Columbia River Project Water Use Plan

Lower Columbia River Fish Stranding Assessment and Ramping Protocol

Implementation Year 7

Reference: CLBMON-42A

Lower Columbia River [CLBMON#42(A)] and Kootenay River Fish Stranding Assessments

Study Period: April 1, 2013 to April 1, 2014

Golder Associates Ltd.
201 Columbia Ave
Castlegar, BC
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May 30, 2014

May 30, 2014

ANNUAL SUMMARY REPORT

Lower Columbia River [CLBMON#42(A)] and Kootenay River Fish Stranding Assessments: Annual Summary (April 2013 to April 2014)

Submitted to:
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REPORT

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Cover Photo: CPR Island site looking downstream. The start of pool formation is evident in the foreground.

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Executive Summary

Discharge reductions and flow ramping from Hugh L. Keenleyside Dam/Arrow Lakes Generating Station (HLK/ALH) and Brilliant Dam/Expansion (BRD/X) can result in stranding of native fish species of the lower Columbia and Kootenay rivers. The program assessed fish stranding at pre-determined sites (Appendix A) between HLK and the Canada/USA border. The revised fish stranding protocol, "Canadian Lower Columbia River: Fish Stranding Risk Assessment and Response Strategy" (Golder 2011), was intended to decrease the number of flow reductions that required stranding assessments. The number of occurrences when stranding crews were deployed due to flow reductions from HLK has remained constant over the past five years of data collection. The number ranged from 10 to 15 deployments with crews going out on an average of 84% of the reductions. Since there were higher than normal water levels in the Columbia and Kootenay rivers in the past two years, an increase in reduction events (REs) was recommended. These REs occurred during the time period where flows were outside the normal range of flows in the Lower Columbia River Fish Stranding Database (the database) and therefore reconnaissance assessments were recommended to help to identify areas of risk for future flow reductions within that range. Over time the number of flow reductions requiring assessments may decrease as the continued collection of data will eliminate data gaps in less common discharge levels and will further focus stranding assessment efforts.

This report summarizes the information collected following flow reductions at HLK/ALH on the Columbia River and BRD/X on the Kootenay River. Stranding assessments were conducted for 14 of 17 REs that occurred between April 1, 2013 and April 1, 2014. One assessment was conducted in response to flow reductions from BRD/X and 13 assessments were in response to flow reductions from HLK/ALH. An estimated 4845 isolated or stranded fish were observed during the 14 REs. The majority (75%) of stranded fish were observed during the six REs that occurred during the known high stranding risk period (June 1 to September 30). None of the stranding assessments conducted during the sample period were classified as a "significant" stranding event (>5000 fish observed).

Information from the two systems (HLK/ALH and BRD/X) was combined into a single document. Fish stranding in the study area from HLK to the Canada/USA border, including the Kootenay River below BRD, is influenced by both dams and the key variables that affect fish stranding are thought to be similar for both dams. Since each system has unique operation management strategies and operation drivers, distinct information for each system has been identified. [i.e., the Water Use Planning Objectives, Management Questions and Hypotheses specific to CLBMON #42A (Table ES1)].

Table ES1: CLBMON #42A Status of Hugh L. Keenleyside Dam Program Objectives, Management Questions and Hypotheses.

Primary Objective	Secondary Objectives	Management Questions	Management Hypotheses	Year 5 (2013/2014) Status
To assess the impact of flow reductions and flow ramping rates from HLK on the native species of the lower Columbia River.	To determine ramping rates for flow reductions which reduce the stranding rate of fish at different times of the year.	Is there a ramping rate (fast vs. slow, day vs. night) for flow reductions from HLK that reduces the number of fish stranded (interstitially and pool) per flow reduction event in the summer and winter?	The number of stranded fish is independent of either the ramping rate or time of day of flow reductions in the summer and winter.	Previous studies suggested that ramping rates were not a statistically significant predictor of fish stranding (Golder/Poisson 2010). No additional data collected during this study period.
	To determine whether the wetted history influences the stranding rate of fish for flow reductions.	Does wetted history (length of time the habitat has been wetted prior to the flow reduction) influence the number of fish stranded (interstitially and pool) per flow reduction event for flow reductions from HLK?	Wetted history does not influence the stranding rate of fish (both interstitially and pool stranding) for flow reductions from HLK.	Wetted history influences the stranding rate of fish. A significant increase in the number of stranded fish was observed after a 10-day wetted history, although the effect size (rate of stranding as a function of days of wetted history) was not accurately described (Golder/Poisson 2010). No additional data collected during this study period.
	To determine whether a conditioning flow reduction from HLK reduces the stranding rate of fish.	Can a conditioning flow (temporary, one step, flow reduction of approximately 2 hours to the final target dam discharge that occurs prior to the final flow change) from HLK reduce the stranding rate of fish?	A conditioning flow from HLK does not reduce the stranding rate of fish in the lower Columbia River.	Hypothesis cannot be rejected at this time due to the limited data and the preliminary stages of analysis (Golder/Poisson 2010). No additional data collected during this study period.
	To determine whether physical habitat manipulation will reduce the incidence of fish stranding.	Can physical habitat works (i.e., re-contouring) reduce the incidence of fish stranding in high risk areas?	Physical habitat manipulation does not reduce the stranding rate of fish in the lower Columbia River.	Previous studies demonstrated that physical habitat manipulation reduces incidences of fish stranding. The effect size (rate of stranding reduction) has not been adequately quantified.
	Reduce the number of occurrences when a stranding crew would be deployed for a flow reduction.	Does the continued collection of stranding data, and upgrading of the lower Columbia River stranding protocol, limit the number of occurrences when stranding crews need to be deployed due to flow reductions from HLK?	The number of fish salvage events can be reduced through adaptive adjustments made as a result of ongoing data collection.	Data collected over the previous 5 years does not support this hypothesis. Continued collection of stranding data and upgrading the Columbia River stranding protocol has not decreased the number of stranding events where crews were deployed. The number of occurrences when stranding crews were deployed due to flow reductions from HLK has remained fairly constant over the past five years of data collection. The number ranged from 10 to 15 deployments with crews going out on an average of 84% of the reductions.

Key Words

Lower Columbia River

Kootenay River

Water Use Planning

Fish Stranding

Flow Reduction

Discharge Regulation

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1.0 INTRODUCTION

1.1 Scope and Objectives

The main objective of the monitoring program was to collect fish stranding data to assess the impact of flow reductions and flow ramping rates from Hugh L. Keenleyside Dam/Arrow Lakes Generating Station (HLK/ALH) and Brilliant Dam/Expansion (BRD/X) on native fish species of the lower Columbia and Kootenay rivers. The program assessed fish stranding at pre-determined sites (Appendix A) between Hugh L. Keenleyside Dam (HLK) and the Canada/USA border. Secondary objectives included: 1) determining ramping rates for flow reductions that reduced incidences of fish stranding at different times of the year; 2) determining whether wetted history influenced the stranding rate of fish during flow reductions; 3) determining whether a conditioning flow reduction from HLK reduced the stranding rate of fish; 4) determining whether physical habitat manipulation (e.g., re-contouring the shoreline) reduced incidences of fish stranding in the lower Columbia River; and, 5) reducing (through risk management strategies) the number of occurrences when stranding crews needed to be deployed during flow reductions (BC Hydro 2007).

This report describes the results of fish stranding assessments conducted in the lower Kootenay and Columbia rivers from April 2013 to April 2014. Results are compared with data from previous years of monitoring and are discussed in relation to the objectives, management questions, and hypotheses outlined above and below.

1.2 Management Questions

The key management questions identified under the Columbia Water Use Plan and addressed under the current monitoring program are (BC Hydro 2007):

1) Is there a ramping rate (fast vs. slow, day vs. night) for flow reductions from HLK that reduces the number of fish stranded (interstitially and pool) per flow reduction event in the summer and winter?

2) Does wetted history (the length of time the habitat has been wetted prior to the flow reduction) influence the number of fish stranded (interstitially and pool) per flow reduction event for flow reductions from HLK?

3) Can a conditioning flow (a temporary, one step, flow reduction of approximately 2 hours to the final target dam discharge that occurs prior to the final flow change) from HLK reduce the stranding rate of fish?

4) Can physical habitat works (i.e., re-contouring) reduce the incidence of fish stranding in high risk areas?

5) Does the continued collection of stranding data, and upgrading of the lower Columbia River stranding protocol, limit the number of occurrences when stranding crews need to be deployed due to flow reductions from HLK?

1.3 Management Hypotheses

For fish stranding in the lower Columbia River, the following hypotheses (BC Hydro 2007) will be tested:

Ho_1: The number of stranded fish is independent of either the ramping rate or time of day of flow reductions in the summer and winter.

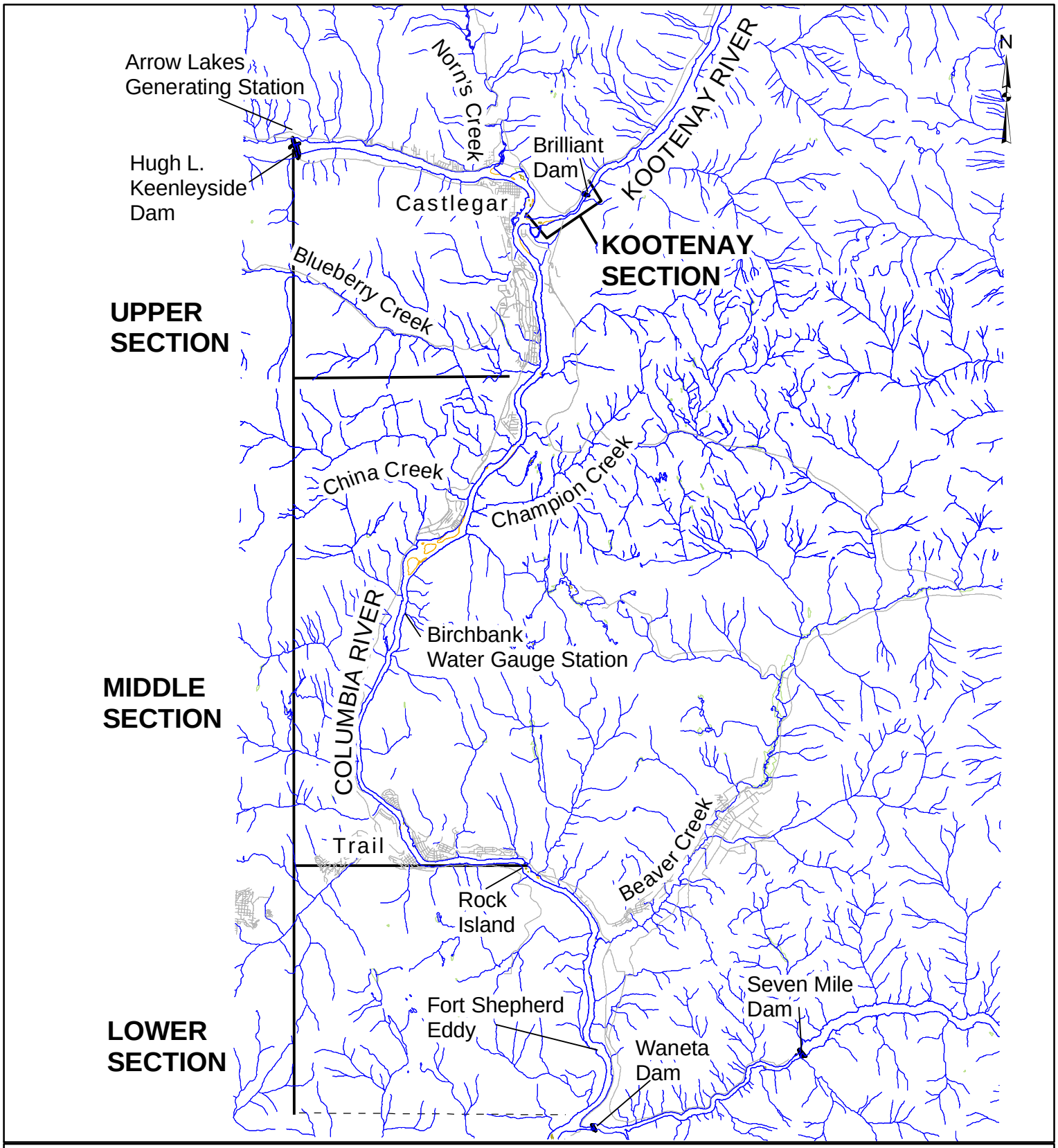
Ho_2: Wetted history does not influence the stranding rate of fish (both interstitially and pool stranding) for flow reductions from HLK.

Ho_3: A conditioning flow from HLK does not reduce the stranding rate of fish in the lower Columbia River.

Ho_4: Physical habitat manipulation does not reduce the stranding rate of fish in the lower Columbia River.

1.4 Study Area

The study area encompasses the approximately 56 km long section of the lower Columbia River from HLK to the Canada/USA border and the lower Kootenay River (approximately 2 km) from below BRD/X to the Columbia River confluence (Figure 1).



Legend

- River/Stream
- Island
- Road

5 0 5
SCALE 1:200,000 KILOMETRES

PROJECT
Lower Columbia River and
Kootenay River Fish Stranding

TITLE
Study Area Overview

REFERENCE

Digital Data Sets 082F.002, 082F.003, 082F.012, 082F.013, 082F.022, 082F.023, 082F.032, 082F.033 from BC Hydro. Datum: NAD 83 Projection: UTM Zone 11

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
DESIGN	SS	24 May 2012	Figure 1	
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

2.0 METHODS

2.1 Fish Stranding Risk Assessment

The fish stranding protocol *Canadian Lower Columbia River Fish Stranding Risk Assessment and Response Strategy* (Golder 2011) was implemented preceding each reduction event and during all of the stranding surveys that were conducted and included in this summary. Fish stranding protocols were previously developed by BC Hydro, Columbia Power Corporation (CPC) and FortisBC, in collaboration with Columbia Operations Fish Advisory Committee (COFAC). The protocols were developed to manage fish impacts associated with flow reductions from HLK/ALH and the Kootenay system. Fish stranding risk was based on current knowledge of factors known to influence fish stranding in regulated systems and the results of previous stranding assessments (Vonk 2003, BC Hydro 2005, Golder and Poisson 2010). An evaluation of fish stranding risk was based on the current environmental conditions at the time of the reduction and the results of previous stranding assessments. The risk periods were designated as 'High Risk' or 'Low Risk' based on the probability of stranding fish and used the criteria below.

Risk periods were defined by:

- **Timing of Reduction**- Day of Year is a proxy for fish use of near-shore habitats which is similar in timing with the previous protocol. The high stranding risk period occurs from June 1 to September 30; the Low Risk period occurs from October 1 to May 31 (Golder and Poisson 2010). Stranding risk is greatest in the summer months because newly emerged juvenile fish occupy shallow near-shore habitats where they are more susceptible to stranding (Golder and Poisson 2010).
- **River Stage**- The probability of fish stranding is typically inversely related to water levels. The steeper substrate gradient and presence of shallow depressions at lower water levels result in greater risk of fish stranding than during higher water levels. During the High Risk period (June 1 to September 30), fish stranding risk is less when discharge is greater than 110 kilo cubic feet per second (kcfs) (based on limited data). During the Low Risk period (October 1 to May 31), stranding risk decreases when discharge is greater than 60 kcfs (Golder and Poisson 2010).

The Lower Columbia River Fish Stranding Database was developed to archive historic flow reduction assessment data (discharge levels, ramping rates, sites, number of pools isolated, number and species of fish/egg stranded either interstitially or within pools, etc.) for use in predicting the potential impacts of a proposed flow reduction. Data from each stranding survey were entered into a MS-Access database. A database operating manual assists with the operation and maintenance of the database (Golder 2005).

The database is queried to help define fish stranding risk at a particular site based on historical data collected during similar times of the year under similar flow conditions. Data entered into the query include daily discharge from HLK/ALH and BRD/X (current) and proposed resultant daily discharge from HLK/ALH and BRD/X, the Columbia River water temperature from Birchbank Water Station and the date of the proposed reduction. Based on these data, the database provides a prediction of stranding risk at individual sites.

A fish stranding event at a site is defined as having a 'Minimal Effect' when the site has a history of stranding less than 200 fish. A fish stranding event at a site is defined as likely having an 'Effect' when the maximum number of fish stranded at the site at one time has been equal to or greater than 200 fish (all species combined), or when species of conservation concern (i.e., species listed under Canada's Species at Risk Act or the British

Columbia Conservation Data Centre's red or blue lists) have been recorded at the site at similar flow levels. A site is defined as a 'Recon' site if it has been visited less than five times and there are insufficient data to classify the site under one of the other categories. A site is defined as a 'No Pools' site if pools have never been recorded at the site during assessments conducted under similar conditions (river level and reduction amount).

A 'Significant Effect' is defined as greater than 5000 stranded fish of all species identified during a single flow reduction event (all sites combined). It is uncertain if this level of stranding would result in a population level effect for a given species therefore, stranding of this magnitude requires a thorough assessment and, in some cases may warrant additional management attention (e.g., alterations to the flow reduction strategy), particularly where threatened or endangered species are involved (Golder 2011).

The fish stranding risk categories (i.e., minimal effect, effect, or significant effect) are defined based on absolute numbers of fish that were stranded during previous assessments (Golder 2011) and do not take into account the survey effort in time or area. As it is the number of stranded fish that could have population level impacts, and not the areal density of stranded fish, the absolute numbers are appropriate guidelines for stranding risk. The assumptions of using the absolute numbers of stranded fish to define risk are that all the area of isolated pools are searched, and that the amount of time spent searching pools and the efficiency in detecting fish are constant among surveys. These assumptions are likely reasonable, as all the area of pools are typically searched, experienced survey crews attempt to have similar search effort among surveys, and pool habitats are typically simple, which likely results in consistent detection efficiency over time. However, it is possible that not all stranded fish are detected during assessments, leading to underestimates of the stranding risk in terms of the number of fish. As the thresholds for an 'Effect' (>200 fish) or 'Significant Effect' (>5000 fish) are often based on approximate visual estimates, and these guidelines are used consistently over time, these methods are unlikely to seriously bias the stranding risk categories predicted by using the Lower Columbia River Fish Stranding Database. However, if managers wish to validate assumptions of this method or refine estimates of the number of stranded fish, then additional studies or modifications to the assessment and survey protocols would be necessary.

The highest priority for the sites selected for fish salvage and surveying in 2013/2014 were sites likely to have an 'Effect', based on projected flow conditions and the stranding history classification that has been assigned in the database. The next priorities were 'Reconnaissance' sites, and, if time permitted, 'Minimal Effect' or 'No Pools' sites to confirm information in the database. Data in the database are summarized and presented in a report "Stranding Risk Assessment Output".

2.2 Salvage Methods

Standard methodologies used during the field component for each fish stranding assessment were outlined in the *Canadian Lower Columbia River Fish Stranding Risk Assessment and Response Strategy* (Golder 2011) and are summarized below. The primary objective was to collect information on effects of flow reduction on fish stranding with fish salvage as a secondary objective. Fish stranding and salvage assessments began at the most upstream site identified for assessment by the Lower Columbia River Fish Stranding Database Fish Stranding Database query and continued downstream following the stage recession. The crew was on site no later than one hour after the initiation of a flow reduction from HLK/ALH or BRD/X.

At each site the crew conducted the following activities:

1) Documented the current conditions (date, time, weather, air and water temperature, approximate vertical drawdown of the water level, etc.) on Stranding Field Forms.

2) Observed and recorded the number of new isolated pools (pools isolated during prior reductions were not enumerated) that were created as a result of the flow reduction.

3) Inspected each pool for fish and attempted to salvage any fish that were present using dipnets, backpack electrofishers (Smith-Root Model LR 24 or 12-B POW), or beach seines.

4) Transferred the captured fish into a bucket of water where each fish was identified to species and life stage and released into the main channel of the river. Where possible, fish were classed into one of the following life stages; egg, young-of-the-year, juvenile, and adult. If stranded fish were numerous (>200), subsamples of the catch were examined. If field identification to species was not possible, a subsample of up to approximately 30 individuals was preserved for positive laboratory identification. Samples were preserved in *Prefer*™ solution for identification in the laboratory.

5) Visually estimated the number of larvae and alevins present if sample methods were ineffective at capturing these life stages.

6) Inspected interstitial stranding areas and salvaged any fish observed.

7) Photographed representative areas of the site at the time of sampling and photographed representative or unusual fish species where appropriate.

8) Fish length data was collected from up to 20 individuals of each species identified during each reduction event.

The collection of fish fork length data was proposed in the *Columbia River Project Water Use Plan Monitoring Program Terms of Reference - Lower Columbia River Fish Management Plan (CLBMON-42 Lower Columbia River Fish Stranding Assessment and Ramping Protocol, 31 August 2007)*. These data were collected and will be used to investigate whether there is a size at which certain species are more susceptible to stranding.

All length data previously collected were combined, in order to increase the sample size available to assess the frequency of stranding of different size-classes. Combining all length data for each species was considered reasonable based on the assumption was that there was very little variation in length of individuals sampled between years. Length-frequency data is presented for seven non sportfish species [Longnose Dace (*Rhinichthys cataractae*), Northern Pikeminnow (*Ptychocheilus oregonensis*), Prickly Sculpin (*Cottus asper*), Redside Shiner (*Richardsonius balteatus*), sucker species (Catostomidae), Torrent Sculpin (*Cottus rhotheus*) and Umatilla Dace (*Rhinichthys umatilla)*] and one sportfish species [Rainbow Trout (*Oncorhynchus mykiss*)].

3.0 RESULTS

3.1 Operations Overview 2013/2014

3.1.1 Columbia River Discharge

Mean daily discharge in the Columbia River at the Birchbank gauging station ranged from 37.3 kcfs to 156.6 kcfs in 2013/2014).

3.1.2 Hugh L. Keenleyside and Arrow Lakes Generating Station (HLK/ALH)

From April 1, 2013 to April 1, 2014, the Columbia River mean hourly discharge from HLK/ALH ranged from a minimum of 20.1 kcfs on February 20, 2014 to a maximum of 75.6 kcfs on July 16, 2013. During the study period, there were 16 operational flow reduction events (REs) from HLK/ALH (Figure 2).

Of the 16 REs, eight occurred during the High Risk period (June 1 to September 30) and eight occurred during the Low Risk period (October 1 to May 31). The magnitude of flow reductions ranged from 3.0 to 15.0 kcfs.

3.1.3 Brilliant Dam and Brilliant Expansion (BRD/X)

From April 1, 2013 to April 1, 2014, the Kootenay River mean hourly discharge from BRD/X ranged from a minimum of 15.4 kcfs on March 2, 2014 to a maximum of 89.0 kcfs on June 25, 2013. During the study period, there was one operational Base Flow RE from BRD/X (Figure 2). This operational Base Flow (defined as the minimum average hourly discharge from BRD/X that occurred during the previous 48 hrs) RE occurred during the High Risk period. The magnitude of flow reduction was 14 kcfs. Load factoring, which results in shaping average daily inflows into peak discharge during high load hours (typically 0600 to 2200 hrs) and minimum discharge during low load hours (typically 2200 to 0600 hrs), can occur when Kootenay River inflows are between 18.0 and 43.0 kcfs. Load factoring occurred during August and November/December. Flow reductions associated with load factoring were not considered REs.

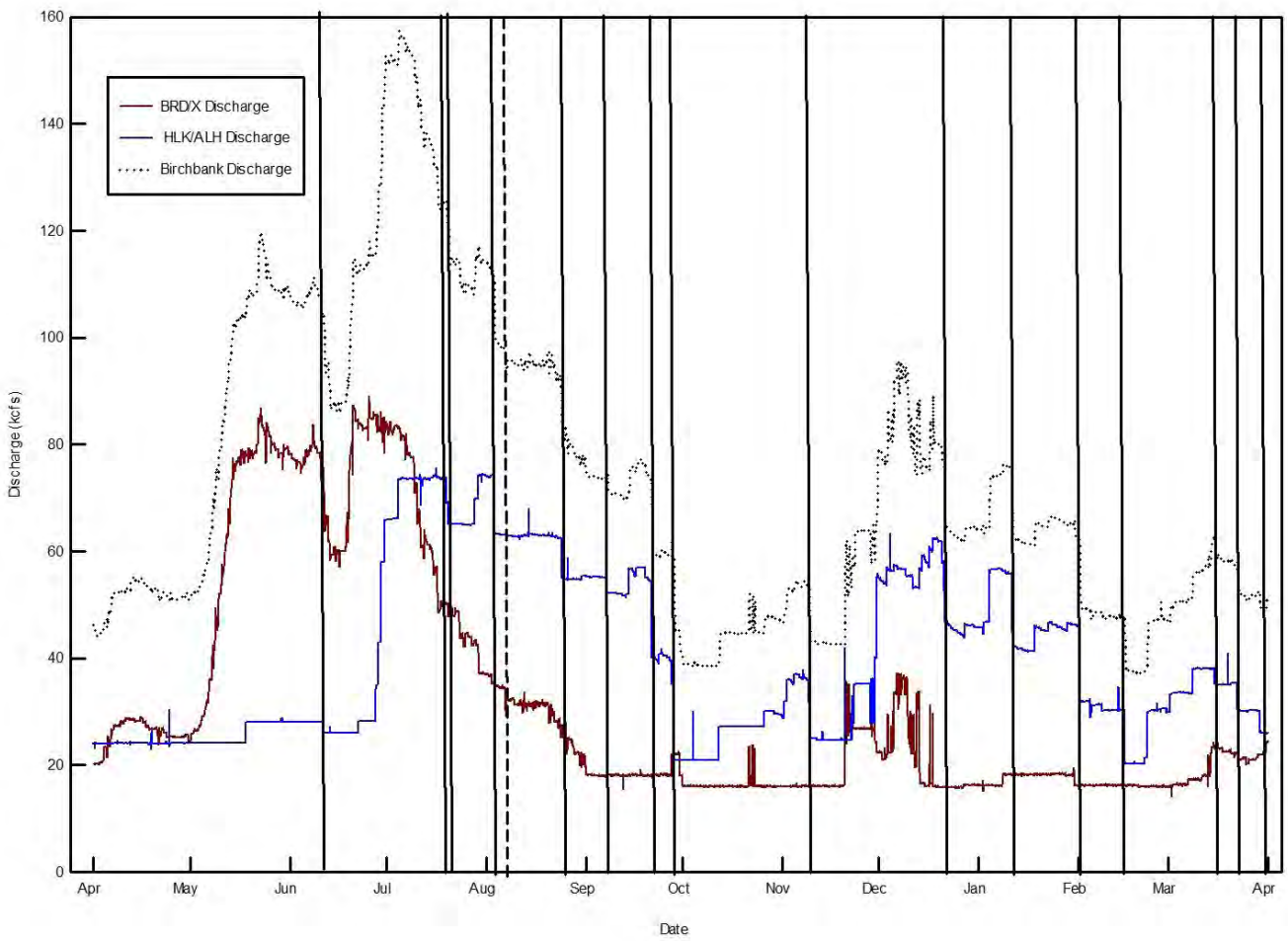


Figure 2: Mean hourly discharge from HLK/ALH (solid blue line), BRD/X (solid red line), and at the Water Survey of Canada Gauging Station at Birchbank (dotted black line), April 1, 2013 to April 1, 2014. The solid black vertical lines indicate REs at HLK/ALH and the dashed black vertical lines indicate REs at BRD/X. REs were numbered from RE2013-08 to RE2014-06 (left to right on the figure).

3.2 Fish Stranding Assessments

Fish stranding assessments were conducted for 14 of the 17 REs that occurred between April 1, 2013 and April 1, 2014 (Table 1). The total number of reductions in 2013/2014 (n = 17) was the same as the total number of reductions recorded during year 2012/2013, and lower than the number of total reductions recorded in the previous three annual summaries(Figure 3). Year 2009/2010 recorded 23 reductions, year 2010/2011 recorded 21 reductions, year 2011/2012 recorded 22 reductions and year 2012/2013 recorded 17 reductions. Reductions from HLK/ALH have remained constant at between 12 and 16 reductions during each reporting period. Reductions from BRD/X and combined reductions from both facilities have generally decreased (from nine reductions to one reduction).

The same percentage (82%) of reductions required a stranding assessment as last year (Figure 3) and was higher than the previous 60%. This may have been the result of higher water levels over the past two summers. Stranding assessments were conducted at these high flow level reductions because there were no data recorded in the database and the majority of the sites were identified as 'recons" from the database queries. All of the flow reductions for the 2013/2014 period occurred during times where the resultant Birchbank discharge queried had potential effects (greater than 200 fish stranded or listed species observed during past stranding assessments). This study period had a very narrow range of resultant discharge, especially during the Low Risk period (all resultant discharge was <62.0 kcfs). Four assessments occurred within one resultant discharge range (Birchbank between 40.0 and 50.0 kcfs). During the High Risk period the resultant discharge range was slightly wider, but still within the range where effects were historically documented. The total number of stranding assessments has declined from 23 in 2010/2011 to 17 in 2013/2014, reflecting a decline in total REs over time.

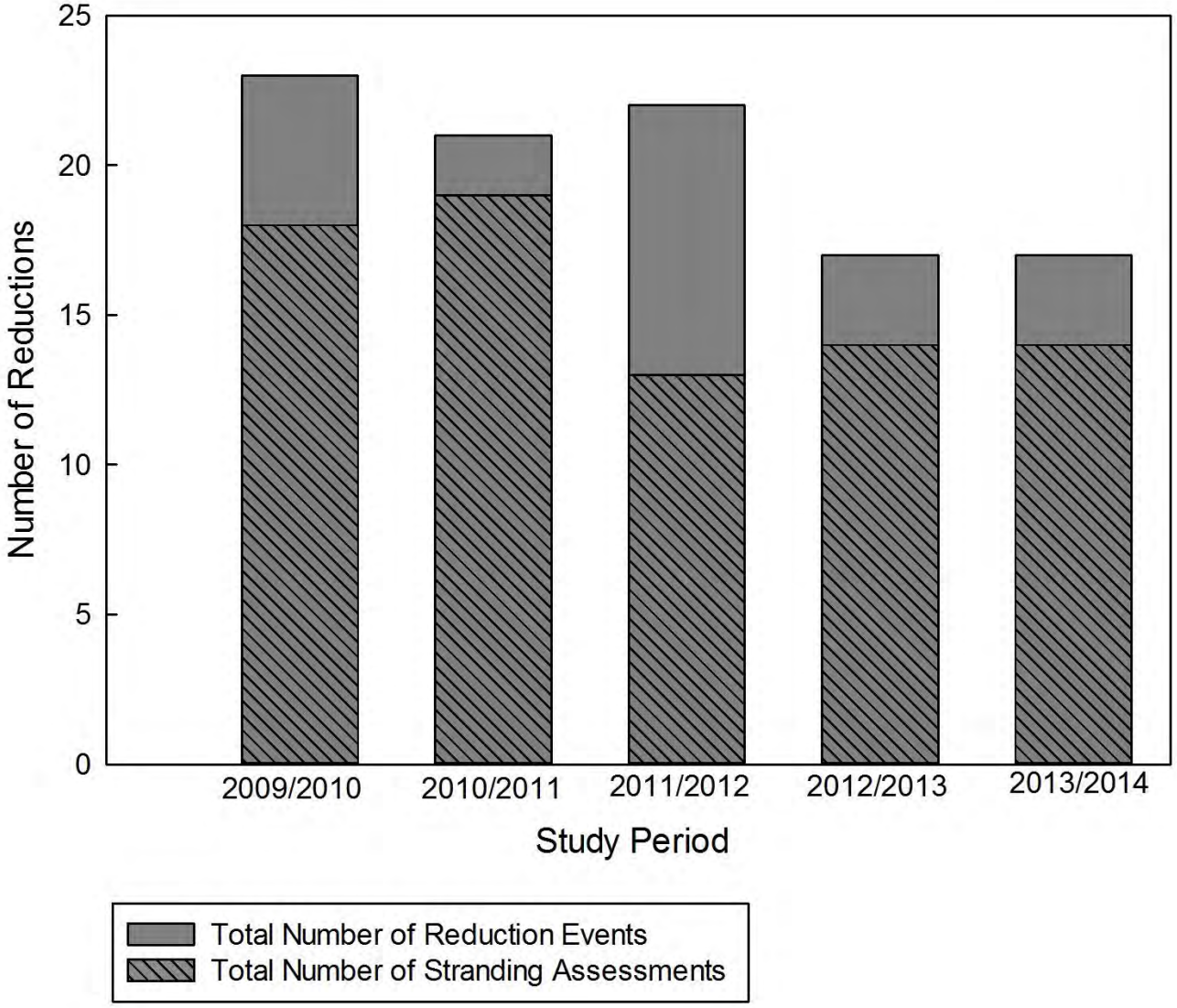


Figure 3: Total number of Flow Reductions and Stranding Assessments conducted during each study period.

In total, 18 different sites were assessed at least once during the 2013/2014 stranding assessment period (Table 2). Similar to previous study years, assessment efforts were concentrated on sites located upstream of, and including, the Genelle Mainland LUB site (Appendix A, Figure A1 to A4) that are known areas of high fish stranding risk, as outlined in the *Columbia River Project Water Use Plan Monitoring Program Terms of Reference - Lower Columbia River Fish Management Plan (CLBMON-42 Lower Columbia River Fish Stranding Assessment and Ramping Protocol, 31 August 2007).*

As with previous years, poor site access (e.g., excessive snow) and limited daylight hours during the Low Risk winter season restricted the number of sites that could be assessed on some occasions, most notably, sites downstream of the Genelle Mainland LUB site on the right upstream bank [Beaver Creek RUB, Trail Bridge RUB, Casino Bridge LUB (upstream), Casino Bridge LUB (downstream), and Bear Creek RUB] and the sites accessed using the Fort Shepherd Conservancy Area access road on the left upstream side of the Columbia River [Beaver Creek LUB and Fort Shepherd Eddy LUB sites (Appendix A, Figures A5 to A8)]. Neither of the sites accessed using the Fort Shepherd Conservancy Area access roads were visited during this reporting period.

3.2.1 Fish Captured or Observed During 2013/2014 Stranding Assessments

Isolated pools and stranded fish were identified during all but one RE (2013-14) for which stranding assessments were conducted (Table 1). During the 14 REs in which fish stranding assessments were conducted, 4845 stranded fish were recorded (Table 1). The majority (63.0%) of these fish were observed during the six RE assessments conducted during the High Risk period. The total number of fish observed or salvaged for each RE ranged from 0 to 1371 (Table 1). None of the stranding assessments conducted during the sample period were classified as a “significant” stranding event (>5000 fish observed).

The majority (86.4%) of the isolated fish were recorded in pools located at the Genelle Mainland LUB (28.3%), Gyro Boat Launch (21.4%), Tin Cup Rapids RUB (20.9%) and Norns Creek Fan (15.7%) sites (Table 2). See Appendix A; Figure A1 through A8 for site locations.

Table 1: Summary of Reduction Events (RE) from HLK/ALH and BRD/X 1 April 2013 to 1 April 2014.

Reduction Event No.	Reduction Date	Concern Category	Crew Dispatched?	Birchbank				Brilliant Dam/BRX			No. Ramped Flow Reductions	Avg. Ramping Rate (kcfs)	HLK/ALGS			No. Ramped Flow Reductions	Avg. Ramping Rate (kcfs/hr)	Pools Formed	Interstitial Stranding	Fish Stranded	Sites Visited	Purpose of flow reduction
				Mean Daily Water Temp (°C)	Max. Q (kcfs)	Min. Q (kcfs)	Magnitude of Reduction (kcfs)	Prev Q (kcfs)	Resulting Q (kcfs)	Magnitude of Reduction (kcfs)			Prev Q (kcfs)	Resulting Q (kcfs)	Magnitude of Reduction (kcfs)							
HLK/ALH 2013-08	11-Jun-13	High	No	13.1	99.8	97.8	2.0	71.8	71.8	0.0	N/A	N/A	28.0	26.0	2.0	1	2.0	N/A	N/A	N/A	0	Reduction of inflows; Treaty requirements
HLK/ALH 2013-09	19-Jul-13	High	No	15.9	124.0	119.0	5.0	50.0	50.0	0.0	N/A	N/A	74.0	69.0	5.0	1.0	5.0	N/A	N/A	N/A	0	Reduction of inflows; Treaty requirements
HLK/ALH 2013-10	20-Jul-13	High	No	16.4	117.7	113.7	4.0	48.7	48.7	0.0	N/A	N/A	69.0	65.0	4.0	1.0	4.0	N/A	N/A	N/A	0	Reduction of inflows; Treaty requirements
HLK/ALH 2013-11	3-Aug-13	High	Yes	17.0	114.0	102.5	11.5	39.5	39.5	0.0	N/A	N/A	74.5	63.0	11.5	3	3.8	Yes	Yes	803	8	Reduction of inflows; Treaty requirements
BRD/X 2013-12	7-Aug-13	High	Yes	17.5	98.3	93.3	5.0	34.0	29.0	5.0	1.0	5	66.3	66.3	0.0	N/A	N/A	Yes	No	1331	4	Implentation of base flow at BRX for load shaping.
HLK/ALH 2013-13	24-Aug-13	High	Yes	17.9	85.0	77.0	8.0	22.0	22.0	0.0	N/A	N/A	63.0	55.0	8.0	2	4.0	Yes	No	132	5	Reduction of inflows; Treaty requirements
HLK/ALH 2013-14	7-Sep-13	High	Yes	18.4	73.8	70.8	3.0	18.0	18.0	0.0	N/A	N/A	55.0	52.0	3.0	1	3.0	Yes	No	0	8	Reduction of inflows; Treaty requirements
HLK/ALH 2013-15	21-Sep-13	High	Yes	16.0	76.0	61.0	15.0	21.0	21.0	N/A	N/A	N/A	55.0	40.0	15.0	3	5	Yes	Yes	452	5	Reduction of inflows: Treaty requirements
HLK/ALH 2013-16	28-Sep-13	High	Yes	14.8	59.8	40.8	15.0	19.8	19.8	0.0	N/A	N/A	40.0	21.0	14.0	3	4.7	Yes	No	340	8	Adjustments to meet Treaty requirements.
HLK/ALH 2013-17	9-Nov-13	Low	Yes	7.0	52.0	41.0	11.0	16.0	16.0	0.0	N/A	N/A	36.0	25.0	11.0	3	3.7	Yes	No	32	5	Adjustments to meet Treaty requirements.
HLK/ALH 2013-18	21-Dec-13	Low	Yes	4.8	77.0	62.0	15.0	16.0	16.0	0.0	N/A	N/A	61.0	46.0	15.0	4	3.8	Yes	No	5	13	Treaty storage requirements and end of non treaty storage releases.
HLK/ALH 2014-01	11-Jan-14	Low	Yes	3.7	74.0	60.0	14.0	18.0	18.0	0.0	N/A	N/A	56.0	42.0	14.0	3	4.7	Yes	No	4	14	Adjustments to meet Treaty requirements.
HLK/ALH 2014-02	1-Feb-14	Low	Yes	3.8	62.0	48.0	14.0	16.0	16.0	0.0	N/A	N/A	46.0	32.0	14.0	3	4.7	Yes	Yes	282	7	Adjustments to meet Treaty requirements.
HLK/ALH 2014-03	15-Feb-14	Low	Yes	2.0	46.0	36.0	10.0	16.0	16.0	0.0	N/A	N/A	30.0	20.0	10.0	2	5	Yes	No	18	14	Adjustments to meet Treaty requirements.
HLK/ALH 2014-04	22-Mar-14	Low	Yes	3.7	57.5	52.5	5.0	22.5	22.5	0.0	N/A	N/A	35.0	30.0	5.0	1	5.0	Yes	No	18	10	Adjustments to meet Treaty requirements. Establishment of rainbow trout protection flows.
HLK/ALH 2014-05	29-Mar-14	Low	Yes	3.7	52.5	48.5	4.0	22.5	22.5	0.0	N/A	N/A	30.0	26.0	4.0	1	4.0	Yes	Yes	57	14	Adjustments to meet Treaty requirements. Establishment of rainbow trout protection flows.
HLK/ALH 2014-06	1-Apr-14	Low	Yes	3.8	50.5	42.5	7.0	24.5	24.5	0.0	N/A	N/A	25.0	18.0	7.0	2	3.5	Yes	Yes	1371	13	Adjustments to meet Treaty requirements. Establishment of rainbow trout protection flows.

Table 2: Percentage of the Total Number of Fish Stranded during the Reduction Events from April 1, 2013 to April 1, 2014 that were Stranded at each Site.

Site[a]	Total Number of Visits	Total Number of Fish Stranded	% of Total Stranded Fish at each Site
Genelle Mainland LUB[b]	14	1371	28.3
Gyro Boat Launch RUB[b]	9	1039	21.4
Tin Cup Rapids RUB	12	1013	20.9
Norn's Creek Fan RUB	7	763	15.7
Kootenay River LUB	11	197	4.1
Kootenay River RUB	11	179	3.7
CPR Island Mid	8	175	3.6
Beaver Creek RUB	5	48	1.0
Lions Head RUB	8	40	0.8
Millennium Park LUB	4	8	0.2
Trail Bridge RUB	2	5	0.1
Casino Road Bridge LUB (downstream)	6	3	0.1
Fort Shepherd Launch RUB	5	2	<0.1
Fort Shepherd Launch RUB (Before Re-Contouring)	2	1	<0.1
Blueberry Creek LUB	2	1	<0.1
Bear Creek RUB	4	0	0
Casino Road Bridge LUB (upstream)	4	0	0
Zuckerberg Island LUB	2	0	0
Total	**116**	**7004**	**100**

[a]Appendix A; Figures A1 through A8
[b]LUB=left upstream bank; RUB=right upstream bank

Table 3 shows the fish species and numbers stranded during the 2013/2014 study period. Mountain Whitefish (*Prosopium williamsoni*) eggs (*n*=301) were observed during RE2014-02 at the CPR Island and Kootenay River (LUB) sites. The dewatering of Rainbow Trout redds and stranding of Mountain Whitefish eggs in the interstitial areas of the substrate are known to occur as a result of flow reductions. Procedures for responding specifically to Mountain Whitefish eggs and Rainbow Trout redd dewatering issues are addressed under separate contracts (Golder 2011). These egg numbers were not included in Table 2 or 3.

Table 3: Summary of Fish Species Captured or Observed during Fish Stranding Assessments Subsequent to Reductions in Discharge from Hugh L. Keenleyside Dam/Arrow Lakes Generating Station or from Brilliant Dam/Brilliant Expansion, April 1, 2013 to April 1, 2014.

Species		Total Stranded and/or Captured	Percent of Total Stranded and/or Captured (%)	Number of Mortalities	Number Salvaged	Species Classification		
						SARA[a]	COSEWIC[b]	CDC[c]
Sportfish	Brook Trout (*Salvelinus fontinalis*)	4	0.1	0	4	N/A	N/A	N/A
	Kokanee (*Oncorhynchus nerka*)	3	0.1	1	2	N/A	N/A	Yellow
	Rainbow Trout (*Oncorhychus mykiss*)	224	4.6	32	117	N/A	N/A	Yellow
	Whitefish species (Coregoninae)	501	10.3	501	0	N/A	N/A	Yellow
Non-Sportfish	Longnose Dace (*Rhinichthys cataractae*)	640	13.2	100	279	N/A	N/A	Yellow
	Umatilla Dace (*Rhinichthys umatilla*)	104	2.1	0	103	Schedule 3 Special Concern	Threatened	Red
	Northern Pikeminnow (*Ptychocheilus oregonensis*)	59	1.2	4	55	N/A	N/A	Yellow
	Peamouth (*Mylocheilus caurinus*)	43	0.9	1	42	N/A	N/A	Yellow
	Redside Shiner (*Richardsonius balteatus*)	1853	38.2	54	781	N/A	N/A	N/A
	Sculpin species (Cottus)	96	2.0	10	17	N/A[d]	N/A[d]	N/A[d]
	Prickly Sculpin (*Cottus asper*)	16	0.3	0	16	N/A	N/A	N/A
	Torrent Sculpin (*Cottus rhotheus*)	78	1.6	4	69	N/A	N/A	Yellow
	Common carp (*Cyprinus carpio*)	27	0.6	15	10	N/A	N/A	N/A
	Sucker species (Catostomidae)	1164	24.0	21	673	N/A[e]	N/A[e]	N/A[e]
	Unidentified[f]	42	0.9	41	1	N/A[d]	N/A[d]	N/A[d]
Totals			**100**					

[a]Species at Risk Act; Species that were designated at risk by COSEWIC (the Committee on the Status of Endangered Wildlife in Canada) before the creation of the *Species at Risk Act* must be reassessed according to the new criteria of the Act before they can be added to Schedule 1. These species are listed on Schedules 2 and 3, and are not yet officially protected under SARA (COSEWIC 2010).
[b]Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2010).
[c]Conservation Data Centre; Red=ecological communities and indigenous species and subspecies that are extirpated, endangered or threatened in British Columbia; Blue= ecological communities and indigenous species and subspecies of special concern in British Columbia; Yellow= ecological communities and indigenous species and subspecies that are not at risk in British Columbia (BCCDC 2011).
[d]Fish identified to family level or other high level taxa may potentially be species of concern under the classification systems listed.
[e]No species are listed from this region that are found under any of the classification criteria for species of concern.
[f]Not identified to species because they were young-of-the-year life stage or observed but not captured.

3.2.1.1 Fish Species

3.2.1.1.1 Sportfish

All of the whitefish species (Coregoninae) recorded during the 2013/2014 stranding assessments were larval fish associated with RE2014-06 which occurred in early spring to facilitate Rainbow Trout Protection Flows. Mountain Whitefish eggs in pre-hatch stage also were observed during RE2014-01, which occurred at the beginning of February. The small body size and fragility of these fish rendered salvage attempts ineffective. For this reason, whitefish numbers were estimated and assumed to be mortalities. All whitefish recorded during RE2014-06 were observed at the Norns Creek Fan site (Appendix A, Figure A1) and approximately half were observed in small dewatered puddles present at the mouth of Norns Creek.

The majority (85%) of Rainbow Trout were recorded from the Norns Creek Fan and CPR Island sites. (Appendix A; Figure A1 and A2). All recorded Rainbow Trout were either young-of-the year or juveniles.

Three Brook Trout were captured at the Beaver Creek RUB site and one Brook Trout was captured at the Fort Shepherd Launch site. All were classified as juveniles based on fork lengths.

Three larval Kokanee were recorded from the pools at the mouth of Norns Creek during RE2014-06.

3.2.1.1.2 Non-sportfish

The majority of non-sportfish found during the 2013/2014 stranding assessments were young-of-the-year Redside Shiner (n = 1853), juvenile sucker species (n = 1164) was the second most abundant non-sportfish species recorded and third most abundant was Longnose Dace (n = 640; Table 3).

3.2.1.1.3 Unidentified Fish

Only 41 unidentified young-of-the-year fish were recorded during this reporting period. All of these fish were in a dewatered pool at the Norns Creek Fan site during RE2013-13 (28 September 2013). These fish were probably stranded during the previous reduction (September 21, 2014) and were too decomposed to identify (Figure 4).

Figure 4: Decomposed juvenile fish at the Norns Creek Fan site during RE2013-13 on September 28, 2013.

Determining the species of young-of-the-year fish, including dace and sculpin species in the field continues to be a challenge. Collecting, preserving and laboratory identification of subsamples of these fish during subsequent reductions will continue to be a priority. During this reporting time no additional samples were preserved in anhydrous ethanol for future DNA analysis to confirm species identification as there is a large number of these samples that are in storage and have not been analyzed.

3.2.1.1.4 Listed Fish Species

Currently, four resident fish species in the study area are considered at risk: Columbia Sculpin, Shorthead Sculpin (*Cottus confusus*), Umatilla Dace, and White Sturgeon (*Acipenser transmontanus*). Only Umatilla Dace (*n* = 104) were documented during the 2013/2014 stranding assessment period (Table 4).

Table 4: Summary of Listed Species Captured or Observed during Stranding Assessments, April 1, 2013 to April 1, 2014.

Site[a]	Risk Period[b]	Total Number of Visits	Number of Visits with Listed Species Present	Number of Listed Fish Stranded
Umatilla Dace				
Kootenay River LUB	Low	11	1	77
Kootenay River RUB	Low	11	2	4
Genelle Mainland	Low	14	1	1
Gyro Boat Launch	Low	9	2	16
Trail Bridge RUB	Low	2	1	1
Beaver Creek RUB	Low	5	1	5
Total				**104**

Of the 41 unidentified fish that were recorded during RE2013-13 (High Risk period), there is the possibility that some of these fish may have been Umatilla Dace. The majority (94%) of listed species recorded in the Standing Database (from 2000 to present) were captured during the Low Risk period. However, it is possible that listed fish were also stranded during the High Risk period, but were not identified to species because of their life stage (i.e., immature). For example, Umatilla Dace probably spawn in the late spring or early summer if similar to closely related species (McPhail 2007). Therefore larval stage dace numbers may be combined in the numbers of unidentified fish collected during REs in late summer.

Although no Columbia or Shorthead sculpin were identified during the 2013/2014 stranding assessments, 95 unidentified sculpin species were captured or observed. Most (86%) of the sculpin species captured or observed during the present study were recorded during the High Risk period. The majority (82%) of the unidentified sculpin species were observed in isolated pools but not captured; consequently field identification was not possible.

3.2.1.1.5 Exotic Fish Species

During the 2013/2014 study period two exotic species were recorded at three sites. Four juvenile Brook Trout were collected from the Beaver Creek RUB and Fort Shepherd Launch sites. Twenty-seven juvenile Common Carp were identified at the Kootenay River (RUB) site.

Several exotic fish species have been identified and recorded during stranding assessments since 2000 in varying numbers. Species composition has remained constant. The majority (99%) of all of the exotic fish species recorded during stranding assessments were Smallmouth Bass (*Micropterus dolomieu*). The remaining 1% was Common Carp, Brook Trout, Tench (*Tinca tinca*) and Yellow Perch (*Perca flavescens*). Although exotic fish species were found at sites throughout the study area, the majority (98%) were from the Fort Shepherd Launch (RUB) site. This site is approximately 2.5 km upstream from the Columbia River confluence with the Pend d'Oreille River, which is known to have an established population of Smallmouth Bass and other invasive species (Golder 2005a).

3.2.1.1.6 Sportfish

During 2013/2014, fork length measurements were recorded for 50 Rainbow Trout (average length = 85 mm) from 5 different stranding assessments (RE2013-12, RE2013-13, RE2014-01, RE2014-02 and RE2014-06). Fork length measurements were recorded for one Brook Trout (100 mm) collected during RE2013-15 and for three Brook Trout (179 mm, 139 mm and 170 mm) collected during RE2014-06. No whitefish were measured during this period since all were post-hatch and too fragile to handle.

Figure 5 shows the frequency of Rainbow Trout stranded by fork lengths using fork length data (n = 98) from all years combined. Rainbow Trout were the only sportfish collected that had sufficient numbers for analysis. All of the stranded Rainbow Trout were small and classified as juvenile or Young-of-the-Year fish. The majority (99%) had fork lengths <140mm and 83% had fork lengths <100mm.

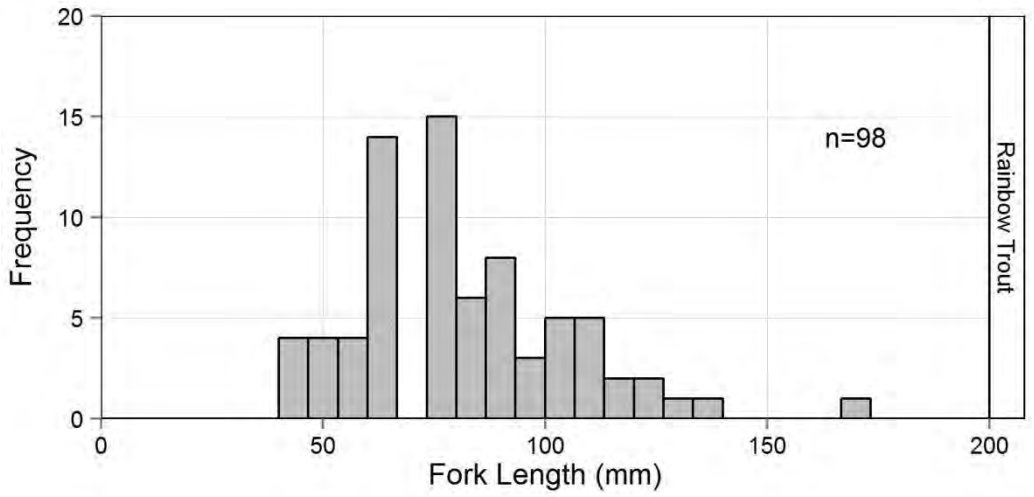


Figure 5: Length-frequency for Rainbow Trout collected during stranding assessments conducted during 2011 to 2014.

3.2.1.1.7 Non-sportfish

A sub-sample of fork length measurements were recorded for all non-sportfish species collected during the 2013/2014 stranding assessments. A total of 603 fork length measurements were collected (97% were from fish captured in isolated pools and 3% were from fish collected from interstitial stranding areas). These measurements were recorded over the course of the reporting period, during all stranding assessments except RE2013-09 and 2013-11. The frequency of fish species stranded by fork lengths (all years combined) is provided in Figures 5 and 6, for the following species:

- Longnose Dace (*n* = 97), combined years (*n* = 226);
- Northern Pikeminnow (*n* = 42), combined years (*n* = 108);
- Redside Shiner (*n* = 88), combined years (*n* = 220);
- Peamouth (*n* = 20), combined years (*n* = 39);
- Prickly Sculpin (*n* = 13), combined years (*n* = 45);
- sucker spp.(*n* = 179), combined years (*n* = 370);
- Torrent Sculpin (*n* = 42), combined years (*n* = 102); and,
- Umatilla Dace (*n* = 44), combined years (*n* = 147).

All of the non-sportfish fish stranded were small and classified as juvenile or Young-of-the-Year fish. The majority (90%) had fork lengths <50 mm. The sucker species had slightly larger individuals recorded as stranded, but the majority (99%) had fork lengths <80 mm.

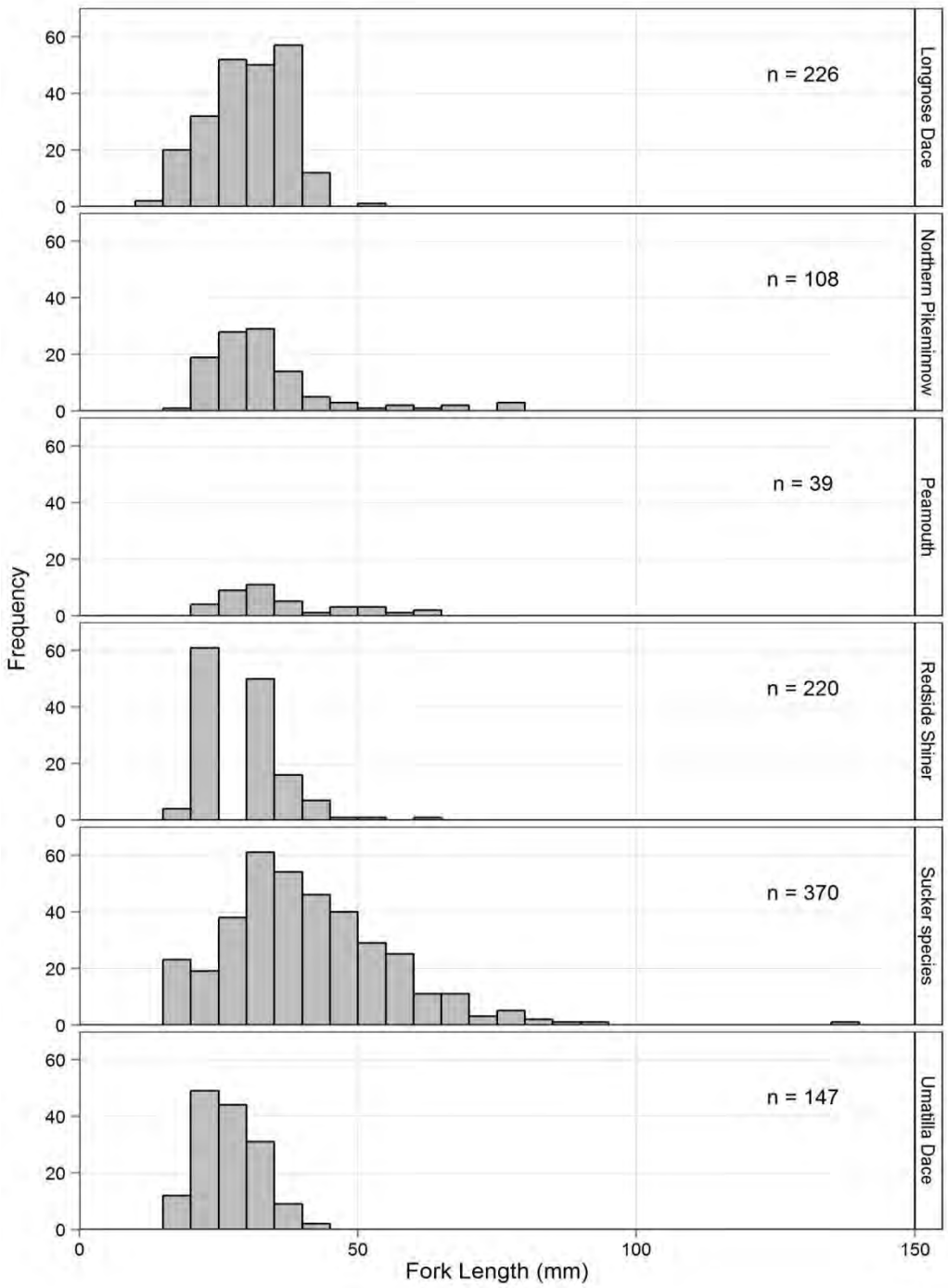


Figure 6: Length-frequencies for Longnose Dace, Northern Pikeminnow, Redside Shiner, Peamouth, sucker spp. and Umatilla Dace collected during stranding assessments conducted during 2011 to 2014.

Both adult and juvenile sculpin were recorded during the stranding events. The majority (82%) of the measured Prickly and Torrent sculpin were juveniles with total lengths <60 mm.

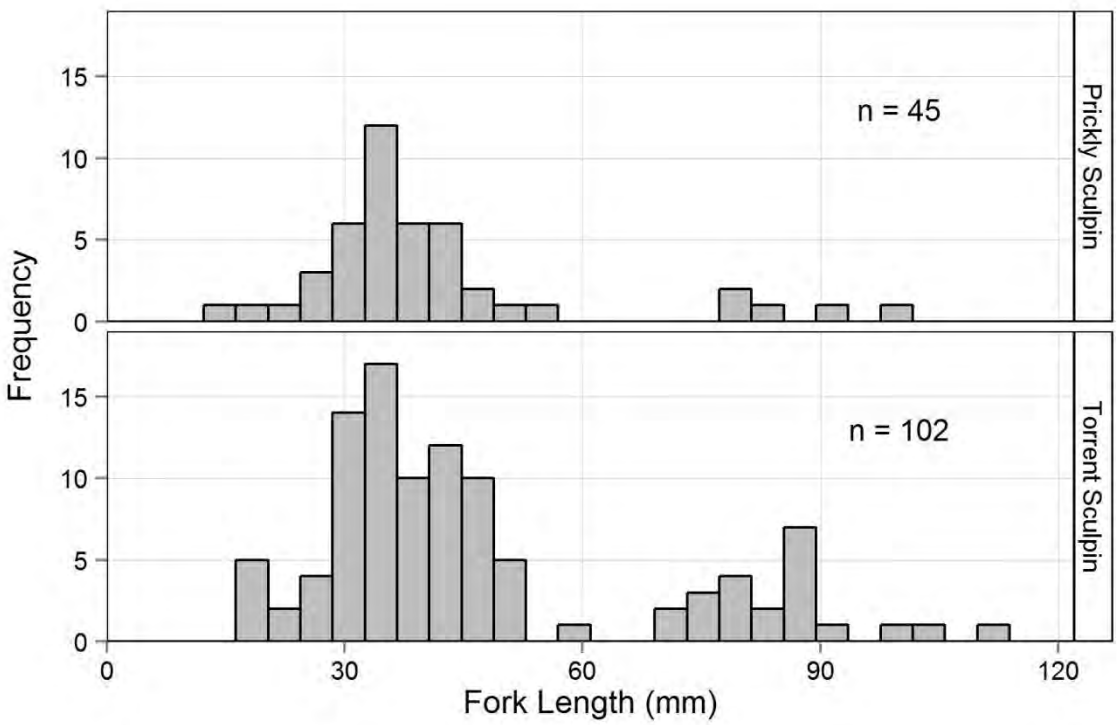


Figure 7: Length-frequencies for Prickly Sculpin and Torrent Sculpin collected during stranding assessments during the previous three years.

3.2.2 Historic Fish Stranding Summary

The results of fish stranding assessments conducted between January 2000 and April 2014 were summarized by site, water elevation and risk period (Table 5). This table can be used as a tool for personnel managing flow reductions to readily identify sites, flows, and seasons of high stranding risk. The classification of sites where listed species have been previously identified is included (yellow highlighted cells). More sites had listed species identified during the Low Risk period than the High Risk period (12 versus 5 sites). The numbers of fish are presented as the maximum number of fish observed stranded at each site during a single assessment. When comparing sites with adequate data (upstream of Trail BC), higher total fish numbers were recorded at the majority of the sites for all resultant discharge levels during the High Risk period (Table 5).

The High Risk period had a larger range of resultant Birchbank discharge (120 kcfs to 30 kcfs) where effects were recorded (Table 5). Aside from the two Kootenay River sites and the Genelle Mainland site during the Low Risk period, resultant Birchbank discharge <50 kcfs had the greatest number of stranded fish (Table 5). Surveys at sites with no previous data or insufficient data will continue to help identify sites that pose a higher risk of fish stranding during flow reductions, so salvage and assessment efforts can be more focussed. An additional emphasis should be made to visit stranding sites downstream of Trail BC. The majority of data gaps at all flow levels during both risk periods occur for these sites (Table 5). There was a decrease in the effort spent on sites where lower fish stranding risk was anticipated over the past year. Total number of visits to 'effects' sites visited was 62 and the total number of visits to 'minimal effects' sites was 18 (Table 5).

Table 5 Summary of effects and corresponding responses for fish stranding on the lower Columbia River from flow reductions at Hugh L. Keenleyside Dam and Brilliant Dam sorted by time of year. (Based on data collected between 2000 and 2014)

Risk Period	Resultant Birchbank Discharge (kcfs)	Observed Effect																																							
		Columbia River										Kootenay River				Columbia River																									
		Lions Head		Norn's Creek Fan		CPR Island		Tin Cup Rapids		Millennium Park		Kootenay River (LUB)		Kootenay River (RUB)		Zuckerberg Island		Kinnaird Rapids		Blueberry Creek		Genelle Mainland		Genelle Upper Cobble Island		Genelle Lower Cobble Island		Gyro Boat Launch		Trail Bridge		Casino Road Bridge, Trail (u/s)		Casino Road Bridge, Trail (d/s)		Bear Creek		Beaver Creek (RUB)		Beaver Creek (LUB)		Fort Shepherd Eddy		Fort Shepherd Launch	
		Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits	Max. # of fish	# of visits
High Risk (1 June 30 September)	≤30																	No Pools		No Pools								No Pools										No Pools		No Pools					
	30-40							13500	1					0	1	620	1	No Pools		No Pools				No Pools		No Pools								0	1							200	1		
	40-50	6	3	311	4	457	4	76	3	0	1	72	3	81	5							14302	3	No Pools		No Pools		464	2					207	2	No Pools									
	50-60	425	10	215	10			155	9	34	4	2894	6	2700	11	18	6	No Pools		No Pools		2865	13			No Pools		No Pools		0	1	0	1	11	4	0	2	1	1	27	1	0	1		
	60-70	16	5	423	17	0	1	258	7	0	3	492	18	2686	18	55	7	No Pools				37964	18			20	2	500	2	No Pools						500	4	1	4						
	70-80	42	5	19	9	No Pools		4	5	0	1	1	4	35	7	48	6	No Pools		50	3	6000	9	54	1	0	1	500	2	No Pools		No Pools				0	1	8	2	No Pools		0	1		
	80-90	2	4	88	9	No Pools		34	5	4	7	No Pools		12	3	No Pools		No Pools		0	4	90	6	No Pools		3	5	0	2	No Pools		No Pools		No Pools				0	2	No Pools		380	2		
	90-100	0	1	5	5	No Pools		458	7	26	2	No Pools		No Pools		No Pools						3060	7	No Pools		No Pools		500	6	No Pools		No Pools		No Pools		No Pools		251	2	No Pools		No Pools			
	100-110	No Pools		2	2	2	2	10307	4	7521	3	No Pools		No Pools		0	3	No Pools		0	1	20	3					500	2																
	110-120	0	2	No Pools		No Pools		1500	4	60	1	No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		0	1		
	>120	0	1	No Pools		No Pools		0	1	100	1	No Pools		No Pools		No Pools				0	1	No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools							
Low Risk (1 October to 31 May)	≤30	13	2	29	2	5	1	54	2	601	2	0	1	642	2	0	2	No Pools		No Pools		1	1					No Pools		8	5	0	3	0	1	2013	1	No Pools		No Pools		0	1		
	30-40	717	16	5002	24	24	4	224	11	522	17	210	2	971	22	95	10	No Pools		No Pools		236	14	No Pools		No Pools		1455	10	5	3	0	2	1	3	12	3	38	1	0	1	0	1	0	1
	40-50	1445	29	623	32	147	23	86	25	92	16	450	23	1450	46	298	25	0	2	0	3	1414	26	No Pools		No Pools		755	18	4	4	4	6	1	5	No Pools		44	7	0	3	0	4	2	2
	50-60	176	20	100	21	4	6	59	16	52	18	157	21	332	30	71	17	No Pools		No Pools		400	27	0	1	0	1	48	4	0	1	0	10	21	12	0	8	0	2	20	2	2	3	0	1
	60-70	8	10	39	18	5	3	11	10	0	13	103	18	529	23	109	19	No Pools		2	3	520	19	1	3		2	4	4	No Pools		1	7	3	7	0	3	4	3	0	2	0	2	0	1
	70-80	0	3	79	10	No Pools		0	2	0	8	0	3	10	5	0	9	No Pools		0	2	7	6			0	1	No Pools		No Pools		No Pools		0	1	3	3	0	2	No Pools					
	80-90					No Pools		0	1	0	2	No Pools				No Pools		No Pools		0	1	1	3	No Pools		0	1			No Pools		No Pools		No Pools		0	1			No Pools					
	90-100	No Pools				No Pools						No Pools		No Pools		No Pools								No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools				No Pools		No Pools			
	100-110	No Pools										No Pools		No Pools														No Pools																	
	110-120			No Pools		No Pools				No Pools		No Pools		No Pools		No Pools				No Pools		No Pools						No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools			
	>120	No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools														No Pools		No Pools						No Pools		No Pools							

Code	Description	Definition and Response
	No Pools	Site has been previously surveyed; pools have not been recorded at or near these flows. No Response.
	Minimal Effect	Site has been previously surveyed; isolated pools were observed; less than 200 fish were recorded during each reduction event under similar conditions (minimum of 5 visits under similar conditions). No Response.
	No Data or Insufficient Data	Site has been previously surveyed less than five times at or near these flows; less than 200 fish were recorded during each reduction event under similar conditions. Reconnaissance Survey.
	Effect	Site has been previously surveyed; isolated pools were observed; more than 200 fish were recorded during a single reduction event under similar conditions. Stranding Survey.
	Unlikely Discharge Range	Birchbank discharge has not been recorded at these levels during the specified time period (based on discharge data collected between 2000 and 2014).
	Listed species were captured or observed.	During at least one of the visits at these sites listed species were captured or observed, during these resultant discharge levels.

Does not include data pre-recontoring.

Includes all visits and fish until 1 April 2014.

4.0 DISCUSSION

4.1 CLBMON-#42(A) Lower Columbia River Fish Standing Assessment and Ramping Protocol Management Questions

Data necessary to address the first four management questions from BC Hydro Water Use Plan terms of reference were not collected during the current study period. These management questions were addressed using data presented in the 2009/2010 and 2010/2011 annual summaries. Since the new protocol was implemented, the program has focused on answering Question #5. Management Questions to be addressed by the program include:

1) *Is there a ramping rate (fast vs. slow, day vs. night) for flow reductions from HLK that reduces the number of fish stranded (interstitially and in pools) per flow reduction event in the summer and winter?*

   Information regarding ramping rates was obtained through a review of the fish stranding database for the lower Columbia and lower Kootenay rivers and presented in the 2010 report- *Columbia and Kootenay River Fish Stranding Protocol Review: Literature Review and Fish Stranding Database Analysis*. This report indicated increased stranding with increased ramping rates during ramping experiments in the Columbia, Kootenay and lower Duncan river systems; however, this trend was not statistically significant. Ramping rates within previously used ranges were not considered a statistically significant predictor for defining fish stranding risk (Golder and Poisson 2010).

2) *Does wetted history (length of time the habitat has been wetted prior to the flow reduction) influence the number of fish stranded (interstitially and in pools) per flow reduction event for flow reductions from HLK?*

   Previous analysis indicated a statistically significant increase in the number of fish stranded during assessments conducted after a wetted history of greater than 10 days versus a wetted history of less than ten days (Poisson 2009). However, there were insufficient data to define the size of the effect (proportion of the population affected and the response to wetted histories of variable lengths greater than 10 days).

3) *Can a conditioning flow (temporary, one step, flow reduction of approximately 2 hours to the final target dam discharge that occurs prior to the final flow change) from HLK reduce the stranding rate of fish?*

   Currently, conditioning flow reductions from HLK are not being considered as a management tool to reduce fish stranding. Two key concerns regarding the assumption that conditioning flow reductions reduce fish stranding were identified in a recent literature review (Golder and Poisson 2010). The first concern was the limited amount of data collected and preliminary stages of research on the suitability of conditioning flows for use on the Columbia and Kootenay rivers. The second concern was with the actual effectiveness of the method (i.e., some fishes may leave the area but the conditioning reduction may cause significant mortality within a short period of time, which would reduce the practicality of the method; Golder and Poisson 2010).

4) *Can physical habitat works (i.e., re-contouring) reduce the incidence of fish stranding in high risk areas?*

   Over the past 13 years, four previously identified high risk stranding sites have been re-contoured in an attempt to mitigate the occurrence and severity of fish stranding. The Genelle Lower Cobble Island site was re-contoured in 2001, Millennium Park site was re-contoured in September 2001, Norn's Creek Fan site was re-contoured in 2002, and Genelle Mainland site was re-contoured in 2003. Re-contouring reduced the incidence of fish stranding in these areas (Golder and Poisson 2010). However, the effect size (the

proportion of the population or the relative number of fish not stranded as a result of the physical habitat works) was not estimated due to limited data.

During the second half of the 2013/2014 reporting period, the Fort Shepherd Launch (RUB) site was re-contoured by Columbia Power Corporation (CPC) as a component of the CPC Owner's Commitment #39 [(Revised November 10, 2006) (CPC 2011)]. This commitment included the development of a Shallow-water Habitat Compensation Plan which was designed as the "Fort Shepherd Bar-Shallow-water Habitat Compensation Site" at the Fort Shepherd Launch (RUB) site. Six stranding assessments have been conducted at this site since the re-contouring. This site was designated as a new site in the Database and will require visits at most flow changes to populate with data and provide any insight as to the effectiveness of this re-contouring. The previous Fort Shepherd Launch (RUB) site was renamed as 'Fort Shepherd Launch (RUB) Before Re-contouring'.

5) *Does the continued collection of stranding data, and upgrading of the lower Columbia River stranding protocol, limit the number of occurrences when stranding crews need to be deployed due to flow reductions from HLK?*

The number of occurrences when stranding crews were deployed due to flow reductions from HLK has remained constant over the past five years of data collection. The number ranged from 10 to 15 deployments, with crews going out on an average of 84% of the reductions. The total numbers of reductions from HLK have remained constant, but reductions from BRD/X have decreased in the past five years. The two most recent study years experienced higher than normal flow conditions in the Columbia River and therefore additional assessments were conducted. There may have been fewer assessments required overtime if the flow ranges were more comparable over the previous five years. If flow ranges were outside the majority of flow ranges recorded in the database additional data was collected to fill in the data gaps associated with these ranges.

The continued collection of data and the use of the Columbia River Stranding Protocol has focused stranding assessments to those occurrences where location, season and resultant discharge level posed an elevated risk to fish stranding. Since the majority of the data clusters around resultant Birchbank discharge between 70 kcfs and 30 kcfs (Table 5) the elimination of data gaps in less common discharge levels will further focus stranding assessment efforts.

5.0 RECOMMENDATIONS

- Fish species identification should continue to be a priority during stranding assessments, including young of-the-year fish identification.

  Continued coordination with AMEC staff during the current sculpin/dace monitoring study will improve fish identification (particularly for sculpin species). When large numbers of fish are encountered, the collection of sub-samples for positive identification is recommended. When a large number of fish are observed in a pool and species identification is not possible due to field conditions and constraints (i.e., too large of pool to effectively sample), a voucher sample should be taken. Tools/methods used to identify young-of-the-year fish also should be improved, as it is currently not possible to identify larval or young-of-the-year fish of most species, which is an important limitation of the stranding assessment methods.

- Continue to collect fish length data for species where insufficient numbers have previously been collected. This would include unusual lengths (i.e., large fish) of fish with previously sufficient numbers (Longnose Dace, Northern Pikeminnow, Rainbow Trout and Redside Shiner). It is recommended that length data continue to be collected for any listed species and for all sculpin species (since sculpin of all age classes have been recorded stranded, the numbers for certain age classes are still insufficient).
- Re-contouring is recommended at a number of areas, including sites that have previously been re-contoured, and sites that were not previously modified. The sites listed below are recommended as candidates for re-contouring because of high stranding risk relative to other sites, and shoreline and substrate features that could be re-contoured or enhanced to reduce stranding risk. Re-contouring at these sites could be conducted using a phased approach, with higher priority sites (based on stranding risk, cost, and other factors) being enhanced first and other sites being re-contoured in subsequent years. Sites recommended for re-contouring are:
  - Re-contour Kootenay RUB site to assist in the draining of Kootenay Oxbow.

    This would help reduce stranding at a public and logistically difficult place to salvage fish (very large, shallow pools with cobble substrate bottoms).
  - Conduct additional re-contouring at the Genelle Mainland LUB site to reduce incidence of fish stranding. This site is a good candidate for re-contouring because of large abundance of fish that are common in this area, a history of significant stranding events, and changes to the shoreline caused by river flow since the previous enhancements were completed. Suggested modifications include:

    a) improve drainage between the access road and the Whispering Pines Trailer Park; and,

    b) make improvements to previously re-contoured area by removing a depositional berm that has formed since the original re-contouring.
  - Re-contour the Lion's Head RUB site to reduce the incidence of fish stranding.

    This site has numerous artificial depressions that are prone to fish stranding.
  - Re-contour the Gyro Park Launch RUB site to reduce incidence of fish stranding.

    The site has a large artificial depression (potential storm drain exit) that is prone to fish stranding.
- Attempt to target sites designated as 'reconnaissance' sites by the database query in order to continue to fill in data gaps. This would include boat access to stranding locations that do not have vehicle access (i.e., Upper and Lower Cobble Island sites in Genelle), to evaluate stranding risk in these areas. This could be done in conjunction with other work in the area (i.e., during Rainbow Trout protection flow surveys).

6.0 REFERENCES

B.C. Conservation Data Centre (BCCDC). 2011. BC Species and Ecosystems Explorer. B.C. Ministry of Environment Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed May 18, 2012).

COSEWIC. 2010. COSEWIC assessment and status report on the Umatilla Dace Rhinichthys umatilla in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xii + 37 p. (www.sararegistry.gc.ca/status/status_e.cfm).

Columbia Power Corporation. 2011. Waneta Expansion Project-Fish and Fish Egg Stranding Assessment Program: Terms of Reference. Castlegar BC. 7 p.

BC Hydro. 2005. Kootenay River Fish Salvage Protocol Draft. Report prepared for the CPA Operating Committee.

BC Hydro. 2007. Columbia River Project, Water Use Plan, Monitoring Program Terms of Reference: Lower Columbia River Fish Management Plan. 37 p + 2 appendices.

Golder Associates Ltd. 2005a. Canadian Lower Columbia River Fish Stranding Database Operating Manual 2005. BC Hydro Stranding Database Operating Manual for the Kootenay Generation Area, B.C. Report prepared for BC Hydro, CPC and FortisBC. Castlegar, B.C. Golder Report No. 05-1480-065D: 10 p. + 3 appendices.

Golder Associates Ltd. 2005b. Fish and Fish Habitat Resources within the Waneta Expansion Project Study Area: Background information for Environmental Assessment Certificate Application December 2004. Report prepared for Waneta Expansion Power Corporation, Castlegar, B.C.86 pp + app.

Golder Associates Ltd. 2011. Canadian Lower Columbia River: Fish Stranding Risk Assessment and Response Strategy, Report prepared for BC Hydro, Columbia Power Corporation, Fortis BC, Columbia operations Fish Advisory Committee (COFAC) and Canal Plant Agreement Operating Committee, Golder Report No. 09-1480-0055F: 31 p. + 4 appendices.

Golder Associates Ltd. and Poisson Consulting Ltd. 2010. Columbia and Kootenay River Fish Stranding Protocol Review: Literature Review and Fish Stranding Database Analysis. 34 p + appendices.

McPhail, J. D. 2007. The Freshwater Fishes of British Columbia. The University of Alberta Press. Edmonton, AB.

Poisson Consulting Ltd. 2009. CLBMON#42 - Columbia and Kootenay Rivers: Stranding Protocol Review-Stranding Database Analysis 23 p.

Vonk, P. 2003. Strategy for Managing Fish Stranding Impacts Associated with Flow Reductions at Keenleyside Dam: Lower Columbia River. Prepared for COFAC and the Columbia WUP FTC.

7.0 CLOSURE

We trust that this report meets your current requirements. If you have any further questions, please do not hesitate to contact the undersigned.

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DB/GB/cmc

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APPENDIX A

Site Maps

200 100 0 200

SCALE 1:6,000 METRES

LEGEND

River Kilometre Downstream of Hugh L. Keenleyside Dam

Stranding Site

N

REFERENCE

Orthophotos from BC Government Web Maps, flows represented vary with date of orthophotos. Site locations are approximations.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Site Locations- Middle Section

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
DESIGN	SS	24 May 2012	A1	
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

300 150 0 300

SCALE 1:10,000 METRES

LEGEND

- River Kilometre Downstream of Hugh L. Keenleyside Dam
- Stranding Site

N

REFERENCE

Orthophotos from BC Government Web Maps, flows represented vary with date of orthophotos. Site locations are approximations.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Site Locations- Middle Section

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
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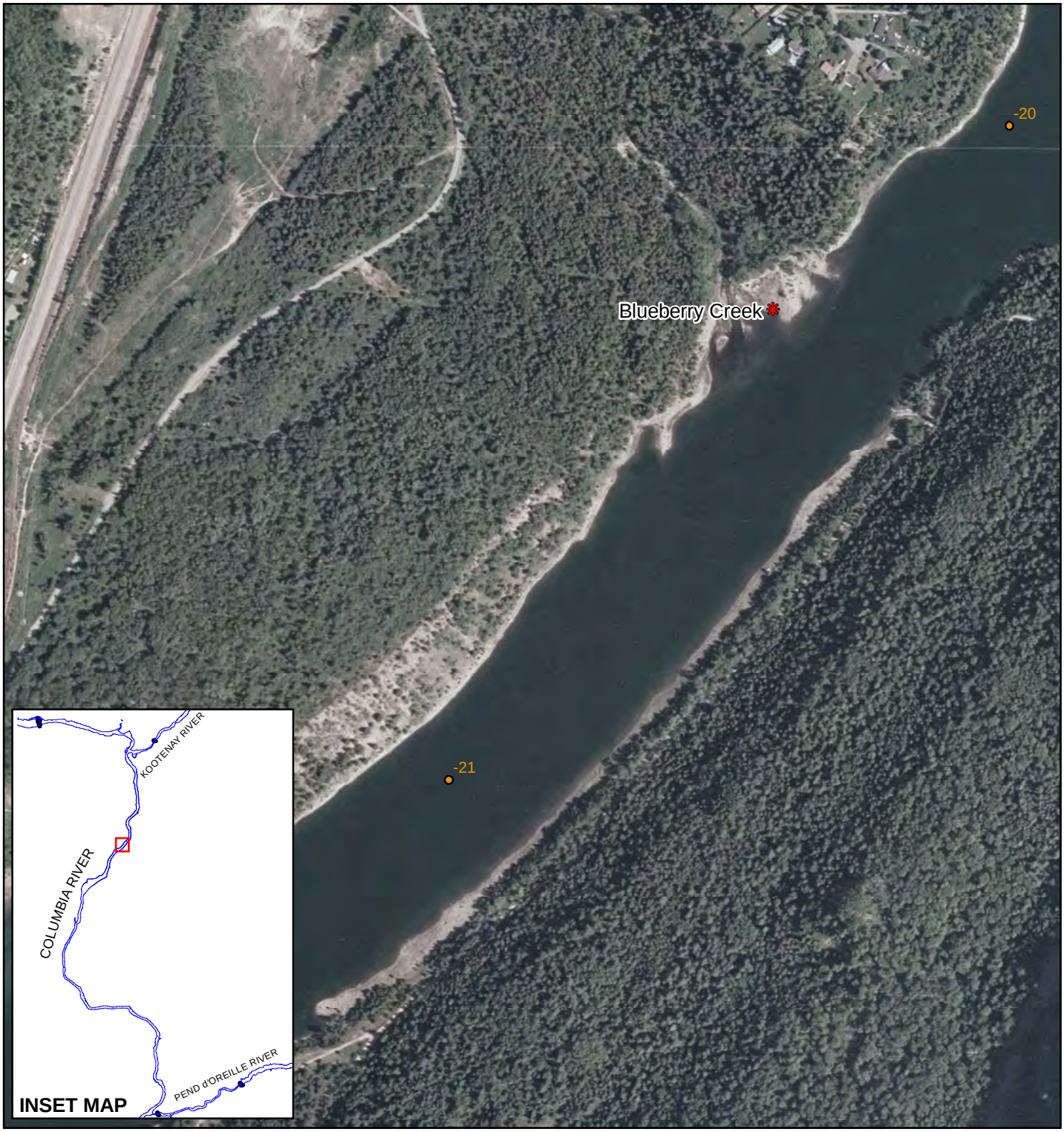
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		



200 100 0 200

SCALE 1:6,500 METRES

LEGEND

- River Kilometre Downstream of Hugh L. Keenleyside Dam
- Stranding Site

N

REFERENCE

Orthophotos from BC Government Web Maps, flows represented vary with date of orthophotos. Site locations are approximations.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Site Locations- Middle Section

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
DESIGN	SS	24 May 2012	A3	
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

300 150 0 300

SCALE 1:10,000 METRES

LEGEND

- River Kilometre Downstream of Hugh L. Keenleyside Dam
- Stranding Site

N

REFERENCE

Orthophotos from BC Government Web Maps, flows represented vary with date of orthophotos. Site locations are approximations.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Site Locations- Middle Section

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
DESIGN	SS	24 May 2012	A4	
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

200 100 0 200

SCALE 1:6,500 METRES

LEGEND

River Kilometre Downstream of Hugh L. Keenleyside Dam

Stranding Site

N

REFERENCE

Orthophotos from BC Government Web Maps, flows represented vary with date of orthophotos. Site locations are approximations.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Site Locations- Middle Section

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
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GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

150 75 0 150

SCALE 1:5,000 METRES

LEGEND

- River Kilometre Downstream of Hugh L. Keenleyside Dam
- Stranding Site

N

REFERENCE

Orthophotos from BC Government Web Maps, flows represented vary with date of orthophotos. Site locations are approximations.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Site Locations- Middle Section

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
DESIGN	SS	24 May 2012	A6	
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

150 75 0 150

SCALE 1:5,000 METRES

LEGEND

- River Kilometre Downstream of Hugh L. Keenleyside Dam
- Stranding Site

N

REFERENCE

Orthophotos from BC Government Web Maps, flows represented vary with date of orthophotos. Site locations are approximations.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Site Locations- Middle Section

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
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GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

200 100 0 200

SCALE 1:6,500 METRES

LEGEND

River Kilometre Downstream of Hugh L. Keenleyside Dam

Stranding Site

N

REFERENCE

Orthophotos from BC Government Web Maps, flows represented vary with date of orthophotos. Site locations are approximations.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Site Locations- Middle Section

Golder Associates
Castlegar, British Columbia

PROJECT No. 10-1492-0042/10-1492-0100			SCALE AS SHOWN	REV. 0
DESIGN	SS	24 May 2012	A8	
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

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