water events. It would imply first to identify the most important pools in the Restigouche River and the Upsalquitch River. Then angling would be completely closed in these pools at the same time as morning angling only is applied in the rest of the river.

6.10. Protect cold-water refuges

The presence of cold-water refuges (CWRs) in a river reach is a key element for thermally stressed fish, especially for post-release recovering during warm water periods. However, CWRs are expected to decrease in size and number and become increasingly fragmented (Daigle et al., 2015; Fullerton et al., 2018; Steel et al., 2019). It is thus essential to preserve existing CWRs by including them in river and watershed management plans (Mejia et al., 2023). In the Restigouche River watershed, the WaterShade™ initiative aims to achieve this goal based on four pillars: protection, enhancement, research, and outreach. Regulating angling during warm water events without managing and protecting CWRs at the watershed scale and on the long term would be inconsistent and inefficient on the long term.

6.11. Control recreational activities during warm periods

In the present document, focus is put on angling regulation but other recreational activities occurring in rivers during warm water periods can negatively affect salmon by increasing their activity and exposing them to warmer water when they are displaced from cool water refuges: tubing, canoeing, kayaking, swimming, snorkelling, boating, etc. The warm water protocol implies sacrifices from anglers to preserve salmon, but this becomes frustrating if, at the same time, nothing is done to control these recreational activities. Collaborative work should be done with transport Canada to sensitize users and regulate these activities.

6.12. Coordinate provincial protocols (QC/NB) by applying a full closure protocol on the Matapedia River

As stated in section 4.1, the application of a warm water protocol is still experimental in the province of Quebec, on two rivers: Rivière Petit-Saguenay and Rivière-Saint-Jean-Saguenay. Fishing is closed as soon as water temperature reaches 23 °C or even as of 22 °C depending on meteorological forecasts. Partial closure (morning only fishing) is not allowed by provincial regulation.

Within the warm water protocol in the Restigouche River, real-time water temperature has been monitored since 2023 in the Matapedia River. In 2023, 2024 and 2025, minimal temperature has reached 20 °C several times, and, if the warm water protocol was applied at the same time as in the Restigouche River, this would have led to 5, 11 and 4 days respectively with morning angling only. Minimal temperature has never reached 23 °C but was close in 2025, with 22.3 °C on August 12. Maximum temperature was higher than 28 °C for three days (August 11 to 13), reaching 28.7 °C on August 12.

In a warming climate context, it is likely that water temperature in the Matapedia River will continue to increase and will exceed full closure thresholds more frequently in a near future. Thus, it is recommended to consider implementing the warm water protocol as well as applying the recommendations above on the Matapedia River too.

References

Anttila, K., Dhillon, R. S., Boulding, E. G., Farrell, A. P., Glebe, B. D., Elliott, J. A., ... & Schulte, P. M. (2013). Variation in temperature tolerance among families of Atlantic salmon (Salmo salar) is associated with hypoxia tolerance, ventricle size and myoglobin level. *Journal of experimental biology*, *216*(7), 1183-1190.

Bouchard, R., Wellband, K., Lecomte, L., Bernatchez, L., & April, J. (2022). Effect of catch-and-release and temperature at release on reproductive success of Atlantic salmon (Salmo salar L.) in the Rimouski River, Québec, Canada. *Fisheries Management and Ecology*, *29*(6), 888-896.

Boyd, J.W., Guy, C.S., Horton, T.B., & Leathe, S.A. 2010. Effects of catch-and-release angling on salmonids at elevated water temperatures. N. Amer. J. Fish. Manag. 30: 898-907.

Breau, C. & Caissie, D. 2013. Adaptive management strategies to protect salmon (Salmo salar) under environmentally stressful conditions. DFO Can. Sci. Adv. Secr. Res. Doc. 2012/164. ii+14 p.

Breau, C. 2013. Knowledge of fish physiology used to set water temperature thresholds for in-season closures of Atlantic salmon (*Salmo salar*) recreational fisheries. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/163. iii + 24 p.

Brobbel, M. A., Wilkie, M. P., Davidson, K., Kieffer, J. D., Bielak, A. T., & Tufts, B. L. (1996). Physiological effects of catch and release angling in Atlantic salmon (Salmo salar) at different stages of freshwater migration. *Canadian Journal of Fisheries and Aquatic Sciences*, *53*(9), 2036-2043.

CGBVRR (2020). Protocole de gestion de la pêche récréative pour la rivière Restigouche en période d'eaux chaudes. Conseil de gestion du bassin versant de la rivière Restigouche.

Collet, E. (2025). The intersection of thermal hysteresis and river-specific thermal regimes: Effects on thermal aggregation thresholds in juvenile Atlantic Salmon (Salmo salar) and brook trout (Salvelinus fontinalis). M.Sc. Thesis, University of New Brunswick, Fredericton, New Brunswick, Canada.

Cooke, S. J., & Suski, C. D. (2005). Do we need species-specific guidelines for catch-and-release recreational angling to effectively conserve diverse fishery resources?. *Biodiversity & Conservation*, *14*, 1195-1209.

Cunjak, R. A., Caissie, D., El-Jabi, N., Hardie, P., Conlon, J. H., Pollock, T. L., ... & Komadina-Douthwright, S. (1993). The Catamaran Brook (New Brunswick) Habitat Research Project: Biological, physical and chemical conditions (1990-1992).

Cunjak, R. A., Roussel, J. M., Gray, M. A., Dietrich, J. P., Cartwright, D. F., Munkittrick, K. R., & Jardine, T. D. (2005). Using stable isotope analysis with telemetry or mark-recapture data to identify fish movement and foraging. *Oecologia*, *144*, 636-646.

Daigle, A., Jeong, D.I., & Lapointe, M.F. (2015). Climate change and resilience of tributary thermal refugia for salmonids in eastern Canadian rivers. Hydrological Sciences Journal, 60(6).

Debes, P. V., Solberg, M. F., Matre, I. H., Dyrhovden, L., & Glover, K. A. (2021). Genetic variation for upper thermal tolerance diminishes within and between populations with increasing acclimation temperature in Atlantic salmon. *Heredity*, *127*(5), 455-466.

Dempson, J. B., O'Connell, M. F., & Cochrane, N. M. (2001). Potential impact of climate warming on recreational fishing opportunities for Atlantic salmon, Salmo salar L., in Newfoundland. Canada. Fisheries Management & Ecology, 8, 69–82.

DFO (2006). A Harvest Strategy Compliant with the Precautionary Approach. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2006/023.

DFO (2012). Temperature threshold to define management strategies for Atlantic Salmon (*Salmo salar*) fisheries under environmentally stressful conditions. DFO Can Sci Advis Sec Sci Advis Rep. 2012:019.

DFO (2015). Protocol for In-season Conservation Measures for Atlantic salmon during Environmentally Stressful Conditions in the Miramichi Watershed (Warm Water Protocol). Version 5.

DFO (2018). Notice to Recreational Anglers for angling closure on the Margaree River (NS), August 9, 2018.

DFO (2019). Guidance for the development of rebuilding plans under the Precautionary Approach Framework: Growing stocks out of the critical zone.

DFO (2020). Atlantic Salmon - Newfoundland and Labrador Region. https://www.dfo-mpo.gc.ca/fisheries-peches/ifmp-gmp/salmon-saumon/2020/index-eng.html#toc7.3

DFO (2022). Nepisiguit River strategy for managing angling in periods of warm waters, Version 2.

DFO (2023a). Protocol for In-season Conservation Measures for Atlantic Salmon during Environmentally Stressful Conditions in the Margaree River (Warm Water Protocol).

DFO (2023b). Protocol for In-season Conservation Measures for Atlantic salmon during Environmentally Stressful Conditions in the Miramichi Watershed (Warm Water Protocol). Version 8.

DFO (2023c). Gulf Region/Restigouche River strategy for managing angling during periods of warm water.

Dolson, R., Boudreau, S.A., Tunney, T.D., McDermid, J.L., & Breau, C. (2024). Considering Environmental Variables in the Management of Atlantic Salmon Recreational Angling: A Retrospective Review of A Warm Water Protocol for the Miramichi River in New Brunswick from 1987-2020. Can. Manuscr. Rep. Fish. Aquat. Sci. 3278: vii + 50 p.

Elliott, J., & Elliott, J. A. (2010). Temperature requirements of Atlantic salmon Salmo salar, brown trout Salmo trutta and Arctic charr Salvelinus alpinus: predicting the effects of climate change. *Journal of fish biology*, *77*(8), 1793-1817.

FitzGerald, A. M., & Martin, B. T. (2022). Quantification of thermal impacts across freshwater life stages to improve temperature management for anadromous salmonids. *Conservation Physiology*, *10*(1), coac013.

Frechette, D. M., Dugdale, S. J., Dodson, J. J., & Bergeron, N. E. (2018). Understanding summertime thermal refuge use by adult Atlantic salmon using remote sensing, river temperature monitoring, and acoustic telemetry. *Canadian Journal of Fisheries and Aquatic Sciences*, *75*(11), 1999-2010.

Fullerton, A.H., Torgersen, C.E., Lawler, J.J., Steel, E.A., Ebersole, J.L., & Lee, S.Y. (2018). Longitudinal thermal heterogeneity in rivers and refugia for coldwater species: Effects of scale and climate change. Aquatic Sciences, 80(3), 1–15. https://doi.org/10.1007/s00027-017-0557-9

Gale, M. K., Hinch, S. G., & Donaldson, M.R. (201)3. The role of temperature in the capture and release of fish. Fish Fish. 14(1):1–33. doi:10.1111/j.1467-2979.2011.00441.x.

Gargan, P. G., Stafford, T., Økland, F., & Thorstad, E. B. (2015). Survival of wild Atlantic salmon (Salmo salar) after catch and release angling in three Irish rivers. *Fisheries Research*, *161*, 252-260.

Gillis, C. A., Ouellet, V., Breau, C., Frechette, D., & Bergeron, N. (2023). Assessing climate change impacts on North American freshwater habitat of wild Atlantic salmon-urgent needs for collaborative

research. *Canadian Water Resources Journal/Revue canadienne des ressources hydriques*, *48*(2), 222-246.

Gouvernement du Québec (2025). Projet expérimental de gestion de la pêche au saumon adaptée aux conditions thermiques des rivières. https://www.quebec.ca/agriculture-environnement-et-ressources-naturelles/faune/gestion-faune-habitats-fauniques/gestion-especes-fauniques/plans-gestion/saumon-atlantique/projet-experimental-conditions-thermiques-rivieres. Retrieved in May 2025.

Keefe, D., Young, M., Van Leeuwen, T. E., & Adams, B. (2022). Long-term survival of Atlantic salmon following catch and release: Considerations for anglers, scientists and resource managers. *Fisheries Management and Ecology*, *29*(3), 286-297.

Lennox, R. J., Cooke, S. J., Diserud, O. H., Havn, T. B., Johansen, M. R., Thorstad, E. B., ... & Uglem, I. (2016). Use of simulation approaches to evaluate the consequences of catch-and-release angling on the migration behaviour of adult Atlantic salmon (Salmo salar). *Ecological Modelling*, *333*, 43-50.

Martin, B. T., Dudley, P. N., Kashef, N. S., Stafford, D. M., Reeder, W. J., Tonina, D., ... & Danner, E. M. (2020). The biophysical basis of thermal tolerance in fish eggs. *Proceedings of the Royal Society B*, *287*(1937), 20201550.

Mejia, F. H., Ouellet, V., Briggs, M. A., Carlson, S. M., Casas-Mulet, R., Chapman, M., Collins, M. J., Dugdale, S. J., Ebersole, J. L., Frechette, D. M., Fullerton, A. H., Gillis, C-A., Johnson, Z. C., Kelleher, C., Kurylyk, B. L., Lave, R., Letcher, B. H., Myrvold, K. M., Nadeau, T.-L., Neville, H., Piégay, H., Smith, K. A., Tonolla, D., & Torgersen, C. E. (2023). Closing the gap between science and management of cold-water refuges in rivers and streams. Global Change Biology. https://doi.org/10.1111/gcb.16844.

MELCCFP (2025). Atlas hydroclimatique du Québec méridional. https://www.cehq.gouv.qc.ca/atlas-hydroclimatique/index.htm

Mowbray, F. & Locke, A. (1999). The effect of water temperature on angling catch of Atlantic salmon in the Upsalquitch River. DFO Can. Stock Assess. Sec. Res. Doc. 99/56. 17p.

Ouellet-Proulx, S., St-Hilaire, A., & Boucher, M. A. (2017). Water temperature ensemble forecasts: Implementation using the CEQUEAU model on two contrasted river systems. *Water*, *9*(7), 457.

Ouellet-Proulx, S., Daigle, A., St-Hilaire, A., Gillis, C. A., Linnansaari, T., Dauphin, G., & Bergeron, N. É. (2023). A potential growth thermal index for estimating juvenile Atlantic salmon (Salmo salar) size-at-age across geographical scales. *Journal of Fish Biology*, *103*(6), 1488-1500.

O'Sullivan, A. M., Corey, E., Cunjak, R. A., Linnansaari, T., & Curry, R. A. (2021). Salmonid thermal habitat contraction in a hydrogeologically complex setting. *Ecosphere*, *12*(10), e03797.

O'Sullivan, A. M., Corey, E. M., Collet, E. N., Helminen, J., Curry, R. A., MacIntyre, C., & Linnansaari, T. (2023). Timing and frequency of high temperature events bend the onset of behavioural thermoregulation in Atlantic salmon (Salmo salar). *Conservation Physiology*, *11*(1), coac079.

Papatheodoulou, M., Závorka, L., Koeck, B., Metcalfe, N. B., & Killen, S. S. (2022). Simulated pre-spawning catch and release of wild Atlantic salmon (Salmo salar) results in faster fungal spread and opposing effects on female and male proxies of fecundity. *Canadian Journal of Fisheries and Aquatic Sciences*, *79*(2), 267-276.

Richard, A., Dionne, M., Wang, J., and Bernatchez, L. (2013). Does catch and release affect the mating system and individual reproductive success of wild Atlantic salmon (*Salmo salar* L.). Mol. Ecol. 22: 187-200.

Shepard, S.L. (1995). Atlantic salmon spawning migrations in the Penobscot River, Maine: fishways, flows, and high temperatures. M.Sc. Thesis, University of Maine, Orono, Maine.

Steel, E.A., Marsha, A., Fullerton, A.H., Olden, J.D., Larkin, N.K., Lee, S.Y., & Ferguson, A. (2019). Thermal landscapes in a changing climate: biological implications of water temperature patterns in an extreme year. Canadian Journal of Fisheries and Aquatic Sciences, 76(10), 1740-1756.

Thorstad, E. B., Næsje, T.F., & Leinan, I. (2007). Long-term effects of catch-and-release angling on Atlantic Salmon during different stages of return migration. Fish Res. 85(3):330–334. doi:10.1016/j.fishres.2007.02.010.

Thorstad, E. B., Bliss, D., Breau, C., Damon-Randall, K., Sundt-Hansen, L. E., Hatfield, E. M., ... & Sutton, S. G. (2021). Atlantic salmon in a rapidly changing environment—Facing the challenges of reduced marine survival and climate change. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *31*(9), 2654-2665.

Van Leeuwen, T. E., Dempson, J. B., Burke, C. M., Kelly, N. I., Robertson, M. J., Lennox, R. J., ... & Bates, A. E. (2020). Mortality of Atlantic salmon after catch and release angling: assessment of a recreational Atlantic salmon fishery in a changing climate. *Canadian Journal of Fisheries and Aquatic Sciences*, *77*(9), 1518-1528.

Van Leeuwen, T. E., Dempson, J. B., Cote, D., Kelly, N. I., & Bates, A. E. (2021). Catchability of Atlantic salmon at high water temperatures: implications for river closure temperature thresholds to catch and release angling. *Fisheries Management and Ecology*, *28*(2), 147-157.

Van Leeuwen, T. E., Lehnert, S. J., Breau, C., Fitzsimmons, M., Kelly, N. I., Dempson, J. B., ... & Cote, D. (2023). Considerations for water temperature-related fishery closures in recreational Atlantic salmon (Salmo salar) catch and release fisheries: A case study from eastern Canada. *Reviews in Fisheries Science & Aquaculture*, *31*(4), 598-619.

Van Leeuwen, T. E., Keefe, D., Young, M., & Adams, B. (2024). Water temperature at the time of the catch-and-release event is a better predictor of survival in Atlantic salmon (Salmo salar) than acute water temperature changes before and after. *Journal of Fish Biology*, *104*(5), 1623-1627.

Wilbur, N. M., O'Sullivan, A. M., MacQuarrie, K. T., Linnansaari, T., & Curry, R. A. (2020). Characterizing physical habitat preferences and thermal refuge occupancy of brook trout (Salvelinus fontinalis) and Atlantic salmon (Salmo salar) at high river temperatures. *River Research and Applications*, *36*(5), 769-783.

Wilkie, M. P., Brobbel, M. A., Davidson, K. G., Forsyth, L., & Tufts, B. L. (1997). Influences of temperature upon the postexercise physiology of Atlantic salmon (Salmo salar). *Canadian Journal of Fisheries and Aquatic Sciences*, *54*(3), 503-511.

Wilkie, M. P., Davidson, K., Brobbel, M. A., Kieffer, J. D., Booth, R. K., Bielak, A. T., & Tufts, B. L. (1996). Physiology and survival of wild Atlantic salmon following angling in warm summer waters. *Transactions of the American Fisheries Society*, *125*(4), 572-580.

Appendix A. Warm water protocol in the Restigouche River watershed

Parameters recorded / observed	Information collected	Management action
T_{min} (MT_{min}) for a given day	**MT_{min} < 20°C**	Maintain access to the river under normal angling rules
T_{min} (MT_{min}) for a given day	**MT_{min} > 20°C for 2 consecutive periods of 24h**	Implement a 'morning angling only' (for all species) restriction for all species (angling to be prohibited after 11 a.m. in the main section of the Restigouche river as defined in page 2.
Water levels	Water levels are low or decreasing	
Long term forecast (next 7 days)	High daily temp Warm nightly temp Little chance of rain	
Fish behaviour (anecdotal information)	Salmon congregating in cold water pools	
T_{min} (MT_{min}) for a given day	**MT_{min} > 23°C for 2 consecutive periods of 24 hours**	Implement a closure of angling for all species in the main section of the Restigouche River as defined on page 2, until conditions improve (see reopening criteria)
Water levels	Water levels are low and/or lowering	
Long term forecast (next 7 days)	High daily temp Warm nightly temp Little chance of rain	
Fish behaviour (anecdotal information)	Observations of salmon in distress, or dead salmon	

Table 5: Criteria for applying restrictions in the Restigouche River (DFO, 2023)

Parameters recorded / observed	Information collected	Management action
T_{min} (from the Upsalquitch real-time station)	**T_{min} < 20°C**	Maintain access to the river under normal angling rules
T_{min} (from the Upsalquitch real-time station)	**T_{min} > 20°C for 2 consecutive periods of 24h**	Implement a 'morning angling only' (for all species) restriction for all species (angling to be prohibited after 11 a.m. in the section of Upsalquitch River described on page 2
Water levels	Water levels are low or decreasing	
Long term forecast (next 7 days)	High daily temp Warm nightly temp Little chance of rain	
Fish behaviour (anecdotal information)	Salmon congregating in cold water pools	
T_{min} (from the Upsalquitch real-time station)	**T_{min} > 23°C for 2 consecutive periods of 24 hours**	Implement a closure of angling for all in the section of Upsalquitch River described on page 2, until conditions improve (see reopening criteria)
Water levels	Water levels are low and/or lowering	
Long term forecast (next 7 days)	High daily temp Warm nightly temp Little chance of rain	
Fish behaviour (anecdotal information)	Observations of salmon in distress, or dead salmon	

Table 6: Criteria for applying restrictions in the Upsalquitch River (DFO, 2023)

Parameters recorded / observed	Information collected	Management action
Mean of all T_{min} (MT_{min}) provided by partners for a given day (Restigouche) or T_{min} (Upsalquitch River)	**MT_{min} or T_{min} < 23°C for two consecutive periods of 24H**	Reopen angling daily until 11 a.m. in the concerned section of the river
Water levels	Stable or increasing	
Long term forecast (7 days)	Moderate or Lowering daily temp Cooler night temp Chance of rain	
Fish behaviour (anecdotal information)	Salmon remain in cold water pools, no more fish in distress or mortalities observed	
Mean of all T_{min} (MT_{min}) provided by partners for a given day (Restigouche) or T_{min} (Upsalquitch River)	**MT_{min} or T_{min} < 20°C for 2 consecutive periods of 24H**	Remove angling restrictions – return to normal rules.
Water levels	Stable or increasing water levels	
Long term forecast (next 7 days)	Moderate daily temp Cool nightly temp Chance of rain	
Fish behaviour (anecdotal information)	Salmon observed leaving cold water refuges	

Table 7: Criteria for angling reopening in the Restigouche River and the Upsalquitch River