Columbia River Project Water Use Plan

Lower Columbia River Fish Stranding Assessment and Ramping Protocol

Implementation Year 6

Reference: CLBMON-42A

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

Study Period: April 1, 2012 to April 1, 2013

Golder Associates Ltd.
201 Columbia Avenue
Castlegar, BC

August 28, 2013

August 28, 2013

ANNUAL SUMMARY REPORT

Lower Columbia River [CLBMON#42(A)] and Kootenay River Fish Stranding Assessments: Annual Summary (April 2012 to April 2013)

Submitted to:
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REPORT

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Cover Photo: Clock-wise from top right photo: The Genelle Mainland site viewed upstream during RE2013-03 (February 9, 2013); Umatilla Dace and Longnose Dace salvaged from an isolated pool at the Kootenay River LUB site during RE2013-04 (February 16, 2013); Crew member backpack electrofishing an isolated pool at the Beaver Creek RUB site; whitefish eggs found stranded in the interstitial spaces during RE2013-03 (February 9, 2013) at the Kootenay River LUB site.

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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 Hugh L. Keenleyside Dam 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 for flow reductions; 3) determining whether a conditioning flow reduction from HLK reduced the stranding rate of fish; 4) determining whether physical habitat manipulation 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). Although the revised fish stranding protocol, "Canadian Lower Columbia River: Fish Stranding Risk Assessment and Response Strategy" (Golder 2011) was used to direct effort towards decreasing the number of flow reductions that required stranding assessments, this stranding assessment period saw an increase of 23% in flow reductions that required stranding assessments from the last stranding assessment period (i.e., April 1 2011 to April 1 2012). This increase was possibly due to the high flow levels in the Columbia River during the 2012 summer. Reduction events (REs) that occurred during this time period 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. The continued use of the database directed fish salvage efforts and salvage locations. The ability to accurately identify sites likely to strand fish during flow reductions is suspected to increase as the database becomes populated with more data. The continued accumulation of fish stranding and salvage information, as it relates to location, timing, and magnitude of stranding, will assist in predicting the type of events and the locations that are more likely to have significant incidences of fish stranding.

This report summarizes the information collected as a result of flow reductions from operations 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, 2012 and April 1, 2013. One assessment was conducted in response to flow reductions from BRD/X, 12 assessments were in response to flow reductions from HLK/ALH and one assessment was in response to flow reductions from the two facilities combined. An estimated 6700 isolated or stranded fish were observed during the 14 REs. The majority (73%) of stranded fish were observed during the seven 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).

Similar to the previous two years' annual reports, information from the two systems (HLK/ALH and BRD/X) has been combined into a single document. This was done because fish stranding in this section of river (defined as the study area from Hugh L. Keenleyside Dam to the Canada/USA border, including the Kootenay River below Brilliant Dam) is influenced by both systems and the same key variables that affect fish stranding and the management and methods are similar. However, each system has unique operation management strategies and operation drivers (e.g., BRD/X has a minimum flow requirement and loadshaping capacity). Information that is distinct 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 4 (2012/2013) 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.	Data collected and analyzed in previous studies have demonstrated that ramping rates were not considered 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) has not been 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.	Hypotheses 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.	Data collected and analyzed in previous studies demonstrates that physical habitat manipulation reduces incidences of fish stranding. The affect 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.	There was an increase in the number of occurrences which required the deployment of a stranding crew in Year 4 compared to Year 3. In Year 3, 60% of the reductions required a response and in Year 4, 82% of the reductions required a response. There were less total reductions in Year 4 (n=17) compared to previous years (n=21, n=22 and n=23).

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 Hydro (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 for 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).

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.

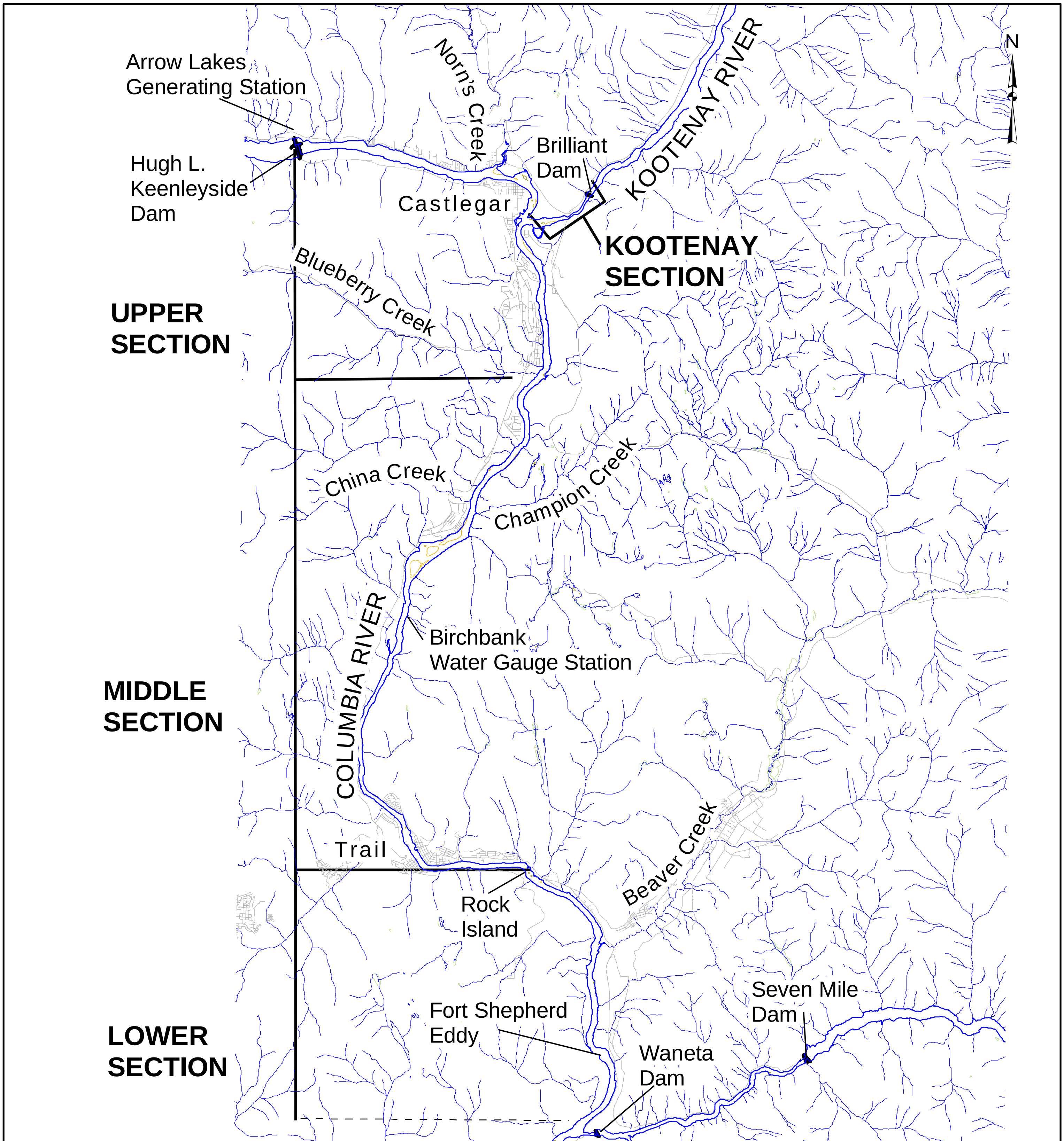
Ho_2: Wetted history does not influence the stranding rate of fish (both interstitially and pool stranding) for flow reductions from HLK.

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 US 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

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

PROJECT

Lower Columbia River and Kootenay River Fish Stranding

TITLE

Study Area Overview

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. Similar to the previous fish stranding protocols which BC Hydro, Columbia Power Corporation (CPC) and FortisBC, in collaboration with Columbia Operations Fish Advisory Committee (COFAC), 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/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 nearshore 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/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/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 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 kcfs (limited data). During the Low Risk period (October 1 to May 31), stranding risk decreases when discharge is greater than 60 kcfs (Golder/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 evaluating 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. Based on these data, the database provides an estimate 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' as a result of fish stranding in the lower Columbia and Kootenay rivers has been defined greater than 5000 fish of all species identified during a single flow reduction event (all sites combined) are stranded. 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 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 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 that were selected for fish salvage and surveying in 2012/2013 was sites likely to have an 'Significant Effect', based on projected flow conditions and the stranding history classification that has been assigned in the database. The next priority were 'Recon' 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 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, 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*™ 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/or 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.

3.0 RESULTS

3.1 Operations Overview 2012/2013

3.1.1 Columbia River Discharge

In 2012, discharges in the lower Columbia River (downstream of HLK) were substantially higher than normal. Mean daily discharge in the Columbia River at the Birchbank gauging station ranged from 38.1 kcfs to 213.4 kcfs in 2012, compared to the average range of 38.5-104.7 kcfs during 2001 to 2011 (BC Hydro Temperature and Discharge Database).

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

From April 1, 2012 to April 1, 2013, the Columbia River mean hourly discharge from HLK/ALH ranged from a minimum of 20.1 kcfs (on November 4, 2012) to a maximum of 115.1 kcfs (on July 24, 2012). During the study period, there were 14 operational flow reduction events (REs) from HLK/ALH (Figure 2). One RE was the result of combined flow reductions from HLK/ALH and BRD/X.

Of the 14 REs, six occurred during the High Risk period and seven occurred during the Low Risk period. The one combined reduction occurred during the High Risk period. The magnitude of flow reductions ranged from 3.0 to 15.0 kcfs.

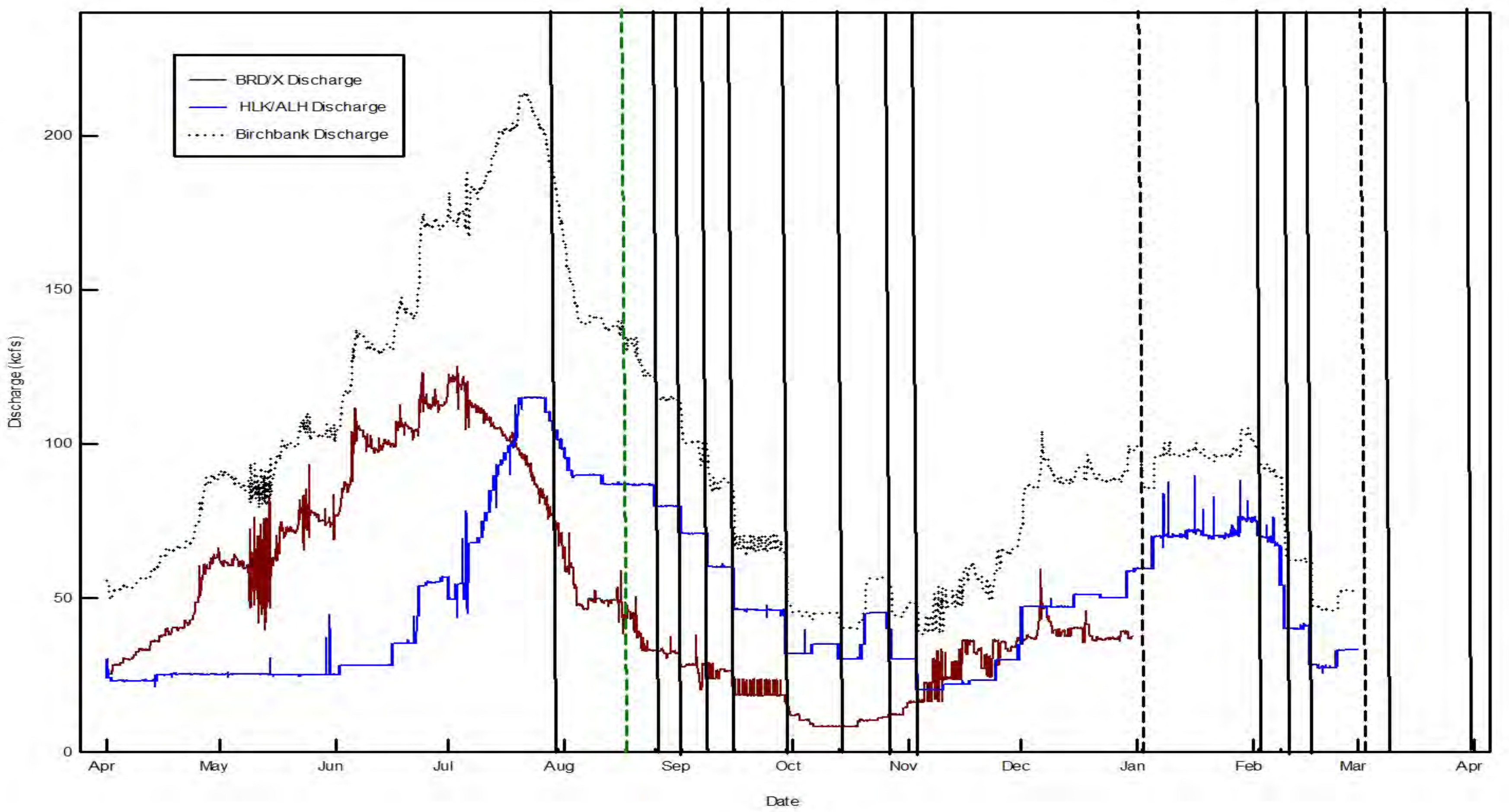


Figure 2: Mean hourly discharge from HLK/ALH (solid blue line), BRD/X (solid red line), and at the Water Survey of Canada Gauging Station at Birchbank (dotted black line), April 1, 2012 to April 1, 2013. The solid black vertical lines indicate REs at HLK/ALH, the dashed black vertical lines indicate REs at BRD/X, the dashed green vertical lines indicate combined REs. REs were numbered from RE2012-09 to RE2013-07 (left to right on the figure).Discharge data for BRD/X is currently missing for all of 2013.

3.1.3 Brilliant Dam and Brilliant Expansion (BRD/X)

From April 1, 2012 to April 1, 2013, the Kootenay River mean hourly discharge from BRD/X ranged from a minimum of 8.0 kcfs (October 10, 2012) to a maximum of 125.1 kcfs (July 3, 2012). Discharge data for BRD/X for 2013 was not available at this time. During the study period, there were two operational Base Flow REs from BRD/X (Figure 2). As mentioned above, one RE was a combined flow reduction from HLK/ALH and BRD/X.

Both of the operational Base Flow (defined as the minimum average hourly discharge from BRD/X that occurred during the previous 48 hrs) REs, occurred during the Low Risk period and the one combined RE occurred during the High Risk period. The magnitude of flow reductions ranged from 2.0 to 17.0 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 May, September and November. Flow reductions associated with load factoring were not considered REs.

3.2 Fish Stranding Assessments

Fish stranding assessments were conducted during 14 of the 17 REs that occurred between April 1, 2012 and April 1, 2013 (Table 1). The Discharge Change Coordinator did not deploy stranding crews for three REs based on the information gathered using the “Routine Communication and Consultation Procedure from Flow Change Planning through Implementation and Assessment” flow diagram in the *Canadian Lower Columbia River Fish Stranding Risk Assessment and Response Strategy* (Golder 2011).

Table 1: Summary of Reduction Events (RE) from HLK/ALH and BRD/X April 1, 2012 to April 1, 2013.

				Birchbank				Brilliant Dam/BRX					HLK/ALGS									
Reduction Event No.	Reduction Date	Concern Category	Crew Dispatched?	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)	No. Ramped Flow Reductions	Avg. Ramping Rate (kcfs)	Prev Q (kcfs)	Resulting Q (kcfs)	Magnitude of Reduction (kcfs)	No. Ramped Flow Reductions	Avg. Ramping Rate (kcfs/hr)	Pools Formed	Interstitial Stranding	Fish Stranded	Sites Visited	Purpose of flow reduction
HLK/ALH 2012-08	28-Jul-12	High	Yes	10.3	195.0	187.0	14.0	70.0	70.0	0.0	N/A	N/A	110.0	107.0	3.0	1	3.0	N/A	N/A	N/A	N/A	Reduction of inflows; Treaty requirements
	29-Jul-12				187.0	184.0							107.0	104.0	3.0	1	3.0	N/A	N/A	N/A	N/A	
	30-Jul-12				184.0	181.0							104.0	101.0	3.0	1	3.0	Yes	Yes	1200	17	
BOTH 2012-09	17-Aug-12	High	Yes	16.0	141.0	133.0	8.0	51.0	46.0	5.0	2.0	2.5	90.0	87.0	3.0	1	3.0	Yes	No	500	16	Reduction of inflows
HLK/ALH 2012-10	25-Aug-12	High	Yes	17.0	123.0	116.0	7.0	36.0	36.0	0.0	N/A	N/A	87.0	80.0	7.0	2	3.5	Yes	No	1560	8	Reduction of inflows; Treaty requirements
HLK/ALH 2012-11	1-Sep-12	High	Yes	16.0	114.0	104.0	10.0	32.0	30.0	2.0	1	2.0	80.0	71.0	9.0	2	4.5	Yes	No	552	11	Reduction of inflows; Treaty requirements
HLK/ALH 2012-12	8-Sep-12	High	Yes	16.0	93.0	83.0	10.0	22.0	23.0	N/A	N/A	N/A	71.0	60.0	9.0	3	3	Yes	No	534	11	Reduction of inflows: Treaty requirements
HLK/ALH 2012-13	15-Sep-12	High	Yes	16.0	80.0	65.0	15.0	20.0	20.0	0.0	N/A	N/A	60.0	46.0	14.0	3	4.7	Yes	No	550	13	Adjustments to meet Treaty requirements
HLK/ALH 2012-14	29-Sep-12	High	Yes	15.0	62.0	49.0	13.0	16.0	16.0	0.0	N/A	N/A	46.0	33.0	13.0	3	4.3	Yes	Yes	67	8	Adjustments to meet Treaty requirements

HLK/ALH 2012-15	13-Oct-12	Low	Yes	8.0	44.0	39.0	5.0	9.0	9.0	0.0	N/A	N/A	35.0	30.0	5.0	2	2.5	Yes	No	352	8	Reduction of inflow
HLK/ALH 2012-16	27-Oct-12	Low	Yes	8.0	57.0	42.0	15.0	11.0	11.0	0.0	N/A	N/A	45.0	30.0	15.0	3	5	Yes	No	1	9	Treaty and NTS
HLK/ALH 2012-17	3-Nov-12	Low	Yes	8.0	45.0	35.0	10.0	16.0	16.0	0.0	N/A	N/A	30.0	20.0	10.0	2	5.0	Yes	No	31	5	Non-treaty storage opportunities
BRD/X 2013-01	2-Jan-13	Low	No	7.4	96.0	79.0	17.0	37.0	20.0	17.0	4	4.3	59.0	59.0	0.0	N/A	N/A	N/A	N/A	N/A	N/A	Outage at BRX
HLK/ALH 2013-02	2-Feb-13	Low	No	6.1	99.0	79.0	5.0	26.0	26.0	0	N/A	N/A	74.0	69.0	5.0	2	2.5	N/A	N/A	N/A	N/A	Adjustments to meet Treaty requirements
HLK/ALH 2013-03	8-Feb-13	Low	Yes	7.0	86.0	72.5	13.5	19.0	19.0	0.0	N/A	N/A	67.0	53.5	13.5	3	4.5	Yes	No	0	9	Adjustments to meet Treaty requirements
	9-Feb-13				72.5	59.0	13.5	19.0	19.0	0.0	N/A	N/A	53.5	40.0	13.5	3	4.5	Yes	Yes	30	9	
HLK/ALH 2013-04	16-Feb-13	Low	Yes	7.3	60.1	48.1	12.0	18.0	18.0	0.0	N/A	N/A	40.0	28.0	12.0	4	3.0	Yes	Yes	282	5	Adjustments to meet Treaty requirements.
HLK/ALH 2013-05	2-Mar-13	Low	No	7.0	49.0	45.0	4.0	18.0	18.0	0.0	N/A	N/A	31.0	27.0	4.0	2	2.0	N/A	N/A	N/A	N/A	Adjustments to meet Treaty requirements
BRD/X 2013-06	6-Mar-13	Low	Yes	7.0	45.3	43.0	2.0	18.3	16.3	2.0	1	2	27.0	27.0	0.0	N/A	N/A	Yes	No	159	6	Outage at BRX
HLK/ALH 2013-07	30-Mar-13	Low	Yes	4.3	55.0	45.0	10.0	20.0	20.0	0.0	N/A	N/A	35.0	25.0	10.0	2	5.0	Yes	No	749	22	Adjustments to meet Treaty requirements. Establishment of rainbow trout protection flow.

The total number of reductions in 2012/2013 (*n* = 17) was lower than the number of total reductions recorded in the last three annual summaries where Year 2009/2010 recorded 23 reductions, year 2010/2011 recorded 21 reductions and year 2011/2012 recorded 22 reductions. The decrease in reductions may have been due to the high water during the summer as the first reduction for this summary period was at the end of July.

There was an increase (82% versus 60% last year) in the percentage of reductions that required a stranding assessment (Figure 3). This may also have been the result of the high water during the 2012 summer. Many 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.

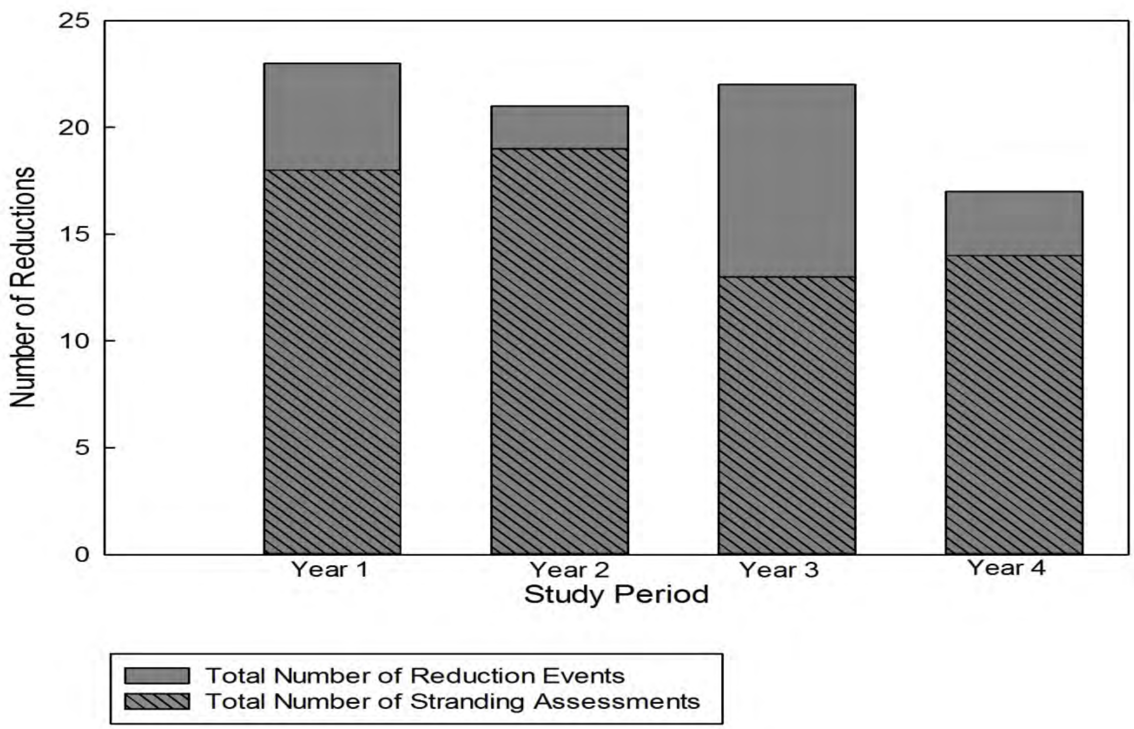


Figure 3: Total number of Flow Reductions and Stranding Assessments conducted during each study period, 2009/2010, 2010/2011, 2011/2012 and 2012/2013.

In total, 19 different sites were assessed at least once during the 2012/2013 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) 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)* that are known areas of high fish stranding risk.

Similar to previous years, poor site access (e.g., excessive snow) and limited daylight hours during the winter season limited 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)].

3.2.1 Fish Captured or Observed During 2012/2013 Stranding Assessments

Isolated pools and stranded fish were identified during all REs for which a stranding assessment was conducted (Table 1). The summer of 2012 was an exceptionally high water year and reductions that occurred during this time (RE2012-08, RE2012-09 and RE2012-10) were all conducted as reconnaissance stranding assessments where no fish salvage was attempted. During these assessments the numbers of pools isolated and estimates of the number of fish present were recorded. If possible the fish species were identified and recorded.

During the 14 REs in which fish stranding assessments were conducted, 6729 stranded fish were recorded (Table 2). The majority (73%) of these fish were observed during the seven RE assessments conducted during the High Risk period. The total number of fish observed or salvaged for each RE ranged from 1 to 1560 (Table 1). None of the stranding assessments conducted during the sample period were classified as a “significant” stranding event (>5000 fish observed).

The majority (96.0%) of the isolated fish were recorded in pools located at the Tin Cup Rapids RUB (47.0%), Gyro Boat Launch (24.7%), Kootenay River RUB (10.1%), Fort Shepherd Launch RUB (4.4%), Lions Head RUB (4.1%), Millennium Park LUB (3.8%) and Genelle Mainland LUB (2.5%) sites. All other fish (4.0%) were recorded at the Kootenay River LUB, CPR Island Mid, Norns Creek Fan, Zuckerberg Island LUB, Bear Creek RUB, Beaver Creek RUB and Casino Road Bridge LUB (downstream) sites (Appendix A; Figure A1 through A8 for site locations). Fish were not recorded at the Blueberry Creek LUB, Trail Bridge RUB, Casino Road Bridge LUB (upstream), Beaver Creek LUB, or Fort Shepherd Eddy LUB sites (Table 2).

Table 2: Percentage of the Total Number of Fish Stranded during the Reduction Events from April 1, 2012 to April 1, 2013 that were Stranded at each Site.

Site[a]	Total Number of Visits	Total Number of Fish Stranded	% of Total Stranded Fish at each Site
Tin Cup Rapids RUB[b]	11	3165	47.0
Gyro Boat Launch RUB	12	1659	24.7
Kootenay River RUB	15	681	10.1
Fort Shepherd Launch RUB	8	298	4.4
Lions Head RUB	12	273	4.1
Millennium Park LUB[b]	4	215	3.2
Genelle Mainland LUB	11	171	2.5
Kootenay River LUB	12	124	1.8
CPR Island Mid	11	67	1.0
Norn's Creek Fan RUB	10	32	0.5
Zuckerberg Island LUB	8	32	0.5
Bear Creek RUB	6	6	0.1
Beaver Creek RUB	7	4	0.1
Casino Road Bridge LUB (downstream)	3	2	<0.1
Blueberry Creek LUB	6	0	0
Casino Road Bridge LUB (upstream)	3	0	0
Fort Shepherd Eddy LUB	3	0	0
Beaver Creek LUB	3	0	0
Trail Bridge RUB	2	0	0
Total		**6729**	**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 2012/2013 study period.

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, 2011 to April 1, 2012.

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	Bull Trout (*Salvenlinus confluentus*)	1	<0.1	0	1	N/A	Threatened	Blue
	Brook Trout (*Salvelinus fontinalis*)	1	<0.1	0	1	N/A	N/A	N/A
	Rainbow Trout (*Oncorhychus mykiss*)	50	0.7	0	35	N/A	N/A	Yellow
	Whitefish species (*Coregonidae*)	246	3.7	0	14	N/A	N/A	Yellow
Non-sportfish	Dace species (*Rhinichthys* spp.)	1	<0.1	0	0	N/A[d]	N/A[d]	N/A[d]
	Longnose Dace (*Rhinichthys cataractae*)	80	1.2	0	61	N/A	N/A	Yellow
	Umatilla Dace (*Rhinichthys umatilla*)	102	1.5	1	98	Schedule 3	Threatened	Red
	Northern Pikeminnow (*Ptychocheilus oregonensis*)	52	0.8	0	20	N/A	N/A	Yellow
	Peamouth (*Mylocheilus caurinus*)	12	0.2	1	11	N/A	N/A	Yellow

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]
Redside Shiner (*Richardsonius balteatus*)	484	7.2	3	261	N/A	N/A	N/A
Sculpin species (*Cottus* spp.)	177	2.6	0	21	N/A[d]	N/A[d]	N/A[d]
Prickly Sculpin (*Cottus asper*)	26	0.4	1	24	N/A	N/A	N/A
Torrent Sculpin (*Cottus rhotheus*)	29	0.4	1	28	N/A	N/A	Yellow
Common carp (*Cyprinus carpio*)	1	<0.1	0	1	N/A	N/A	N/A
Columbia Sculpin (*Cottus hubbsi*)	5	0.1	0	5	Schedule 1	Special Concern	Blue
Sucker species (*Catostomidae*)	2825	42.0	253	265	N/A[e]	N/A[e]	N/A[e]
Unidentified[f]	2637	39.2	0	0	N/A[d]	N/A[d]	N/A[d]
Totals	**6729**	**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 whitefish species recorded during the 2012/2013 stranding assessments were young-of-the-year fish associated with RE2013-07 which occurred in early spring to facilitate Rainbow Trout Protection Flows. Whitefish eggs in pre-hatch stage also were observed during RE2013-03 and RE2013-04 which occurred in mid-February. The small body size and fragility of these fish rendered salvage attempts ineffective. For this reason, whitefish numbers were estimated. All whitefish recorded during RE2013-07 were observed at the Lions Head site (Appendix A, Figure A1).

All of the Rainbow Trout that were recorded in the Columbia River were from sites upstream of the Kootenay River confluence (Appendix A; Figure A1 and A2). And the majority (76%) of these fish were recorded at the CPR Island site. All recorded Rainbow Trout were either young-of-the year or juveniles.

The one Eastern Brook Trout was captured at the CPR Island site during RE2013-04 and the one Bull Trout was captured at the Beaver Creek RUB site during RE2013-07. The Eastern Brook Trout was classified as an adult and the Bull Trout was classified as a juvenile based on fork lengths.

3.2.1.1.2 Non-sportfish

The majority of non-sportfish found during the 2012/2013 stranding assessments were young-of-the-year and juvenile sucker species (n = 2825). Redside Shiner (young-of-the-year or juvenile) were the second most abundant non-sportfish species recorded (n = 484; Table 3).

3.2.1.1.3 Unidentified Fish

Approximately 2825 unidentified young-of-the-year fish were recorded. This number was substantially higher than the number of unidentified captured or observed fish (n = 550) from last years' sampling period. This suggests that flow reductions during very high river stages like in 2012 may result in greater numbers of stranded larval or young-of-the-year fish, compared to reductions during lower river levels. However, greater numbers of stranded young-of-the-year fish in 2012 compared to previous years may have been because during the stranding assessments conducted during the high water period in late July and August, fish were only enumerated and no salvages were attempted. Existing salvage methods are ineffective at capturing young-of-the-year fish (i.e., beach seining is not effective in pools with cobble substrate bottoms and the backpack electrofisher is not effective at attracting and immobilizing very small bodied fish).

Determining the species of young-of-the-year fish in the field continues to be a challenge; therefore, subsamples of young-of-the-year fish were collected during stranding assessments. The subsamples which were later identified in the laboratory were exclusively sucker species. 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*)]. Umatilla Dace (n = 102) and Columbia Sculpin (n = 5) were documented during the 2012/2013 stranding assessment period (Table 4). This was the first stranding assessment year since 2007/2008 that more Umatilla Dace than Longnose Dace (n = 80) were documented.

Table 4: Summary of Listed Species Captured or Observed during Stranding Assessments, April 1, 2012 to April 1, 2013.

Site[a]	Risk Period[b]	Total Number of Visits	Number of Visits with Listed Species Present	Number of Listed Fish Stranded
Umatilla Dace				
Lions Head	Low	12	1	1
Kootenay River LUB	Low	12	2	33
Kootenay River RUB	Low	15	4	33
Zuckerberg Island	Low	8	1	1
Gyro Boat Launch	Low	12	1	34
Total				**102**
Columbia Sculpin				
Kootenay River RUB	Low	15	3	4
Kootenay River LUB	Low	12	1	1
Total				**5**

Approximately, 2825 unidentified young-of-the-year cyprinids and catostomids were recorded during the stranding assessments conducted in 2012/2013; all of these were recorded during the High Risk period. Some of these fish may have been Umatilla Dace.

Approximately 180 unidentified sculpin species were captured or observed during the 2012/2013 stranding assessments. Five Columbia Sculpin were captured and positively identified during the Low Risk period. All of these fish were from the two sites on the Kootenay River. Most (96%) of the sculpin species captured or observed during the present study were recorded during the High Risk period. All unidentified sculpin species during the high risk period were young-of-the-year stage; consequently field identification was not possible.

3.2.1.1.5 Exotic Fish Species

Several exotic fish species have been identified and recorded during stranding assessments since 2000 in varying numbers. 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). During the 2012/2013 study period two exotic species were recorded at two sites. One Common Carp was identified at the Kootenay River (RUB) site and one Brook Trout was identified at the CPR Island (mid) site.

3.2.1.2 Fish Fork Lengths

Fish fork length data were collected during the 2012/2013 stranding assessments. These data were collected and will be used to investigate whether there is a size at which certain species are more susceptible to stranding. A total of 355 lengths were collected from 13 different fish species. The length data collected this year were combined with the length data collected during 2011/2012, in order to increase the sample size available to assess the frequency of stranding of different size-classes. The same five non sportfish species (Longnose Dace, Northern Pikeminnow, Redside Shiner, sucker spp., and Umatilla Dace) were used for this analysis.

3.2.1.2.1 Sportfish

Fork length measurements were recorded for 22 Rainbow Trout (average length = 77 mm) from five different stranding assessments (RE2012-14, RE2012-17, RE2013-03, RE2013-04 and RE2013-07). Fork length measurements were recorded for one Brook Trout (300 mm) collected during RE2013-04 and one Bull Trout (150 mm) collected during RE2012-07. No whitefish were measured during this period since all were post-hatch and too fragile to handle. The following figure shows the percent frequency of Rainbow Trout stranded by fork lengths using combined fork length data (n = 48) from last yea’rs and this year’s stranding summaries (Figure 4).

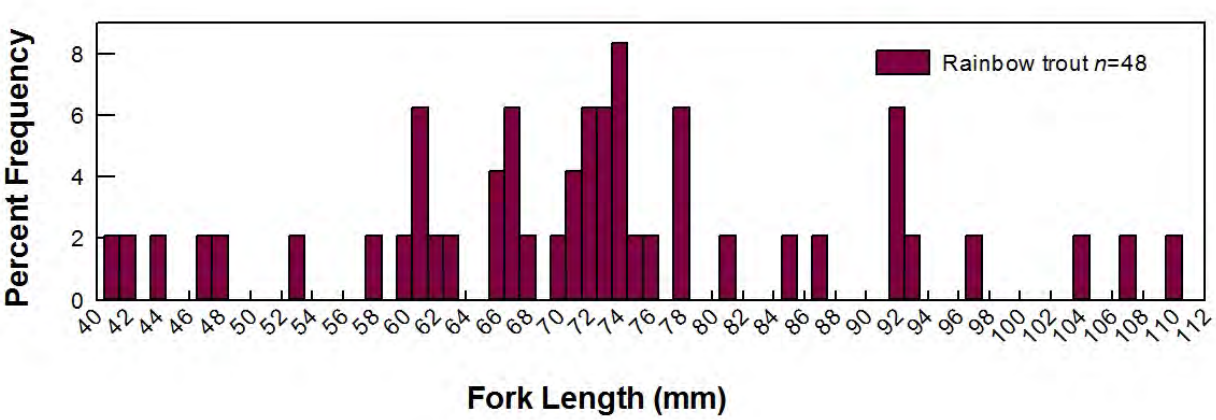


Figure 4: Length-frequency for rainbow trout collected during stranding assessments conducted during the 2011/2012 and 2012/2013 study period.

3.2.1.2.2 Non-sportfish

Fork length measurements were recorded for all non-sportfish species collected during the stranding assessments. The percent frequency of fish species stranded by fork lengths (two years data combined) is provided in Figure 5, for the following species:

- Longnose Dace (*n* = 43), combined years (*n* = 129);
- Northern Pikeminnow (*n* = 12), combined years (*n* = 66);
- Redside Shiner (*n* = 67), combined years (*n* = 132);
- sucker spp.(*n* = 80), combined years (*n* = 190); and,
- Umatilla Dace (n = 58), combined years (*n* = 103).

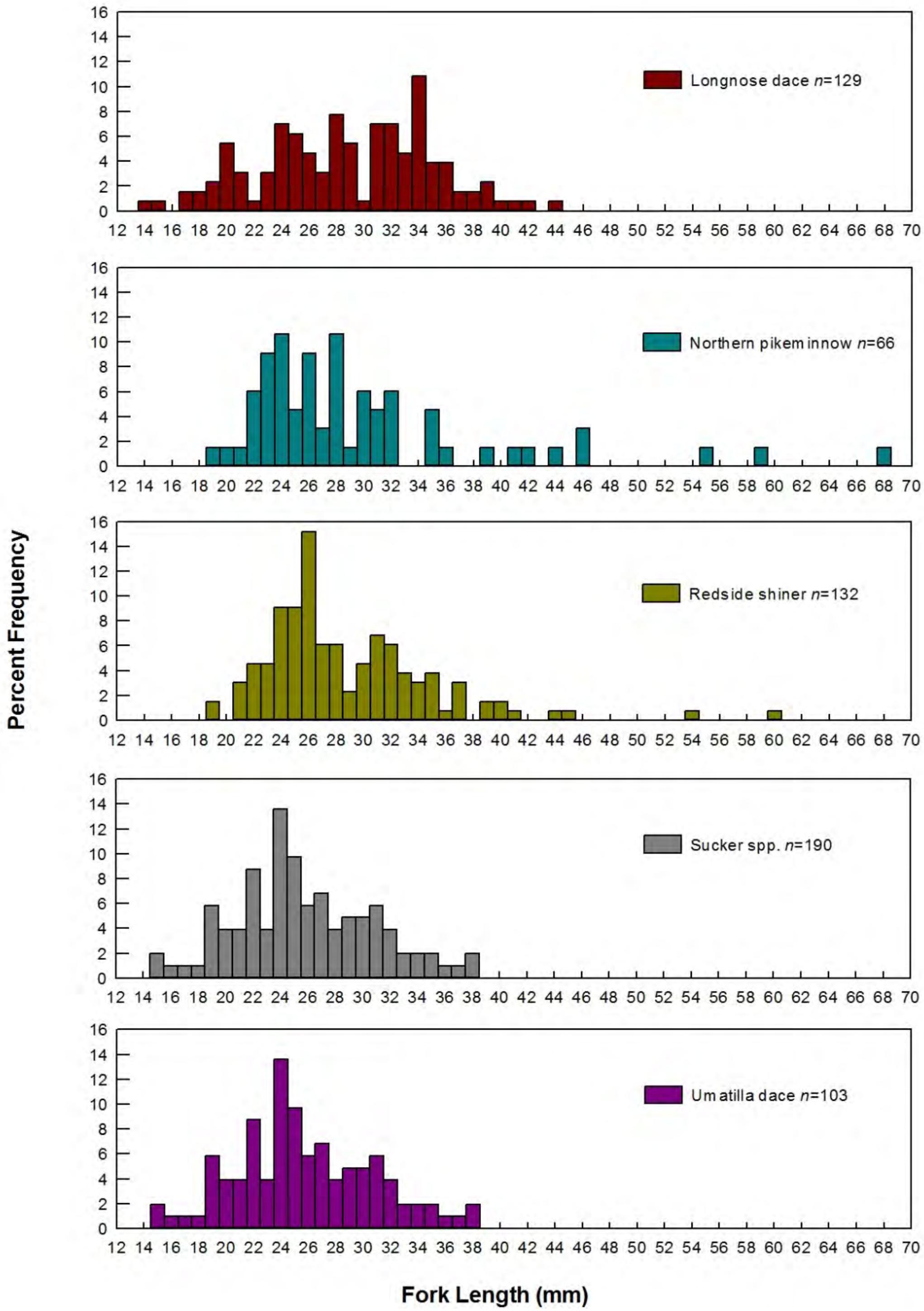


Figure 5: Length-frequencies for Longnose Dace, Northern Pikeminnow, Redside Shiner, sucker spp. and Umatilla Dace collected during stranding assessments during the 2011/2012 and 2012/2013 study period.

These measurements were recorded during seven stranding assessments (RE2012-14, RE2012-16, RE2012-17, RE2013-03, RE2013-04, RE2013-05 and RE2013-07). A total of 271 fork length measurements were collected (95% were from fish captured in isolated pools and 5% were from fish collected from interstitial stranding areas). Longnose Dace, Northern Pikeminnow, Redside Shiner and Peamouth length measurements were only collected during REs in February and March. Sucker spp. and Umatilla Dace length measurements were collected during REs that occurred in September, October and November, as well as during the REs in February and March.

3.2.2 Historic Fish Stranding Summary

The results of fish stranding assessments conducted between January 2000 and April 2013 have been summarized by site, water elevation and risk period (Table 5). One of the recommendations from last annual stranding summary was to create a table that reflected the new risk periods (High Risk and Low Risk) rather than the original table which was based on water temperatures. The new table has two periods instead of five periods. Combining the “December 15 to May 1”, “May 1 to June 1” and “September 30 to December 15” periods all into the Low Risk period added additional data to the table in some of the areas that were lacking data.

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). The fish numbers are presented as the maximum number of fish observed stranded at each site during a single assessment. The collection of data at sites with no 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.

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 2013)

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	
		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			
	30-40							13500	1					0	1	620	1	No Pools		No Pools			
	40-50	6	2	311	3	457	3	76	3	0	1	72	3	81	4							14302	2
	50-60	425	10	215	10			155	9	34	4	2894	6	2700	11	18	6	No Pools		No Pools		2865	13
	60-70	16	5	423	16	0	1	258	6	0	3	492	20	2686	17	55	7	No Pools				37964	17
	70-80	42	3	19	8	No Pools		4	3	0	1	1	2	35	6	48	5	No Pools		50	3	6000	7
	80-90	2	4	88	9	No Pools		34	5	4	7	No Pools		12	3	No Pools		No Pools		0	4	90	6
	90-100	0	1	5	5	No Pools		458	6	26	2	No Pools		No Pools		No Pools						513	6
	100-110	No Pools		2	2	2	1	10307	3	7521	2	No Pools		No Pools		0	2			0	1	0	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	
	>120	0	1	No Pools		No Pools		0	1	100	1	No Pools		No Pools		No Pools				0	1	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
	30-40	717	15	5002	23	24	4	224	10	522	16	210	1	971	21	95	10	No Pools		No Pools		236	13
	40-50	1445	27	623	29	147	19	86	22	92	15	450	20	1450	42	298	25	0	2	0	3	1414	22
	50-60	176	19	100	21	4	5	59	15	52	18	157	20	332	30	71	17	No Pools		No Pools		400	26
	60-70	8	10	39	18	5	2	11	8	0	13	103	16	529	21	109	19	No Pools		0	1	520	17
	70-80	0	3	79	10	No Pools		0	2	0	8	0	3	10	5	0	9	No Pools		0	2	7	6
	80-90					No Pools		0	1	0	2	No Pools				No Pools		No Pools		0	1	1	3
	90-100	No Pools				No Pools						No Pools		No Pools		No Pools							
	100-110	No Pools										No Pools		No Pools									
	110-120			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									

Risk Period	Resultant Birchbank Discharge (kcfs)	Observed Effect																					
		Columbia River																					
		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
High Risk (1 June 30 September	≤30					No Pools										No Pools		No Pools					
	30-40	No Pools		No Pools								0	1							200	1	50	1
	40-50	No Pools		No Pools		464	1					207	1	No Pools								46	1
	50-60			No Pools		No Pools		0	1	0	1	11	4	0	2	1	1	27	1	0	1	374	7
	60-70			20	2	500	2	No Pools						500	4	1	4					7000	8
	70-80	54	1	0	1	No Pools		No Pools		No Pools				0	1	8	2	No Pools		0	1	108	8
	80-90	No Pools		3	5	0	2	No Pools		No Pools		No Pools				0	2	No Pools		380	2	6	5
	90-100	No Pools		No Pools		500	6	No Pools		No Pools		No Pools		No Pools		251	2	No Pools		No Pools		0	2
	100-110					500	1															2	1
	110-120	No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		0	1	No Pools	
	>120	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					No Pools		8	5	0	3	0	1	2013	1	No Pools		No Pools		0	1	0	1
	30-40	No Pools		No Pools		1455	9	5	2	0	2	1	2	12	2	38	1	0	1	0	1	363	12
	40-50	No Pools		No Pools		650	15	4	3	4	5	1	4	No Pools		4	5	0	3	0	4	33	7
	50-60	0	1	0	1	48	4	0	1	0	9	21	11	0	7	0	1	20	2	2	3	3	13
	60-70	1	1			4	2	No Pools		1	5	0	5	0	2	0	1	0	2	0	2	0	15
	70-80			0	1	No Pools		No Pools		No Pools		0	1	3	3	0	2	No Pools				0	9
	80-90	No Pools		0	1			No Pools		No Pools		No Pools		0	1			No Pools				0	2
	90-100	No Pools		No Pools		No Pools		No Pools		No Pools		No Pools		No Pools				No Pools		No Pools		0	1
	100-110					No Pools																	
	110-120					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	

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 2012).
	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 for until 1 April 2013.

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 a trend for increased stranding with increased ramping rates displayed in the data collected during ramping experimentation 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/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 has shown 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 are 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 document (Golder/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 river systems. 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/Poisson 2010).

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

   Over the past 10 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. Analysis of data from these sites showed that re-contouring did reduce the incidence of fish stranding in these areas (Golder/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) has not been defined (due to limited data).

During 2012/2013, the Fort Shepherd Launch (RUB) site was in the process of being re-contoured by Columbia Power Corporation (CPC) as a component of the CPC Owner's Commitment #39 [(Revised November 10, 2006) (Columbia Power Corporation 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. Stranding assessments have not been conducted at this site since the 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?*

Preliminary results showed a decline in the number of occurrences when stranding crews were required to conduct stranding assessments. During the 2010/2011 study period, 90% of all flow reductions required stranding assessments and during 2011/2012, 60% of all flow reductions required stranding assessments based on the fish stranding assessment protocols (Golder 2011). There was an increase of approximately 30% of flow reductions that required stranding assessments during the current study period where 82% of the flow reductions required stranding assessments. The increase in the number of occurrences when a stranding crew was required during the 2012/2013 period may be due to high flows in the Columbia River during summer 2012 which contributed to the majority of the queried information being outside the flow ranges recorded in the database. In addition to stranding assessments as required by the stranding protocol and database queries, two surveys were conducted in the summer and fall of 2012 to investigate whether the unusually high discharges in the lower Columbia River that year resulted in changes to the shoreline and river-bed that could affect stranding risk at existing stranding sites and potential new sites (Golder 2013). These results were presented in a separate technical memorandum (Golder 2013).

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.

- 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 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/BC/tc

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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		

LEGEND

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

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	A2	
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

LEGEND

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

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		

LEGEND

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

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		

LEGEND

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

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	A5	
GIS	SS	24 May 2012		
CHECK	DB	24 May 2012		
REVIEW	DS	24 May 2012		

LEGEND

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

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		

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	A7	
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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