Walter Hardman Project Water Use Plan

Walter Hardman Generating Station Tailrace Habitat Monitoring

Implementation Year 5

Reference: WHNMON-6

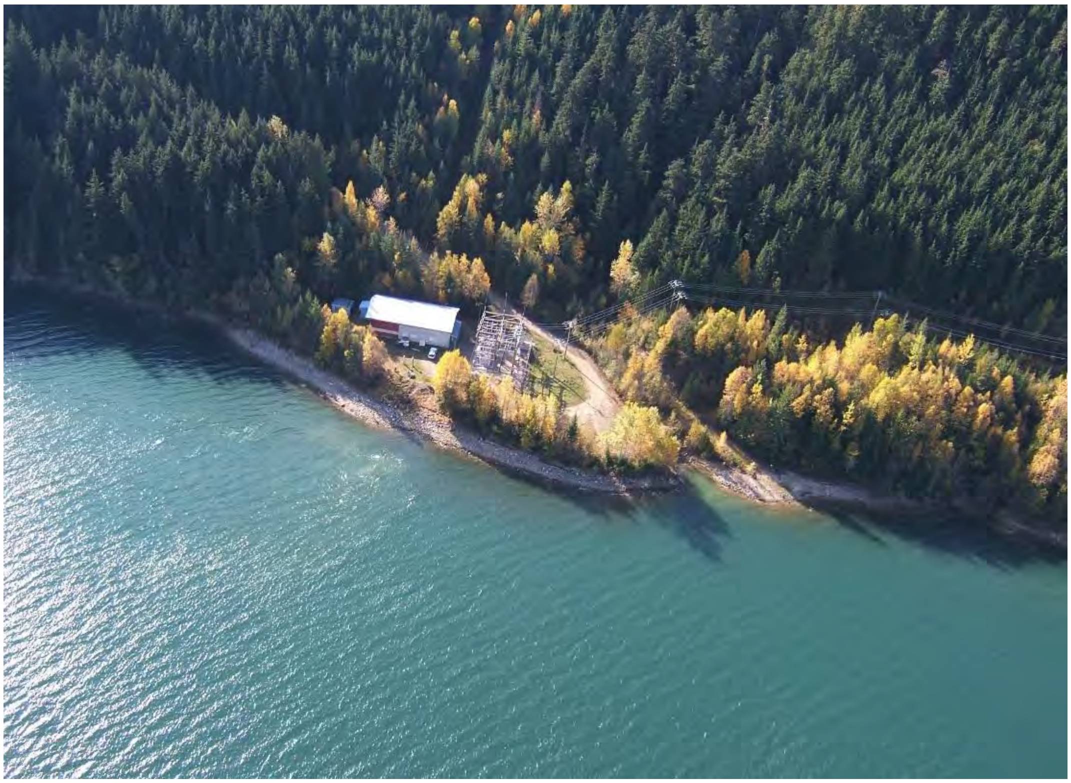
Walter Hardman Generating Station Tailrace Habitat Monitoring Final Report

Study Period: 2007 - 2012

K. Bray
Revelstoke, B.C.

June 2013

WHNMON-6 Walter Hardman Tailrace Habitat Monitoring Final Report



Walter Hardman Generating Station located on the west shore of
Arrow Lakes Reservoir (October 10, 2008, ALR elevation 437.95m)

Karen Bray, M.Sc., R.P.Bio.
Revelstoke, B.C.

June 2013

Executive Summary

A Water Use Plan for the Walter Hardman (WHN) Project was completed in 2006 following a year of public consultation. The Consultative Committee identified the potential impact of plant operations on kokanee (*Oncorynchus nerka*) use of the tailrace area as a data gap. The committee recommended a monitoring study to investigate kokanee use of a backchannel into which the tailrace discharge flows and implications of plant outages on kokanee use of that area. The Management Question addressed by the study is: *How do releases from the Walter Hardman powerhouse affect kokanee habitat in the tailrace channel? In particular, how do releases from the powerhouse affect kokanee spawning behaviour and success?*

Surveys of the WHN tailrace area were conducted each fall from 2007-2011 over the course of the kokanee spawning period. The area was surveyed and photographed and discharge and Arrow Lakes Reservoir (ALR) elevation obtained subsequently from BC Hydro records. Observations of the back channel during a scheduled plant outage were conducted on April 17, 2012. This was the first year the ALR was low enough to expose the entire back channel when the tailrace area was accessible and snow free. A plant outage was scheduled during regular maintenance activities in support of this project. Detailed observations were made and photographs taken of water levels and substrate at the base of the outlet structure before, during, and after plant operations ceased.

In order for kokanee redds in the back channel to be dewatered by a plant outage, four conditions are necessary. The first is an ALR elevation below at least 430 m in the fall spawning period so that a portion of channel unaffected by reservoir backwatering provides potential spawning habitat. The second is that suitable habitat exists in the channel and that kokanee actually spawn there. The third is that cessation of discharge from WHN would cause the channel to dewater, and the fourth is that the WHN generating station ceases generation for an extended period of time between October and June when it is assumed that kokanee eggs may be in the substrate and would suffer from dewatering, with November to March being the period when risk of freezing is greatest.

It was found that ALR elevations are rarely low enough to expose the back channel during the kokanee spawning period, that spawning habitat in the channel is severely limited and of such poor quality as to likely produce few to no fry, and that the WHN facility rarely experiences outages during the incubation or emergence period. Despite anecdotal observations of kokanee in spawning colouration at the tailrace outlet, there is, therefore, small likelihood this back channel area supports kokanee production or that plant operations have any substantive negative impact on kokanee observed at the tailrace or on overall ALR kokanee populations.

Acknowledgements

The following BC Hydro personnel are acknowledged for their contributions to this project.

Alan Laidlaw
Dennis Harper
Ernie Cottingham
Jason Portras
Koreen Morrone

Steve Arndt of Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) is gratefully acknowledged for report review.

Table of Contents

List of Figures

1.0 Introduction

The Walter Hardman (WHN) Project is an 8 MW facility located on Cranberry Creek approximately 25 kms south of Revelstoke along Highway 23 (Figure 1). Constructed in 1961 by the City of Revelstoke, the facility was purchased in 1972 by BC Hydro and consists of a diversion dam, diversion channel with flow control structures, small headpond with intakes, powerhouse with two turbines, and outlet (tailrace) into the Arrow Lakes Reservoir (ALR). Since decommissioning of Coursier Dam in 2003, there is only minor storage provided by the headpond and the facility is operated close to a run of river system.

A Water Use Plan (WUP) for WHN was completed in 2006 following a year of public consultation. Two physical works projects and six monitoring studies were recommended by the Consultative Committee (CC), most addressing data gaps on fisheries issues or monitoring related to the recommended minimum flow. The potential impact of plant operations on kokanee (*Oncorynchus nerka*) use of the tailrace area was identified by the CC as a data gap. Based on anecdotal information of spawning kokanee using a back channel influenced by powerhouse outflows, it was hypothesised that plant outages could result in dewatering of kokanee spawning and incubation habitat. The committee also considered the question of the powerhouse outflows attracting kokanee (BC Hydro 2004). Terms of Reference for WHNMON-6 were submitted to the CWR on September 22, 2006, and Leave to Commence was received November 8, 2006. This study satisfies Clause 1f, Schedule C of the Order dated March 22, 2006.

2.0 Management Question and Objectives

The Management Question to be addressed by this study is twofold:

> "*How do releases from the Walter Hardman powerhouse affect kokanee habitat in the tailrace channel? In particular, how do releases from the powerhouse affect kokanee spawning behaviour and success?"* (BC Hydro 2007, p. 37)

The Terms of Reference also state the objective as:

> "*to address a data gap regarding releases from the Walter Hardman powerhouse and associated effects on kokanee habitat in the tailrace channel (in upper Arrow Lakes Reservoir) and an isolated back channel that is influenced by outflow from the powerhouse. The monitoring program will identify the use of the tailrace and back channel by kokanee, assess the potential for kokanee redd dewatering, and show whether kokanee are attracted to powerhouse outflows*" (BC Hydro 2007 p.37).

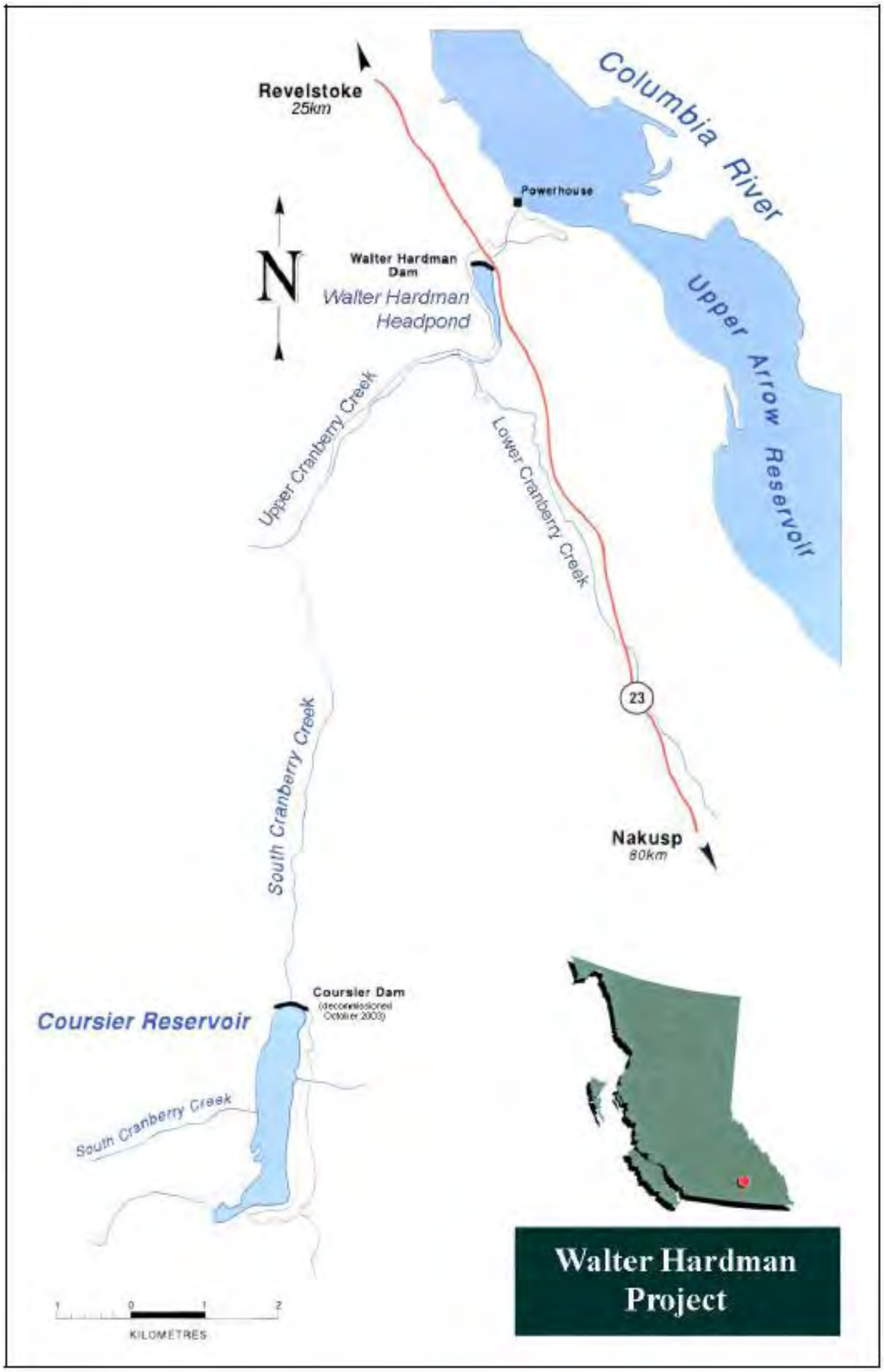


Figure 1. Location of the Walter Hardman facility.

3.0 Study Area

Cranberry Creek is a large (142 km^2), glacial system that drains icefields in the Monashee Mountains and discharges into the ALR. The WHN facility diverts water from Cranberry Creek at a point approximately 7 kms upstream of the confluence, passing flow through a diversion channel, into a headpond, and then through the penstock to the powerhouse located on the shore of ALR (formerly the Columbia River). The generating station operates two turbines capable of producing up to 8MW with a maximum withdrawal of 4.3 m^3/s from Cranberry Creek. Water from each turbine combines into a single underground steel pipe tailrace that discharges into a concrete outlet structure comprised of a stilling basin and a stepped drop. The WHN tailrace outlet structure is approximately 5 m high with the base at 430 m. At ALR elevation approximately 435 m the entire structure is submerged (Figure 2 and Figure 3). An additional small amount of water is discharged continuously into the stilling basin from the HVAC system. This water continues to flow even when the generating station is shut down.

Once discharged from the facility, water then passes into a back channel that is approximately 100 m long and can be from 3-5 m wide depending on the influence of ALR backwatering (Figure 3). At ALR elevations between 429 m and 430 m a.s.l., the backchannel begins to emerge as a distinct channel, albeit still influenced by reservoir levels at the higher elevations.

A minimum flow facility was constructed in 2008 at the diversion area to provide a continuous 0.1 m^3s flow into Lower Cranberry Creek. Prior to construction of this facility, all of the stream flow was directed into the headpond when discharge fell below 4.3 m^3/s, leaving Lower Cranberry Creek fed only by groundwater and local inflow. At times when Cranberry Creek discharge exceeded the plant capacity of 4.3 m^3/s, excess water would overtop the diversion dam and discharge into Lower Cranberry Creek, usually in spring to early summer during freshet although late summer or fall rain events can also raise the flow enough to overtop the diversion dam.

Cranberry Creek supports rainbow trout (Oncoryhnchus mykiss) throughout much of its length and kokanee in the lower 1.5 km. Kokanee are indigenous to the Arrow Lakes system and stocking of fish, predominantly from Kootenay Lake (Meadow Creek), was common through the 1980s and 1990s (Sebastian et al. 2000). All ALR kokanee are presumed to be stream spawners as there has been no evidence of shore spawning (Sebastian et al.2000).

Figure 2. Outlet structure with no turbine outflow. The small amount of discharge from the HVAC system can be seen at the far left of the structure (April 17, 2012). Walter Hardman Generating Station is in the background.

Figure 3. Aerial photograph of WHN generating station and back channel area April 28, 1996. Arrow Reservoir elevation was 428.6 m. Arrow points to outlet structure. Flow from the upstream Mid Columbia River to ALR goes from right to left in the photo.

4.0 Methods

Task 1. Undertake surveys of the tailrace and associated habitats each fall, during peak kokanee spawning, to obtain visual estimates of kokanee abundance and distribution.

Surveys of the WHN tailrace area were conducted each fall from 2007-2011 over the course of 4-6 weeks when kokanee have been observed in Lower Cranberry Creek during previous escapement counts (BC Hydro, data on file). Annual kokanee escapement counts of Lower Cranberry Creek were conducted usually in mid-September to coincide with time of peak spawning. Timing of peak spawning for ALR kokanee is determined through regular aerial escapement counts conducted by Ministry of Forest, Lands, and Natural Resource Operations (MNFLRO) and the Fish and Wildlife Compensation Program - Columbia (FWCP) staff in Nelson in support of the Arrow Reservoir Nutrient Restoration project. Dates for tailrace surveys and Cranberry Creek escapement counts are listed in Appendix A.

During each visit to the tailrace, the area was surveyed and photographed. The discharge and ALR elevation at the time of observations were obtained subsequently from BC Hydro records. In the peak kokanee spawning season, the tailrace discharge was observed for five one minute periods at intervals of fifteen minutes to observe and/or count any kokanee at the outlet and record their behaviour. Observations were made with polarised sunglasses and from viewpoints at both sides of the outlet structure (i.e., looking north and south).

Task 2. In a single year mid-winter period, undertake detailed habitat observations before and after a powerhouse shutdown to assess physical changes in habitat and implications for kokanee redd dewatering.

Observations of the back channel during a scheduled plant outage were conducted on April 17, 2012. This was the first year the ALR was low enough to expose the entire back channel when the tailrace area was accessible and snow free. A plant outage was scheduled during regular maintenance activities in support of this project. Photographs of the channel were taken at five minute intervals for 30 minutes from the start of the outage and cessation of flows and then at 45 minutes and one hour after flow stoppage. Detailed observations were made and photographs taken of water levels and substrate at the base of the outlet structure once turbine discharge had ceased.

Other checks for low water/dewatering were made opportunistically with other projects in the area (Appendix A). Conditions at the tailrace were photographed from shore or by air where possible. An additional check over the tailrace and back channel area was performed by boat in October 2007.

5.0 Results

5.1 ALR and WHN Operations

The ALR was considerably higher in fall and winter of the study period than in the previous five years during the WUP consultation process (Figure 4) and none of the back channel area was dewatered in the fall of any year. The mid-winter survey scheduled for Year 1 of the study as outlined in the TOR, therefore, was not conducted. The ALR must be below 430 m in order to begin exposing and differentiating channel habitat from ALR backwatering (Figure 5). As this elevation did not occur during the kokanee spawning season (September-October) of any year throughout the study period it was not possible to determine use of the back channel by spawning kokanee.

Forced plant outages, i.e., shutdowns not related to planned activities such as maintenance, are very infrequent at WHN. During the study period there were two scheduled plant outages in November 2009 and 2010 (Figure 6a) for maintenance purposes. No outages occurred when ALR was below 430 m. Over the previous ten years of record only one significant winter outage was recorded in January to April 2002 for integration of the Pingston IPP to the electrical system (Figure 6b). Only four forced outages occurred between 2002 and 2012, three of which lasted for less than 5 minutes (Nov 2003, June 2011, July 2012), only one of extended duration (July 2003) that lasted for 19 hours (BC Hydro, data on file). Below freezing temperatures are experienced generally from November to March (Figure 7).

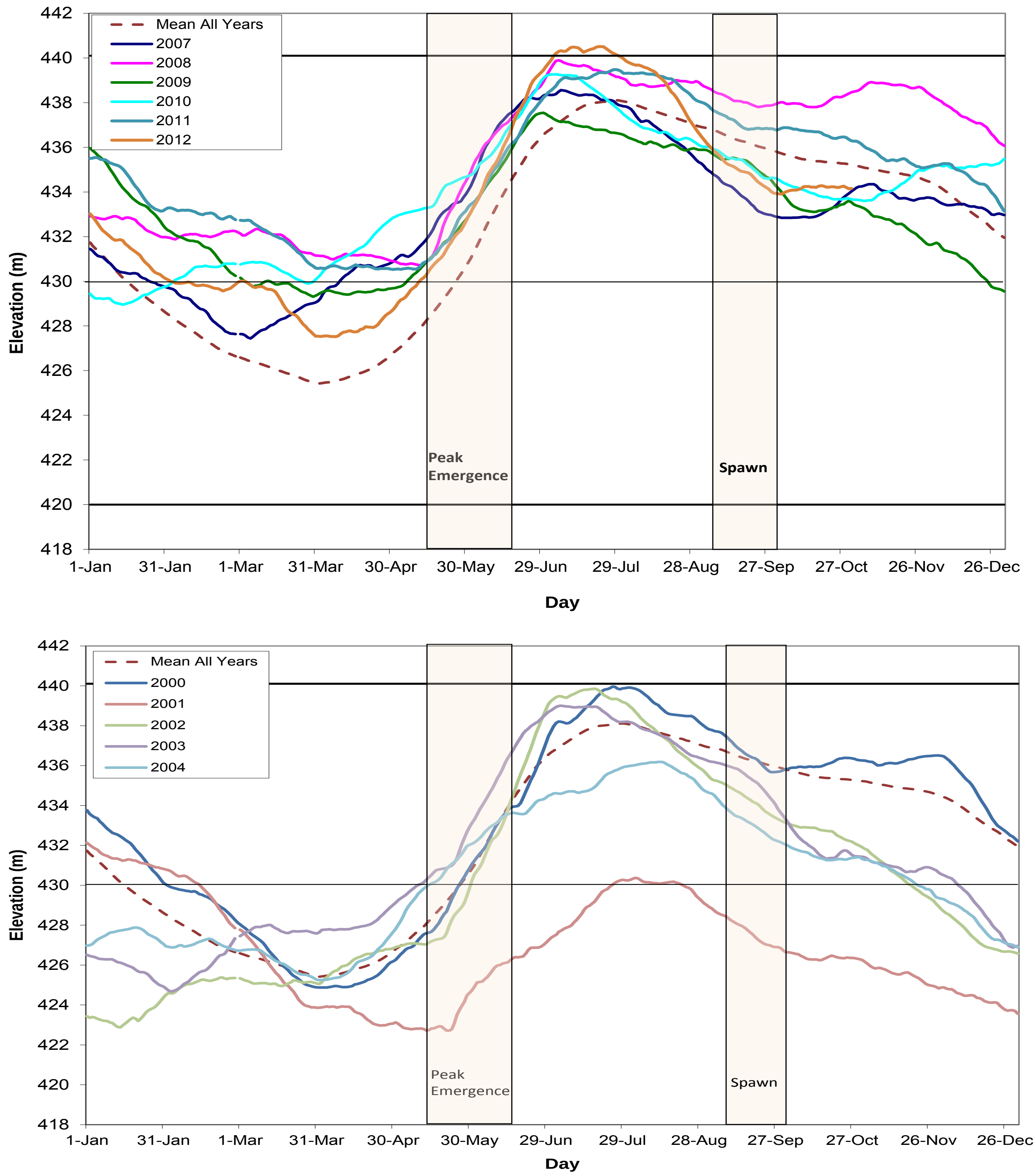
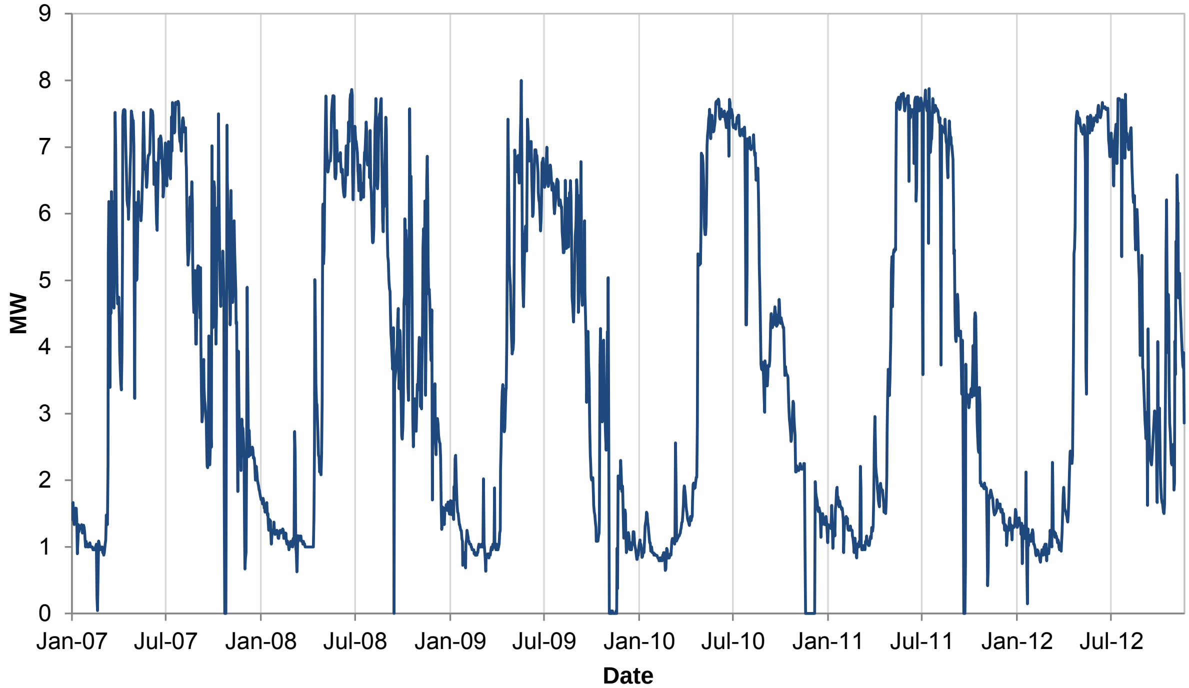


Figure 4. ALR elevations during the study period 2007-2012 (Top) and 2000-2004 (Bottom) during a period of unusually low water years. Mean is calculated for period of reservoir operation (1969-2012). Shaded areas cover peak fry emergence and spawning periods. Horizontal lines at 440, 420, and 430m show ALR maximum and minimum elevations and elevation at which the back channel is completely back watered by the reservoir, respectively.

(A) (B)

Figure 5. View of the back channel at ALR elevations (A) 427.7 m April 16, 2012, and (B) 429.5 m April 23, 2009.



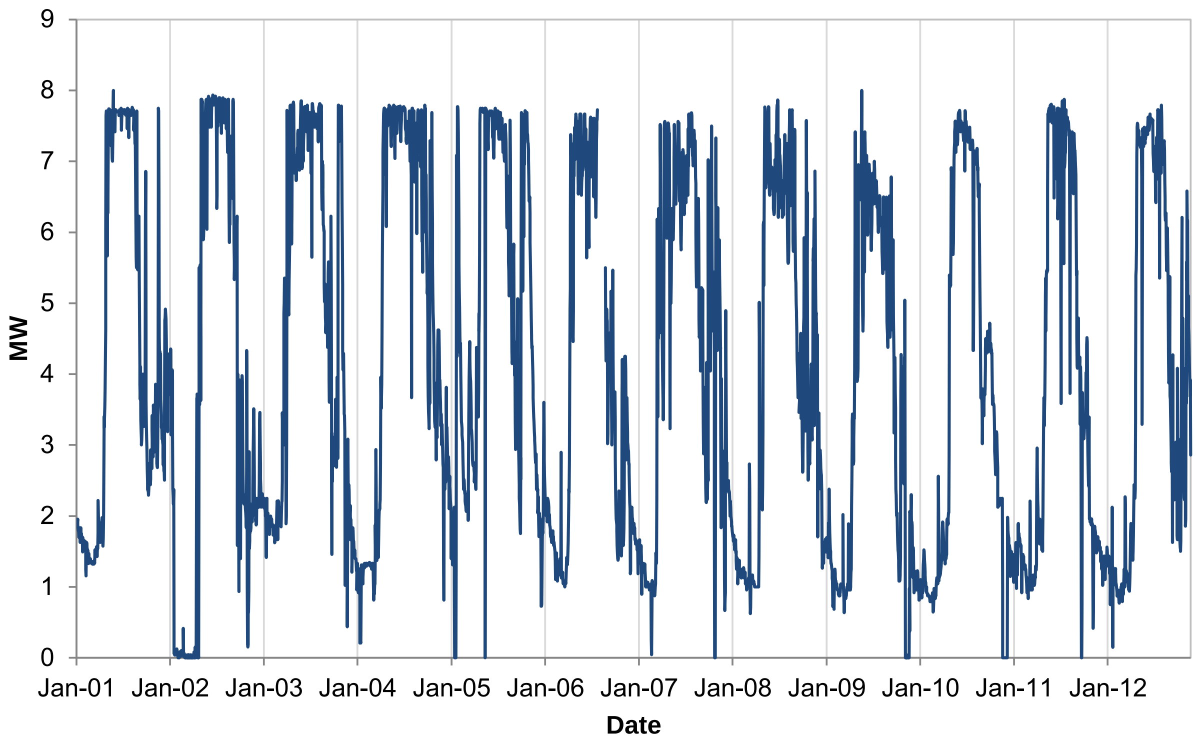


Figure 6. Average daily MW production at the Walter Hardman Facility (Top) 2007-2012 and (Bottom) 2001-2012.

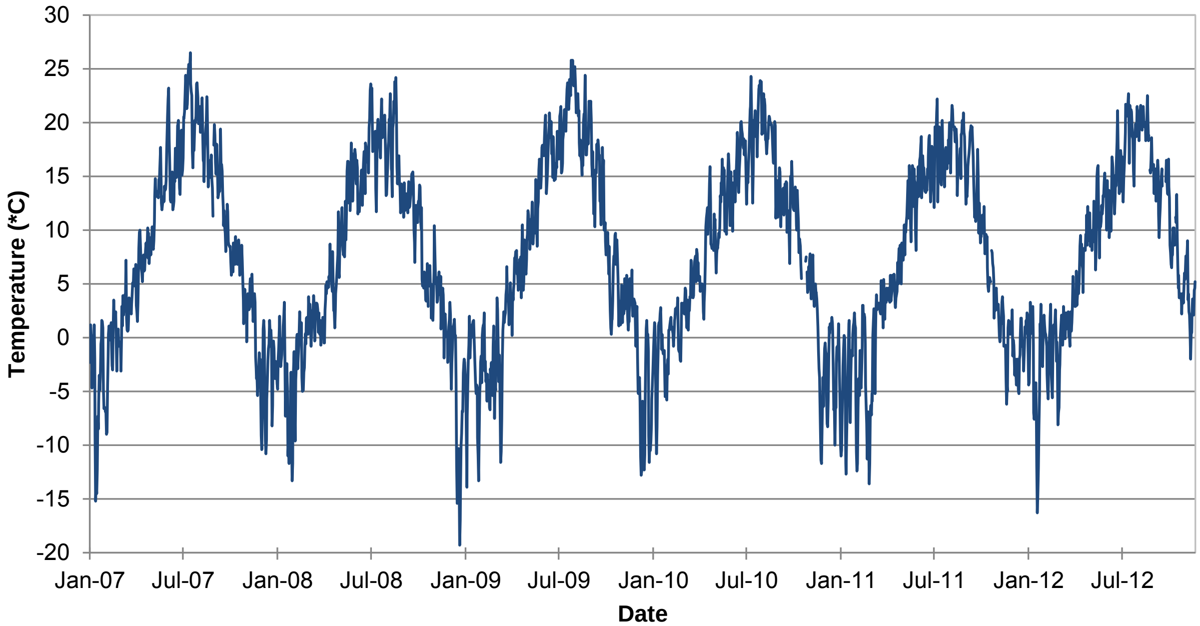


Figure 7. Average daily air temperature recorded at the Revelstoke Airport 2007-2012. (Data from Environment Canada).

5.2 Observation/Estimate of Kokanee Abundance

Kokanee were observed in the tailrace/back channel area during only one of five survey years. On September 29, 2009, kokanee were observed jumping into the stilling basin. A maximum of six kokanee were observed in a one minute interval attempting to or succeeding in jumping over the concrete sill into the stilling basin. Turbidity from Cranberry Creek discharge made it difficult to see kokanee unless they were within ~0.3 m of the surface and outside of the turbulence at the outlet itself (Figure 8). Due to the poor water clarity, turbulence, and observations of some kokanee falling out of the stilling basin, it is not known if the six fish were double counts or separate individuals. The ALR was at 434.5m and WHN plant discharge at 2 MW (~1.5 m^3/s) at the time the kokanee were observed. Anecdotal information from anglers and plant staff, however, support observations of kokanee at the plant outlet even when it is completely inundated.

(A) (B)

Figure 8. (A) Stilling basin when kokanee were observed on September 29, 2009, at ALR elevation 434.5m and (B) one kokanee in the stilling basin (arrow).

5.3 Tailrace Channel Habitat

Existence of a channel at the WHN tailrace is determined predominantly by ALR elevation. At ALR elevations near or above 430 m, the channel is completely inundated to the base of the outlet structure. At about 427 m to 428 m, the channel is no longer influenced by ALR elevations (Figure 3 and Figure 5).

Observations of the channel during a planned plant outage on April 17, 2012, demonstrate that even with cessation of plant discharge, most of the channel remains wetted (Figure 9). ALR elevation at the time was 427 m, therefore, the channel was not backwatered by the reservoir. A small amount of water from the plant's HVAC system is continuously discharged independent of any turbine flow (Figure 2).

(A) (B)

Figure 9. View of the outlet structure and back channel (A) prior to plant outage at Q=1.2 m^3/s and (B) one hour following outage, April 17, 2012.

Habitat at the base of the outlet structure is poor for spawning kokanee. The substrate is composed of large rock or angular rubble placed for protection of the structure or sand and silt laden cobble/gravel that would provide extremely poor conditions for redd excavation or egg deposition and incubation (Figure 10).

(A) (B)

Figure 10. Examples of substrate at the outlet structure showing either (A) rubble with no gravel or (B) cobble and gravel embedded in sand and silt. Wooden stake is 3.7 cm wide and 58.6 cm long for scale.

5.4 Kokanee Escapement in Cranberry Creek

As part of other BC Hydro programs, kokanee escapement counts have been conducted annually (as conditions permit) in Cranberry Creek since 1989. Kokanee are able to access ~2 kms of the lower river before encountering an impassable falls; however, most years spawners are found in only the lower ~1.4 kms, downstream of a bedrock canyon that is considered a velocity barrier to kokanee. Most years no kokanee are found in the drawdown zone and all spawning habitat is considered to be above the reservoir high water level. Escapement counts are conducted by ground at least once in mid-September (considered peak run timing) by two observers who survey the creek on foot from the confluence with ALR to the upstream limit of kokanee spawning.

Annual escapement numbers have varied considerably in Cranberry Creek, the variation comparable to Drimmie Creek, another index tributary located north of Cranberry Creek and draining from the Selkirk Mountains, the east side of the valley (Figure 11). The exceptionally high numbers in 2004 are mirrored in the overall ALR kokanee escapement that year. In 2010, the escapement count in Cranberry Creek was aborted twice due to poor visibility and unsafe conditions caused by heavy fall rain.

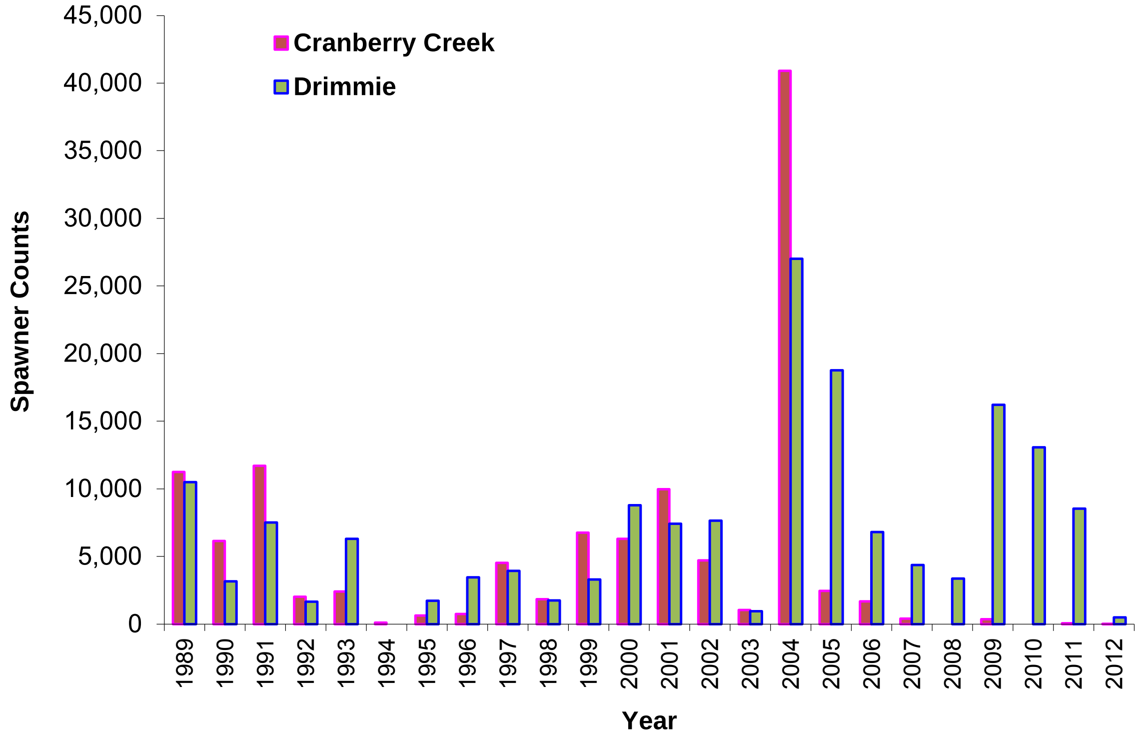


Figure 11. Kokanee spawner escapement counts for Cranberry and Drimmie Creeks, 1989-2012 (BC Hydro data on file).

6.0 Discussion

In order for kokanee redds in the back channel to be dewatered by a plant outage, four conditions are necessary. The first is an ALR elevation below at least 430 m in the fall spawning period so that a portion of channel unaffected by reservoir backwatering provides potential spawning habitat. The second is that suitable habitat exists in the channel and that kokanee actually spawn there. The third is that cessation of discharge from WHN would cause the channel to dewater, and the fourth is that the WHN generating station ceases generation for an extended period of time between October and June when it is assumed that kokanee eggs may be in the substrate and would suffer from dewatering, with November to March being the period when risk of freezing is greatest.

<u>*Condition 1 – ALR Levels*</u>

In forty-five years of operation (1968-2012), ALR has been near (within 0.2 m) or above 430 m between September 15th and October 15th for 91% (41 years) of the time. Of the four years when the levels were lower than 430 m, three were within a metre of 427 m and only in 1973 when construction was occurring on the Mica dam and affected inflow into ALR did the reservoir drop to 422 m. This means that in the 45 years of operation, ALR was below 427 m during the kokanee spawning period for three years, only one of which has occurred within the previous three decades (2001).

Condition 2 – Habitat Suitability

In the event the back channel is exposed as a flowing channel at least partly or wholly uninfluenced by ALR backwatering, habitat conditions are such that it is unlikely that kokanee would spawn there in any numbers or with any success. The channel substrate is mostly thick, soft sands and silts, the only gravel occurring in very small pockets at the base of the outlet works and those embedded in sand and silt (Figure 9 and Figure 10). Salmonids are known to prefer clean gravel for red building and avoid areas where gravel is firmly embedded in mud and silts (Burner 1951).

Condition 3 – Channel Dewatering Occurs

From observations on April 17, 2012, when ALR was at 427 m and the WHN plant was shut down, it was noted that water levels in the channel are not significantly affected by plant outages. The area directly at the base of the outlet structure is most affected by loss of discharge from the plant; however, most of the channel remains wetted (Figure 9).

Condition 4 – WHN Outages

Should kokanee use the sparse pockets of mostly unsuitable gravel/cobble and deposit eggs, in order to dewater the redds, the generating station would have to be shut down for an extended period of time between 15 October and 30 June. The frequency of plant outages during this period at WHN has been low. The last significant event occurred in January to April 2002 as a result of planned work to integrate the Pingston IPP. Forced outages during the incubation time frame have been rare in the last 10 years, only one occurring in November 2003 and that lasting for only a few minutes.

Attraction to the WHN Powerhouse

It cannot be determined if kokanee observed at the outlet at any given time are fish that would otherwise be bound for spawning in Cranberry Creek or if they are investigating flowing water or olfactory cues en route to other streams. Homing via visual and olfactory cues has been researched extensively in sockeye salmon (e.g. Quinn 1993; Stewart et al. 2004; Ueda, et al.1998; Vernon 1957) and results for naturally spawned fish indicate a high degree of fidelity to natal streams. There is also some evidence to suggest hatchery fish have greater straying rates (Quinn 1993). Kokanee entrained from Revelstoke Reservoir could also contribute to spawning runs in the Mid Columbia tributaries.

If Cranberry Creek kokanee are returning from the ALR to spawn most would presumably enter the creek without reaching the WHN tailrace outlet as the creek confluence is (~13 kms) farther south and would be encountered first, although some studies have found that fish will move back downstream if they pass their natal stream (e.g. cited in Chapman et al. 1997). Therefore some kokanee could pass by Cranberry Creek, investigate the discharge at the WHN tailrace outlet, and then move back downstream once they meet with little success at the powerhouse outlet.

Contribution to ALR Kokanee

Cranberry Creek is often an inhospitable stream for kokanee. Prior to construction of the WHN plant and diversion of flows, natural fall discharges would have been cold and turbid, and especially subject to flashy peaking during fall rain events. The substrate is generally large and suitable spawning gravel is found in small isolated pockets or occasional pool or tailwater areas (Triton 2012). Notably, these habitat conditions in Lower Cranberry Creek that had remained relatively unchanged for many years were dramatically altered in 2012. An unusually wet spring and high discharge resulted in significant erosion and bedload transport that has improved habitat in the lower creek through deposition of gravel and restructuring pools and riffles.

Escapement counts in Cranberry Creek have been low most years and particularly low over the past five years of this study (Figure 11). The success of egg to fry survival is unknown, but Bradford (1995) found 7-9% to be the average in a review of freshwater sockeye populations. While natural stream production of kokanee is valuable and desirable, the contribution of Cranberry Creek to the ALR population is likely very low. From 1989-2011, Cranberry Creek spawner escapement has been an average of 2.14% of the total Upper Arrow escapement count, 1.86% when the unusually large year of 2004 is omitted. From 2007-2011, the proportion of kokanee escapement in Cranberry Creek to total Upper Arrow escapement dropped to 0.11% (MFLNRO, unpublished data). In comparison, Drimmie Creek, located north of Cranberry Creek on the east side of the valley, contributes on average 3.43% of the total Upper Arrow escapement (3.35% without 2004 included). Between 2007-2011, Drimmie Creek kokanee escapement averaged 3.97% of the total Upper Arrow tributaries (MFLNRO, data on file). The length of accessible stream habitat in Cranberry Creek is between 1.7 km and 2.3 km (depending on the numbers and flows that encourage and allow for access above the bedrock canyon) while there is roughly 1 km of useable spawning habitat in Drimmie Creek.

7.0 Conclusions

The WUP CC were concerned that generating station discharge of Cranberry Creek water attracts kokanee and encourages spawning in the back channel fed by the plant discharge. The committee postulated that plant shutdown events, particularly in winter, at the Walter Hardman Generating Station could potentially dewater and freeze kokanee redds in the back channel. The Management Question for this study relates to how releases from the powerhouse affect kokanee spawning habitat and, in particular, spawning behaviour and success in the tailrace channel.

Given that ALR elevations are rarely low enough to expose the back channel during the kokanee spawning period, that spawning habitat in the channel is severely limited and of such poor quality as to likely produce few to no fry, and that the WHN facility rarely experiences outages during the incubation or emergence period, there is scant likelihood that, despite any attraction of kokanee to the plant discharge, this back channel area supports kokanee production. Therefore, it is not likely a significant source of egg or fry mortality.

The concerns expressed via the Management Questions, therefore, have been addressed. Normal operation of the WHN facility can be considered to have no substantive negative impact on kokanee observed at the tailrace or on overall ALR kokanee populations.

8.0 Literature Cited

BC Hydro. 2004. Walter Hardman Water Use Plan Consultative Committee Report. Prepared on behalf of the Consultative Committee for the Walter Hardman Water Use Plan.

BC Hydro. 2006. Walter Hardman Project Water Use Plan. Revised for Acceptance by the Comptroller of Water Rights. 13pp.

BC Hydro. 2007. Walter Hardman Project Water Use Plan Monitoring Program Terms of Reference. 40 pp.

Bradford, M.J. 1995. Comparative review of pacific salmon survival rates. CJFAS 52: 1327-1338.

Burner, C.J. 1951. Characteristics of spawning nests of Columbia River salmon. U.S. Fish and Wildlife Service, Fishery Bulletin 61: 95-110.

Chapman, D., C. Carlson, D. Weitkamp, G. Matthews, J. Stevenson, and M. Miller. 1997. Homing in sockeye and Chinook salmon transported around part of their smolt migration route in the Columbia River. NAJFM 17:101-113.

Quinn, T.P. 1993. A review of homing and straying of wild and hatchery-produced salmon. Fisheries Research 18:29-44.

Sebastian, D., H. Andrusak, G. Scholten, and L. Brescia. 2000. Arrow Reservoir Fish Summary. BC Ministry of Fisheries, Stock Management Report. 87 pp. + app.

Stewart, I.J., S.M. Carlson, C.P. Boatright, G.B. Buck, and T.P. Quinn. 2004. Site fidelity of spawning sockeye salmon (*Oncorhynchus nerka* W.) in the presence and absence of olfactory cues. Ecology of Freshwater Fish 13: 104-110.

Triton Environmental Consultants Ltd. 2012. WHNMON-1 Lower Cranberry Creek: Kokanee Spawning and Incubation Habitat Monitoring. Prepared for BC Hydro. 21 pp + app.

Ueda, H., M. Kaeriyama, K. Mukasa, A. Urano, H. Kudo, T. Shoji, Y. Tokumitsu, and K. Kuirhara. 1998. Lacustrine sockeye salmon return straight to their natal area from open water using both visual and olfactory cues. Chem. Senses 23:207-212.

Vernon, E.H. 1957. Morphometric comparison of three races of kokanee (Oncorhynchus nerka) within a large British Columbia lake. J. Fish. Res. Bd. Canada. 14:573-598.

Appendix A

WHN tailrace area survey method and Cranberry Creek escapement count dates 2007-2012.

Date of Survey	Arrow Reservoir Elevation (m) (at time of survey)	Method
2007		
September 13, 2007	434.2	Ground. Kokanee ground count in Cranberry Creek.
September 24, 2007	433.1	Ground
October 9, 2007	432.8	Ground
October 15, 2007	432.9	Ground
October 30, 2007	433.9	Ground
2008		
March 17 and 31, 2008	432.1/431.1	Air
September 18, 2008	438	Ground
September 24, 2008	437.8	Kokanee ground count in Cranberry Creek.
October 2, 2008	438	Ground
October 10, 2008	437.9	Air
2009		
April 23, 2009	429.5	Ground
September 21, 2009	435.4	Kokanee ground count in Cranberry Creek.
September 29, 2009	434.5	Ground
September 30, 2009	434.4	Air
November 10, 2009	433	Ground
2010		
September 1, 2010	436.1	Ground
September 16 and 22, 2010	435.4	Kokanee ground count attempted in Cranberry Creek. Count not be conducted due to high water from heavy fall rainfall.
September 29, 2010	434.6	Air
October 21, 2010	433.7	Ground
2011		
May 13, 2011	430.8	Air
September 16, 2011	437	Ground
September 21, 2011	436.8	Kokanee ground count in Cranberry Creek
September 28, 2011	436.8	Air
November 1, 2011	436	Ground
2012		
April 16, 2012	427.7	Ground
April 18, 2012	427.7	Observations and survey of channel during plant outage
July 24, 2012	440.5	Ground
September 19, 2012	434.7	Kokanee ground count in Cranberry Creek.