Spillimacheen Project Water Use Plan

Monitoring of Habitat Maintenance Flows within Spillimacheen Canyon

Implementation Year 2

Reference: SPNMON#2

*Monitoring of Habitat Maintenance Flows within the Spillimacheen Canyon Channel*

Study Period: October 2010 – March 2011

June 30, 2011
Technical Memorandum

To: Rian Hill, RPF
Water Licence Requirements
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RE: SPNMON#2 – Monitoring of Habitat Maintenance Flows within the Spillimacheen Canyon Channel

Background

Low winter flows downstream of Spillimacheen Dam was a key issue addressed by the Consultative Committee which convened to create the Spillimacheen Water Use Plan (WUP 2005). There was concern that during periods of extended cold air temperature, when inflows to the headpond are less than plant capacity (~7.5 m³/s), flows in the canyon section between Spillimacheen Dam and the powerhouse tailrace outlet (Figure 1) are restricted to releases through the undersluice gate with some dam leakage. The minimum flow release from the dam during these winter months is currently targeted at 0.85 m³/s.

In 2005, a Terms of Reference (TOR) was submitted by BC Hydro to the Comptroller of Water Rights with the objective of reducing uncertainty related to effects of sustained cold weather conditions on the adequacy of the minimum flow release as an over winter habitat maintenance flow (BC Hydro 2005). A key uncertainty associated with this operation is the extent to which low winter flows may affect the suitability and availability of fish and fish habitat; as such it was also recommended that additional opportunistic field observations be initiated to confirm the effectiveness of this recommendation. In order to gain a better understanding of these processes, the following management questions were developed:

1. Does the 0.85 m³/s minimum flow prevent the formation of anchor ice in riffle habitats of the Spillimacheen Canyon?
2. If anchor ice forms, does the formation of ice reduce pool habitat connectivity in the Spillimacheen Canyon?
3. Are changes in overwinter habitat conditions likely to negatively impact productivity or survival of resident fish populations?
Figure 1: Spillimacheen Canyon Site Location Map, October 2010 – March 2011
In 2007, a contract was awarded to Westslope Fisheries Ltd of Cranbrook, BC to attempt a program designed to be implemented using a combination of remote photography and hands on field measurements. To answer the management questions set out in the TOR, they monitored air temperature and discharge within the canyon section while making an assessment of anchor ice development. After the projects conclusion, it was determined that physically measuring both discharge and anchor ice development was far too dangerous considering the rugged nature of the canyon and the time of year (field conditions) which the study must take place. However, the study did produce some interesting conclusions in that the volume of water passing through the canyon during the winter was a measured 2.84 m³/s (November 30, 2007) instead of the anticipated minimum release flow (0.85 m³/s). This could indicate that either leakage through the dam, or flow through the undersluice cannot be controlled to a minimum flow level during the winter. Regardless, anchor ice was observed during field observations and via remote camera photography which warranted further study into the conditions. Some important safety concerns were raised during the implementation of Westslope’s program and therefore recommendations were developed forbidding in-stream data collection of both discharge and anchor ice development.

Anchor Ice

This phenomenon occurs naturally throughout many rivers and streams where ambient air temperatures and atmospheric pressure combine to allow water to super-cool to a few one hundredths of a degree below 0 °C. At this point tiny ice particles, termed “frazil ice” form and begin locking onto each other until a visible mass takes shape (Hicks 2009). What gives rise to the name anchor ice is the process for which they develop, typically from the streambed upwards. Flow hydraulics play a significant role in this process and localized conditions will dictate how river ice forms and deteriorates creating different situations across the landscape. Further, anchor ice typically forms in shallow fast moving portions of the stream (riffles) and can grow from that point upstream (Bisaillon and Bergeron 2007).

Brown et al. (1993) through telemetry showed that the onset of winter caused fish to move from deeper pools with large amounts of cover to deep ice covered pools free of any wood or debris that would attract anchor ice development. By the end of December, 77% of radio tagged fishes were in “safe” pools influenced by the above mentioned characteristics and areas influenced by ground water. Only 1% of fish were found residing in deep pool areas with woody debris prone to anchor ice formation. This research was further supported when a similar telemetry study on juvenile salmonid was completed by Stickler et al. (2008). Tracking showed a statistically significant movement in fish during periods of anchor ice formation, while periods where only super cool or frazel ice was present did not result in significant movements of fish. It appears fish have become accustomed to leaving a particular habitat when the development of anchor ice occurs as they found these juvenile salmonid were largely unaffected by the changes to their proximate habitat composition.

For the purposes of this study, it is important to note that some anchor ice development is expected to occur naturally within the Spillimacheen Canyon; however, it is our intention to observe whether or not the minimum flow conditions are adequate to prevent full ice up conditions with no surface connectivity that could be determined as harmful to fishes overwintering.
Study Design

In October of 2010, BC Hydro designed a study that would further the understanding of winter conditions within the canyon while keeping worker safety paramount. Keeping in mind our overall program objective, as set out in the TOR, was to confirm the effectiveness of the current minimum flow release for prevention of unacceptable freeze-up of pool refuge habitat and maintain habitat connectivity for overwintering fish.

As such, close monitoring of air temperature in conjunction with BC Hydro electrician’s operation of the Generating Facility at Spillimacheen would guide field visits to the site in order to observe the canyon section. The following hypothesis would be maintained:

H₀: The minimum flow release is adequate to prevent development of anchor ice and to maintain surface flow connectivity within the canyon during periods of extended low air temperature.

H₁: The minimum flow release is inadequate to prevent development of anchor ice and to maintain surface flow connectivity within the canyon during periods of extended low air temperature.

The revised approach developed, would maintain monitoring of fish habitat and ice conditions within the canyon during sustained periods of cold weather. The Fisheries Technical Committee defined a minimum threshold trigger as five consecutive (or 120hrs) non-spill days with a daytime high of -10°C or colder. One of the recommendations of Cope’s (2008) work indicated the need to monitor temperatures closely in order to determine if a trigger had been met. It was subsequently determined that temperature monitoring would need to occur in a real-time manner. Since the Spillimacheen Dam is not operated by employees year round, a local electrician was requested to change out an Onset Tidbit V2 temperature logger (two in rotation). Another set of loggers was placed near the Generating Station to be left static during the entire study period. On average, the electrician would switch out the tidbit loggers once per week. This would ensure an up-to-date representation of air temperature was being forwarded to the study lead. Coupled with constant monitoring of local weather stations, an estimate was made based on all available information whether or not a temperature trigger had been met at the canyon and subsequent field observations would be planned accordingly.

In the field, three photo point monitoring locations were set up to optimize information collected while ensuring that safety of the worker was not compromised. Photo Point 1 was set up at the Dam to show approximate flow levels passing down the canyon. Photo Point 2 was situated above the channel at a lookout location approximately mid-canyon. Photo Point 3 was located adjacent to the Generating Station via a walking trail to the river. With this coverage, surface flow connectivity could be observed at a variety of different scales. High resolution digital photos were taken at each location using various settings to ensure high quality images were being cached.

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1 www.soartherockies.com provides hourly temperature reporting located at an airstrip near Invermere BC; approximately 50km from the Spillimacheen Dam and was primarily used.
Results

The temperature loggers were set to begin recording data on October the 18th at midnight although they were configured and installed prior. From October 18th, 2010 until March 18th, 2011 continuous temperature monitoring at Spillimacheen indicated one period of time where the trigger was met. From December 30th at 4:00am to Jan 5th at 11:00am (152 hours) temperatures remained -10°C or colder (Figure 2). On the morning of January 6th, a field visit was conducted capturing photographs at each previously designated location.

Figure 2: Air Temperature Monitoring at the Spillimacheen Canyon, October 2010 – March 2011.
Figure 3: Photo Point 1 cross-sectional view of dam, January 6, 2011. *Notice broken ice surface and considerable flow through bypassing intake/penstock*

Figure 4: Photo Point 1 Downstream view of canyon section, January 6, 2011. *Several ice-free sections observed.*
Figure 5: Photo Point 2 Downstream view of mid-Spillimacheen Canyon, January 6, 2011. *Notice large sections of ice free pool habitat.

Figure 6: Photo Point 2 Downstream view of mid-Spillimacheen Canyon, January 6, 2011. *Zoomed in version of Figure 5 highlighting large sections of ice free pool habitat.
Figure 7: Photo Point 3 Cross-sectional view of lower-Spillimacheen Canyon, January 6, 2011. *Notice large sections of ice free pool habitat.

Figure 8: Photo Point 3 Cross-sectional view of lower-Spillimacheen Canyon, January 6, 2011. *Zoomed in version of Figure 7 highlighting large sections of ice free pool habitat.
Discussion

The study period lasting from October 2010 through March of 2011 produced several periods of sustained cold with only one lasting long enough to be regarded as the trigger being met. Field observations recorded shortly after this trigger was met showed that although large portions of the Spillimacheen Canyon were frozen over, there was also evidence that many sections remained free-flowing both on the surface and in the stream bed. The photos taken at Photo Points 2 and 3 showed visible stream bottom with little to no anchor ice present (Figure 5 through Figure 8).

Considering that our coverage did not encompass the entire canyon, we cannot maintain that this result remained true throughout the entire canyon; however, from this author’s perspective, there was no evidence that extensive ice damming or anchor ice development was occurring during that sustained period of cold weather.

The second part of the trigger as designed by the Fisheries Technical Committee states that the trigger can only be met considering air temperature during periods without prolonged spill over the dam. BC Hydro electricians assigned to operating Spillimacheen generation facility noted that periods of sustained cold typically result in the intake gate freezing and much of the flow then being diverted away from the penstock, and down the canyon. Further, the electricians reported that on January 6th, 2011 two units were running during the sustained cold period: G1 and G2. These two units were producing 2.2 MW of power collectively which equates to approximately 50% of capacity (4.5 MW total). According to the Columbia Basin Generation Local Operating Order 3G – SPN – 06, the maximum discharge going through the penstock at peak performance is 7.5 m³/s. This suggests approximately 3.25 m³/s of water was being diverted through the penstock. The Water Survey of Canada station downstream of the generating station recorded a discharge of approximately 8.0 m³/s that day. It is therefore assumed that the difference in discharge, in this case² 4.75 m³/s, was flowing down the canyon, much higher than the minimum flow level.

This result certainly suggests that when minimum flows are combined with water diverted due to a frozen intake and the leakage through the dam and undersluice gate, the discharge down the canyon during sustained cold periods is much higher than the minimum flow level; therefore it may not be appropriate to attempt testing the hypotheses as part of the TOR. It would then be apparent during higher than minimum discharges observed throughout this study, not to see anchor ice formation or a canyon channel with continuous frozen-solid pools and riffle sections.

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² On January 6, 2011 the Water Survey of Canada station downstream of the Spillimacheen Generating Station recorded a discharge of approximately 8.0 m³/s.
Recommendation

Results show the trigger designed as part of the TOR can only partially be met under the best circumstances. It is the author’s recommendation that BC Hydro move towards a study design more closely linked to fish and fish populations that may utilize the Spillimacheen Canyon for overwintering purposes and the importance and quality of that habitat.
References


