Columbia River Project Water Use Plan

Lower Columbia River Fish Management Plan
Monitoring Programs Annual Report: 2012

Implementation Period: August 2011 to July 2012

- CLBMON-42 Lower Columbia River Fish Stranding Assessment and Ramping Protocol
- CLBMON-43 Lower Columbia River Sculpin and Dace Life History Assessment
- CLBMON-44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring
- CLBMON-45 Lower Columbia River Fish Population Indexing Surveys
- CLBMON-46 Lower Columbia River Rainbow Trout Spawning Habitat Assessment
- CLBMON-47 Lower Columbia River Whitefish Spawning Ground Topographic Survey
- CLBMON-48 Lower Columbia River Whitefish Egg Monitoring & Life History Study
- CLBMON-49 Lower Columbia River Effects of Whitefish Flows on Great Blue Heron & Winter Use of Waldie by Great Blue Heron

Conditional Water Licences for Kinbasket storage (27068 and 39432), Mica diversion (39431), Revelstoke diversion and storage (47215), and Arrow storage (27066)
1 Introduction

This document provides a summary of the status and results of monitoring programs and physical works being implemented under the Lower Columbia River Fish Management Plan of the Columbia River Water Use Plan (WUP) to July 31, 2012, as per the Columbia River Order under the Water Act, dated January 26, 2007. There are eight monitoring programs included within this Management Plan:

- CLBMON-42 Lower Columbia River Fish Stranding Assessment and Protocol
- CLBMON-43 Lower Columbia River Sculpin and Dace Life History Assessment
- CLBMON-44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring
- CLBMON-45 Lower Columbia River Fish Population Indexing Surveys
- CLBMON-46 Lower Columbia River Columbia Rainbow Trout Spawning Habitat Assessment
- CLBMON-47 Lower Columbia River Whitefish Spawning Ground Topographic Survey
- CLBMON-48 Lower Columbia River Whitefish Egg Monitoring & Life History Study
- CLBMON-49 Lower Columbia River Effects of Whitefish Flows on Great Blue Heron and Winter Use of Waldie by Great Blue Heron

2 Background

The water use planning process for BC Hydro’s Columbia River project was initiated in August 2000 and completed in June 2004. The conditions proposed in the WUP for the operation of the project reflect the June 2004 consensus recommendations of the Columbia River WUP Consultative Committee (CC).

In July 2006, the Columbia River Draft WUP was submitted to the Comptroller of Water Rights (CWR). The draft WUP was sent out to regulatory agencies, First Nations and interested stakeholders for review. In January 2007, the CWR approved the final WUP and issued an Order to BC Hydro to implement the conditions proposed in the Columbia River WUP and prepare the monitoring programs and physical works Terms of Reference (TOR).

An addendum to the Columbia River WUP was submitted to the CWR in July 2007 after an Environmental Assessment Certificate was issued for the Revelstoke Unit 5
Project. The addendum proposes additional terms and conditions for the Columbia River WUP, as recommended by the Revelstoke Unit 5 Core Committee in December 2006, to address incremental impacts of the operation of the fifth generating unit at Revelstoke Dam.

In August 2007, the CWR accepted the Columbia River Project WUP Addendum resulting from the Revelstoke Unit 5 Project, and issued amendments to the Columbia River Implementation Order to include the commitments made by BC Hydro to undertake additional monitoring programs and physical works associated with the Revelstoke Unit 5 Project.

An addendum to the Columbia River WUP was submitted to the CWR in April 2010 resulting from Mica Generating Unit 5 and Unit 6. Environmental assessment certificates were issued for the addition of the two units.

In August 2010, the CWR accepted the Columbia River Project WUP Addendum resulting from the Mica Generating Unit 5 and Unit 6, and issued amendments to the Columbia River Implementation Order to include the commitments made by BC Hydro to undertake additional monitoring programs associated with the Mica Generating Unit 5 and Unit 6.

The following table outlines the dates that TOR for the Lower Columbia River Fish Management Plan were submitted to and approved by the CWR.

Table 1. Dates of Lower Columbia River Fish WUP TOR submissions and approvals by the Comptroller of Water Rights

<table>
<thead>
<tr>
<th>Monitoring Programs/ Physical Works TOR</th>
<th>Original TOR Submission</th>
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<td>Date Submitted</td>
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<tr>
<td>CLBMON-43 Lower Columbia River Sculpin and Dace Life History Assessment</td>
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<td>CLBMON-45 Lower Columbia River Fish Population Indexing Surveys</td>
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<td>CLBMON-48 Lower Columbia River Whitefish Egg Monitoring &amp; Life History Study</td>
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As outlined in the Columbia River WUP, the CC recommended a full review of the Plan 13 years after implementation, unless results of the monitoring program suggest an earlier review is appropriate or significant risks are identified that could result in a recommendation to change operations.

BC Hydro will convene a multi-party panel five years after commencing the implementation of this WUP to evaluate the effectiveness of operations and physical works in meeting the stated objectives for Arrow Lakes Reservoir and the lower Columbia River. The outcomes from this process will be used to assess any potential need to review the Arrow Lakes Reservoir component of this WUP. If a replacement Non-Treaty Storage Agreement (NTSA) is negotiated within this 5-year period, it is also recommended that agreement provisions and implications be reported out through this panel. Signing of a new NTSA is not a trigger for panel evaluation or a review of this Water Use Plan recommendation to change operations.

3 Schedule

The following table (Table 3-1) outlines the current schedule for the monitoring programs being delivered under the Lower Columbia River Fish Management Plan of the Columbia River WUP.

Table 3-1: Schedule of Columbia River WUP Monitoring Program Implementation under the Lower Columbia River Fish Management Plan

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Legend:
- ✔ = Program to be undertaken/initiated in identified year
- ✔ = Program completed for the year
- ✔ = Program started, but encountered operational or hydrological delays
- ✔ = Project is underway
- ✔ = Program to be undertaken/initiated in identified year

4 Columbia River WUP Monitoring Programs – Lower Columbia River Fish Management Plan

This section summarizes the status of the monitoring programs being implemented under the Lower Columbia River Fish Management Plan of the Columbia River Water Use Plan, as per the Order under the Water Act, dated January 26, 2007.

4.1 CLBMON-42 Lower Columbia River Fish Stranding Assessment and Ramping Protocol

4.1.1 Management Questions

The key management questions addressed by this monitoring program are:
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., recontouring) 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?

4.1.2 Overview

The primary objective of this monitoring program is to collect fish stranding data to assess the impact of flow reductions and flow ramping rates from Hugh L. Keenleyside (HLK) Dam on the native fish species of the lower Columbia River. Secondary objectives include: (1) reducing (through risk management strategies) the number of occurrences when stranding crews need to be deployed with flow reductions; (2) determining ramping rates for flow reductions that reduce the stranding rate of fish at different times of the year; (3) determining whether the wetted history influences the stranding rate of fish for flow reductions; (4) determining whether a conditioning flow reduction from HLK reduces the stranding rate of fish; and (5) determining whether physical habitat manipulation reduce the incidence of fish stranding in the lower Columbia River.

The Columbia River WUP CC agreed on four actions that could provide the greatest potential gains to wild indigenous fish populations in the lower Columbia River (BC Hydro 2005a, 2005b). Two of these actions were related to fish impacts associated with flow regulation at HLK and included:

- Explore opportunities to minimize the frequency and magnitude of flow reductions and develop a flow reduction protocol and standard methods for assessment, data collection and mitigation responses to manage fish stranding impacts.

- Conduct flow ramping studies to determine appropriate ramping rates to minimize pool and interstitial stranding.

It was recommended that the above strategy and associated monitoring program was an acceptable approach to addressing the impacts of flow reductions at HLK on fish stranding in the lower Columbia River.

Monitoring Indicators:

a) Program will monitor the number of fish stranding incidences in the lower Columbia River (where dictated by the lower Columbia River Stranding Protocol) when flow reductions occur from HLK.
b) Program will monitor the number of fish stranded after utilizing various ramping rate experiments.

c) Program will monitor whether fish stranding continues to occur at locations where gravel bar re-contouring has been conducted.

The approach of this monitoring program is to continue stranding surveys within the study area over the period of the Columbia WUP. These stranding surveys will be undertaken as required through the implementation of the lower Columbia River Stranding Protocol – including future updates.

In addition, flow ramping studies will continue for a period of time as warranted by interpretation of the results. The flow ramping program was initiated through negotiation with Fisheries and Oceans Canada (DFO), and the program was further examined by the Columbia WUP CC. BC Hydro meets with the Columbia Operations Fish Advisory Committee (COFAC) annually to review the results of the flow ramping program and to receive direction on future study/monitoring requirements. As such, the primary objective of the monitoring program is to meet the requirements of the regulatory agencies, and, if agreed to by the regulatory agencies, to approach the Comptroller of Water Rights for sign off on meeting the requirements of this component of the Columbia WUP in an earlier time period.

Finally, where appropriate, physical habitat works in the form of gravel bar re-contouring will be considered for areas where a high rate of fish stranding occurs. Similar work has been undertaken previously in the study area, and further work will be considered if proposed flow ramp rates do not reduce the rate of stranding, or high risk areas are identified through the stranding surveys.

4.1.3 Status

The monitoring program was initiated in August 2007, and will be carried out over 13 years. The lower Columbia River Stranding Surveys component of the monitoring program will be conducted annually until 2019. Identification and assessment of potential areas for physical habitat manipulation will be conducted using information from the ramping studies and stranding surveys, with physical habitat manipulation being implemented (pending DFO approval) in eight of twelve years (from Years 3 to 13). Effectiveness monitoring will be conducted in Years 6 through 13.

A summary of the flow ramping studies conducted on the Lower Columbia and Kootenay rivers (2004 to 2007) was presented to COFAC at their June 24, 2008 meeting. The presentation included a summary of the flow ramping data that had been collected to date, as well as a detailed power analysis to determine “where we are at” with regards to answering the objectives of the monitoring study. A summary of the annual stranding assessment results was also presented for both the lower Columbia and Kootenay rivers. Following the presentation, it was concluded by the committee that flow ramping studies in the lower Columbia River should cease until a full review of the all related information (e.g., ramping studies, stranding assessment data, and grey literature) could be completed.

Program reports for Year 1 (2007/2008), Year 2 (2008/2009), Year 3 (2009/2010) and Year 4 (2010/2011) have been received by BC Hydro. Attached is the Year 5 (2011/2012) report. Due to sustained high waters in the LCR in 2012, we are anticipating that there may be changes to the channel morphology which requires a
reassessment of stranding sites and updates to the stranding database and protocol. We will wait until the waters recede in the fall to determine the extent of change in stranding sites; if necessary, BC Hydro will submit a revision to the TOR for this work.

4.1.4 Interpretation of Data

The 2010-11 fish stranding assessment annual report is the second year that information from the two systems has been combined into a single document. This was done because fish stranding in this section of river is influenced by both systems and the same key variables that affect fish stranding and the management and methods are similar. Information that is distinct for each system has been identified and the BC Hydro Water Use Plan objectives and management questions have been evaluated.

a) Lower Columbia Fish Stranding Assessment

The overall objectives during the 2011/2012 stranding assessment period were to: 1) continue to assess the impact of flow reductions on native fish species; 2) reduce (through risk management strategies) the number of occurrences stranding crews need to be deployed in response to a flow reduction; and, 3) collect data and identify additional potential mitigation measures in response to observed fish stranding impacts. During this period, the revised fish stranding protocol, “Canadian Lower Columbia River: Fish Stranding Risk Assessment and Response Strategy” (Golder, 2011) was used to direct efforts towards reducing the number of flow reductions that required stranding assessments. The 2011/12 period saw a 30% decrease in flow reductions that required stranding assessments. This decrease in the number of occurrences when a stranding crew was required was a result of additional data available for the database queries at different flow levels and different seasons. The additional data eliminated the need to conduct a stranding assessment at certain flow reduction levels (i.e., there were more ‘no effects’ or ‘no pools’ during a Reduction Event than ‘effects’ or ‘recons’). This resulted in fewer sites that have insufficient data, allowed for more concentrated efforts and eliminated the need for an assessment at certain flow levels and seasons.

Stranding assessments were conducted for 13 of 22 reduction events (REs) that occurred between April 1, 2011 and April 1, 2012. Two assessments were conducted in response to flow reductions from BRD/X, 8 assessments were in response to flow reductions from HLK/ALH and 3 assessments were in response to flow reductions from the two facilities combined. An estimated 5500 isolated or stranded fish were observed during 11 of the REs and stranded fish were not identified during 2 stranding events. The majority (76%) of stranded fish were observed during 6 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).

The total number of fish observed or captured for each RE ranged from 0 to 1854. The majority (82.0%) of the isolated fish were recorded in pools located at the Genelle Mainland LUB (33.5%), Tin Cup Rapids RUB (11.6%), Kootenay River RUB (11.7%), Gyro Boat Launch (9.9%), Norns Creek Fan sites (8.4%) and Fort Shepherd Eddy LUB (6.9%). Fish were not recorded at the Trail Bridge RUB, Beaver Creek LUB, or Casino Road Bridge LUB (upstream and downstream) sites.
Fish species recorded during the 2011/2012 stranding assessments were, in descending order of abundance: sucker species (Catostomus spp.); northern pikeminnow (Ptychocheilus oregonensis); unidentified young-of-the-year cyprinids and catostomids; longnose dace (Rhinichthys cataractae); torrent sculpin (Cottus rotneus); redside shiner (Richardsonius balteatus); young-of-the-year whitefish species (Prosopium williamsoni or Coregonus clupeaformis); sculpin species (Cottus spp.); rainbow trout (Oncorhynchus mykiss); prickly sculpin (C. asper); Umatilla dace (R. umatilla); dace species (Rhinichthys spp.); smallmouth bass (Micropterus dolomieu); peamouth (M. caurinus); and shorthead sculpin (C. confusus). One common carp (Cyprinus carpio) was also recorded.

All whitefish species recorded during the 2011/2012 stranding assessments were young-of-the-year fish associated with RE2012-07, which occurred in early spring to facilitate Rainbow Trout Protection Flows. All whitefish recorded during RE2012-07 were observed at five different sites: Lions Head; Norn’s Creek Fan RUB; Kootenay River LUB; Kootenay River RUB; and, Genelle Mainland LUB. Overall, 95% of all rainbow trout were recorded in the Columbia River upstream of the Kootenay River confluence. Over half (56%) of these fish were recorded at the Norns Creek Fan site. All recorded rainbow trout were either young-of-the-year or juveniles.

Currently, four resident fish species in the study area are considered at risk [Columbia sculpin, shorthead sculpin, Umatilla dace, and white sturgeon (Acipenser transmontanus)]. Of these, only Umatilla dace (n = 30) and shorthead sculpins (n = 6) were documented during the 2011/2012 stranding assessment period.

b) Lower Columbia River Ramping Protocol

No ramping experiments were conducted during this last reporting period. The recommendations from the Lower Columbia River Fish Stranding Protocol Review suggest that there have been enough experiments done, between the Duncan and Lower Columbia, to provide adequate direction to BC Hydro.

c) No physical works, in the form of gravel bar re-contouring, has been completed since 2003. Eight locations have been recommended as having potential benefits from recontouring.: Lions Head in Robson; Norn’s Creek Fan; Kootenay Oxbow; Millenium Park in Castlegar; Genelle Mainland; Genelle Cobble Island; Gyro Boat Launch in Trail; and Fort Shephard launch near Waneta Dam. Budget dollars are available for this portion of the project between Years 2013 and 2019.

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. As the database continues to be populated with more data, the ability to accurately identify sites likely to strand fish during flow reductions will increase.

4.2 CLBMON-43 Lower Columbia River Sculpin and Dace Life History Assessment

4.2.1 Management Questions

The key management questions addressed by this monitoring program are:
1) How do water level fluctuations (diel and seasonal) in the lower Columbia River affect the distribution and habitat use of sculpins and dace, especially the listed species?

2) What seasonal and diel habitat shifts do sculpins and dace (especially the listed species) make in response to water level fluctuations?

3) Do the operations of Hugh L. Keenleyside Dam alter these natural movements? Specifically, does this risk of stranding increase?

4) Which operations, and at what season, pose the highest risk of stranding or interference with the normal life cycles of sculpins and dace?

4.2.2 Overview

The primary objective of this monitoring program is to provide information on the life history and habitat use of six species of shallow-water dwelling fish (four sculpins and two dace, with special emphasis on Columbia sculpin and Umatilla dace) in the Lower Columbia River that may be affected by water level fluctuations resulting from daily and seasonal operations of HLK Dam. Two species of sculpin and one species of dace resident in the Lower Columbia River area are considered at risk – Columbia sculpin (Cottus hubbsi), shorthead sculpin (C. confusus), and Umatilla dace (Rhinichthys umatilla). Umatilla dace and Columbia sculpins are listed as Special Concern and shorthead sculpins are listed as Threatened. Information will be collected on the spawning habitats used by Umatilla dace and the timing of their spawning period, the abundance of Columbia sculpin and the habitats used by this species, and the importance of flooded areas at the confluence of tributaries and the main river as nurseries for young-of-the-year sculpins and dace. These nursery areas are the key habitat component of shorthead sculpin that are likely to be affected by the operations of HLK Dam.

During the Columbia River WUP process, the CC noted that the lack of biological information precluded explicit consideration of shallow-water dwelling threatened and endangered fish species in the lower Columbia River. Specifically, data were too limited to assess the potential risks to threatened/endangered sculpins and dace, as may be posed by the seasonal operations of Hugh L. Keenleyside (HLK) Dam. Consequently, the CC recommended a study to determine the relative abundance, distribution, life histories, and habitat use of sculpins and dace in the lower Columbia River between HLK Dam and the US border. The goal of the study is to provide a qualitative assessment of the risks that the operation of HLK Dam may pose for federally listed species of sculpin and dace.

Monitoring Indicators:

a) Program will monitor how water level fluctuations (diel and seasonal) in the lower Columbia River affect the distribution and habitat use of sculpins and dace, especially listed species.

b) Program will monitor what seasonal and diel habitat shifts sculpins and dace (especially listed species) make in response to water level fluctuations.

c) Program will monitor if the operations of HLK Dam alter the natural movements of these species and pose an increased risk of stranding.
d) Program will monitor which operations, and at what season, pose the highest risk of stranding or interference with the normal life cycles of sculpins and dace.

This monitoring program uses existing information on the life history and ecology of sculpins and dace as a basis for selecting monitoring sites in the Columbia River below HLK Dam. Following a literature review methodologies were developed to resolve any data collection obstacles encountered in earlier studies. Passive sampling procedures such as snorkel surveys, view tubes, D-ring or drift net sampling, and nest or egg traps have so far been used. Electrofishing is also used as a means to collect adults of each species.

4.2.3 Status

This project began in December 2008 with the initiation of an extensive literature review on the four sculpin (prickly- *C. asper*; shorthead; Columbia; torrent – *C. rhotheus*) and 2 dace (*Umatilla; longnose* – *R. cataractae*) identified in the Terms of Reference. The draft literature review was completed in 2009 and finalized in 2010. Field work began in February 2009 in several Okanagan drainages to collect life history information from non-regulated river systems. The life history knowledge and lessons learned from the Okanagan sampling were then used for the October 2009 initiation of the Columbia River sampling program. In July 2010, the Literature Review and Year 1 data report were released. Work continued on the Lower Columbia River between March and August, 2010 (Year 2) and from March 2011 to April 2012 (Year 3).

4.2.4 Interpretation of Data

The present summary discusses Year 3 results of this program. Field surveys conducted in Year 3 focused on anticipated spawning times of the target species. Sampling in the LCR study area occurred from late March to November 2011. A survey was conducted in late November 2011 at the Kootenay River RB site for FortisBC, which was incorporated into the program to accommodate data sharing between programs. Flow reduction surveys were completed from March 31 to April 1, 2011 and March 30 to April 1, 2012. The majority of sampling in the LCR study area focused on the spawning period for sculpins and dace (May through September). Field surveys in the LCR occurred approximately biweekly from late April through early June, then weekly through mid-September and back to biweekly through mid-October 2011. Sampling in the Slocan River occurred from mid-April to mid-October 2011. Field surveys occurred monthly from April to late June then weekly from early July through late September during the suspected spawning period for *Umatilla* dace.

HLK water level fluctuations occurring in late March (rainbow trout protection flows) may not influence the short-term distribution and habitat use of sculpins located in shallow shoreline areas that are at risk of dewatering in the LCR. This may also be true for longnose dace, but sample sizes were too small to draw these conclusions at this time (n=1). *Umatilla* dace were not observed during this flow reduction.

Preliminary results indicate that sculpins and dace may shift to deeper habitats in response to water level fluctuations that occurred in late March at HLK Dam. Tagged sculpins were observed at one LCR index site in significantly deeper water after the late March flow reduction compared to depths they were observed in prior to and during this period; this was also observed for one longnose dace that was tagged at
this site. However, this was not observed at the other index site sampled at this time, nor did velocity and substrate use differ between these periods at any of the index sites sampled. Seasonal and diel shifts in habitat use were not commonly observed for Columbia and shorthead sculpins studied in the unregulated systems. Adult Umatilla dace use seasonally flooded shoreline vegetation during high-water periods in the late spring and summer in the unregulated system. Juveniles were observed using seasonally flooded vegetation in the LCR study area.

The operations of HLK Dam did not seem to alter the natural movements of sculpins and longnose dace and increase their risk of stranding during the late March flow reduction period (rainbow trout protection flows). However, we cannot conclude at this time whether operations at HLK Dam during other periods would alter the natural movements of target sculpins and dace and increase their risk of stranding.

The risk of stranding at index sites for adult sculpins and longnose dace during the late March annual rainbow trout spawning protection flow reduction at HLK was low. This operation did not seem to interfere with the normal life cycles of sculpins and dace, since habitat use and movements were similar to what was observed outside of the flow reduction period in late March, a time when these species are not actively spawning nor rearing.

Critical life history periods for sculpins and dace include the spawning through larval rearing periods from June to late September. Male sculpins actively guarding nests (June to July in the LCR study area) may be at risk of stranding should their nest rock become dewatered as was observed in the unregulated Pass Creek. Recently emerged dace YOY using seasonally flooded terrestrial areas have been observed stranded in pools near Beaver Creek mouth as the LCR receded in summer.

The risk of stranding for listed species was observed to be higher during the September 30 to December 15 period at stranding index sites. This higher risk period likely corresponds to a time that would naturally not have much water level fluctuations and would have a longer wetted history, a factor that influences higher fish stranding in isolated pools. In addition, larval sculpins and dace are present in shallow nearshore habitats during this period in late summer/early fall as they are seeking out warmer water to actively feed and grow, which can make them prone to stranding.

More information will be collected in Year 4 during other seasonal flows.

4.3 CLBMON-44 Lower Columbia Physical Habitat and Ecological Productivity Monitoring

4.3.1 Management Questions

The data collected will be used to generate time series data of habitat variables that can be used to form a logical chain of inference from flow to habitat and ecological productivity to fish populations. The data collected will be combined with data from related monitoring programs in the lower Columbia River and used to examine primary hypotheses about change in fish populations.
Physical Habitat Monitoring

The key management questions addressed by the physical habitat monitoring program are:

1) How does continued implementation of whitefish and rainbow trout flows during winter and spring, and fluctuating flows during fall affect water temperature in the lower Columbia River? What is the temporal scale (diel, seasonal) of water temperature changes? Are there spatial differences in the pattern of water temperature response?

2) How does continued implementation of whitefish and rainbow trout flows during winter and spring, and fluctuating flows during fall affect the seasonal and inter-annual range and variability in river level fluctuation in the lower Columbia River?

3) How does continued implementation of whitefish and rainbow trout flows during winter and spring, and fluctuating flows during fall affect electrochemistry and biologically active nutrients in the lower Columbia River?

Ecological Productivity Monitoring

The key management questions addressed by the ecological productivity monitoring program are:

1) What is the composition, abundance, and biomass of epilithic algae and benthic invertebrates in the lower Columbia River?

2) What is the influence of the whitefish and rainbow trout flows during winter and spring, and fluctuating flows during fall on aquatic that determine the abundance, diversity, and biomass of benthic invertebrates?

3) Are organisms that are used as food by juvenile and adult whitefish and rainbow trout in the lower Columbia River supported by benthic production in the lower Columbia River?

The hypotheses and management questions relate to three flow periods:

1) Mountain whitefish (MWF) spawning (January 1 – January 21) and incubation (January 22 – March 31);

2) Rainbow trout (RBT) protection flows (April 1 – June 30); and

3) Fall fluctuating flows (September 1 – October 31).

4.3.2 Overview

Over the past decade, BC Hydro has attempted to stabilize water releases from HLK Dam during the whitefish and rainbow trout spawning seasons (January through March and April through June, respectively) to minimize egg losses in the lower Columbia River. To address existing uncertainties around the effectiveness of these flows to whitefish and rainbow trout populations in the lower Columbia River, the WUP CC supported the continued implementation of the current flow management
strategies (contingent on successful negotiations with the U.S.), as well as the option of testing the effectiveness of whitefish flows by re-introducing the historical flow regime after a total of 12 continuous years of systematic baseline data collection.

The WUP CC considered monitoring of flows and other habitat variables to be essential for supporting future decisions on water release strategies at HLK Dam, and recommended the implementation of a monitoring program to document physical habitat characteristics and ecological productivity of the lower Columbia River. The goal of the monitoring program is to use the resulting data to make inferences about the linkage between the implementation of whitefish and rainbow trout flows and overall ecological health of the river. In addition, the collection of physical habitat and ecological productivity data was viewed as a fundamental information requirement for supporting other monitoring programs associated with the lower Columbia River Fish Management Plan. The physical habitat and ecological productivity study complements parallel monitoring programs being implemented in the mid Columbia River, as well as ongoing large river fish indexing programs that provides an annual metric on the ecological productivity of the mid and lower Columbia River.

The objective of the Physical Habitat component of this monitoring program is to monitor water temperature, stage, electrochemistry and nutrient levels in the lower Columbia River to allow tracking of potential changes in physical habitat and ecological health as a result of flow conditions. The Ecological Productivity component monitors periphyton and benthic invertebrates to assess potential changes in trophic productivity and overall ecological health of the lower Columbia River resulting from the continued implementation of mountain whitefish and rainbow trout flow agreements.

**Monitoring Indicators**

a) Program will monitor the changes in water electrochemistry and biologically active nutrients due to seasonal operations of HLK Dam.

b) Program will monitor the changes in composition, abundance and biomass of epilithic algae and benthic invertebrates due to seasonal operations of Hugh Keenleyside Dam.

This monitoring program involves preparation of artificial substrates and associated rigging to allow for sampling under different velocity and depth scenarios, including desiccated conditions. Monitoring of water temperature and river stage is conducted in each of three reaches. Seasonal water quality sampling is conducted at the beginning and the end of the sample collection for the ecological productivity study at each index location, primary tributaries and at three supplemental times throughout the year.

An electronic database will be developed and maintained to preserve the information collected during the Lower Columbia River Physical Habitat and Ecological Productivity program. The database will be compatible with a similar system being developed for the mid Columbia River and must be able to facilitate the testing of hypotheses about physical habitat or ecological productivity changes.
4.3.3 Status

This monitoring program began in June 2008, and will continue through 12 years. The second year report was delivered in July 2010 and the third year report in July 2011. The fourth year report (2011) was delivered in April 2012. It pertained mostly to hydrology and water quality but also included a brief overview of opportunistically documented biological features. Neither periphyton nor zoobenthos were sampled. This part of the program will resume in 2012.

4.3.4 Interpretation of Data

This study focuses on benthic productivity and investigates how various environmental parameters influence periphyton and macroinvertebrate communities. All field data were collected between June and November 2011.

River flows in LCR are largely comprised of discharge from the HLK Dam and the Kootenay River. In 2011, the mean daily discharge from LCR and Kootenay Rivers were 53.9% and 45.7%, respectively, of the total flows at the downstream Birchbank gauging station.

Water level and temperature data were collected at five sites on LCR and one site on Kootenay River. Water levels during the fall fluctuating flow period declined at all sites until mid-October, prior to gradually increasing.

The year 2011 was characterized by a record freshet that resulted in flows not previously documented in LCR since 1997. The freshet peaked in the last week of June, with approximately 4,155.4 m$^3$/s recorded at the Birchbank Gauging Station. This peak was remarkably higher than the freshet peaks recorded in the first three years of the study (maximum mean daily river flows in 2008, 2009 and 2010 of 3,560.0, 2,730.0 and 2,761.9 m$^3$/s, respectively).

Several water quality parameters including conductivity and nutrients were affected by the record 2011 freshet. Dissolved oxygen, pH, conductivity, total dissolved solids, inorganic nitrogen and total phosphorus all indicated good water quality in both LCR and Kootenay River. Samples were also analyzed for a full suite of dissolved metals, and results were consistent with the long-term provincial database. Only aluminum exceeded the BC MOE guidelines for aquatic life.

Plankton haul samples were dominated by five planktonic diatom species, while true periphyton species were rarely encountered. Diatoms accounted for 93 to 99% of the algae in all drift samples, with some flagellates and very few cyanobacteria or green algae species documented. Chlorophyll-a concentrations were moderate in LCR, ranging from 1.4 to 2.1 µg/L. Didymosphenia geminata was observed, but only in moderate quantities. Furthermore, no mussel veligers were observed in plankton hauls collected from either LCR or Kootenay River in 2011.

It is important to understand the benthic communities and water quality characteristics of LCR during the winter months. To date, no biological or water quality sampling has occurred from November through May, and thus a large portion of the annual cycle is unknown. For example, the MWF flow period occurs from January through March, and to date all inferences surrounding this flow period have originated from data collected well outside the targeted flows. Changes will be implemented to better align the sampling effort with the management questions. The
deployment of artificial samplers within the flow period will allow a better characterization of benthic conditions that may result from the managed flows.

Smaller tributaries had such low flows during the latter part of the season (August – October) that either sampling could not occur, or in some cases the samples resulted in unreliable data. For this reason, water quality sampling will no longer be undertaken at the smallest tributaries (Blueberry, China and Champion Creeks).

4.4 CLBMON-45 Lower Columbia River Fish Population Indexing Surveys

4.4.1 Management Questions

The key management questions addressed by this monitoring program are:

1) What is the abundance, growth rate, survival rate, body condition, age distribution, and spatial distribution of sub-adult and adult whitefish, rainbow trout and walleye in the lower Columbia River?

2) What is the effect of inter-annual variability in the whitefish and rainbow trout flow regimes on the abundance, growth rate, survival rate, body condition and spatial distribution of sub-adult and adult whitefish, rainbow trout and walleye in the lower Columbia River?

4.4.2 Overview

Since 1995, BC Hydro has attempted to ‘stabilize’ water releases from HLK Dam during the whitefish and rainbow trout spawning seasons (January through June) to minimize egg losses in the lower Columbia River. The stabilization for whitefish is intended to reduce flow during peak spawning periods to encourage spawning at lower water level elevations and protect eggs through emergence. For rainbow trout, the protection flows are aimed to minimize potential egg losses for mid-timed rainbow spawners (April and May) by providing stable or increasing discharge over this period. Provision of these flows is subject to annual negotiations with the U.S. to implement mutually beneficial changes to flows required under the Columbia River Treaty.

To address existing uncertainties around the effects of flows on whitefish and rainbow trout populations in the lower Columbia River, the WUP CC recommended the continuation of the existing Large River Fish Indexing Program to address data gaps about the effects of dam operations on fish populations in the lower Columbia River.

BC Hydro initiated the Large River Fish Indexing Program in 2001 with the objectives of collecting information on selected index species. Since its initiation, annual implementation of the program has led to the development of systematic monitoring tools to identify and assess the effects of whitefish and rainbow trout flows on downstream fish communities. The information gained from continued implementation of the Fish Indexing Program, in conjunction with monitoring data from related monitoring studies in the lower Columbia River, will allow assessment of the current flow regime to determine its effectiveness at protecting whitefish and rainbow trout populations.
Monitoring Indicators:

a) Program will monitor for changes in the abundance, growth rate, survival rate, body condition, age distribution and spatial distribution of sub-adult and adult whitefish, rainbow trout and walleye in the lower Columbia River.

b) Program will monitor for the effect of inter-annual variability in the whitefish and rainbow trout flow regimes on the abundance, growth rate, survival rate, body condition and spatial distribution of sub-adult and adult whitefish (MW), rainbow trout (RB) and walleye (WY) in the lower Columbia River.

The methods used in this monitoring program are based on intensive boat electrofishing in the fall over pre-selected index sites. The data are then subject to statistical analysis and used for population estimation, catch-at-age analysis, population modeling, quantitative assessment of temporal patterns in population abundance, mean size-at-age, survival and distribution for each key species to evaluate long-term trends in these parameters. Given the uncertainty about factors that control fish populations, a weight of evidence approach will be applied to interpret fish population index information. Inferences about the patterns and/or trends in fish abundance, growth and survival in relation to the continued implementation of whitefish and rainbow flow will be interpreted in conjunction with other measurements/monitoring provided by physical habitat and ecological productivity monitoring, as well as spawning assessments and habitat use programs.

4.4.3 Status

This monitoring program began in September 2007, and will continue annually over 13 years. The third program report was delivered in July 2010, the fourth program report in August 2011. The fifth year program report was received in July 2012 and is in the process of being finalized.

4.4.4 Interpretation of Data

The study area for CLBMON-45 includes the portion of the Columbia River between HLK and the Canada-U.S. border (approximately 56.5 km of river habitat) and the Kootenay River downstream of Brilliant Dam (BRD).

Field work was conducted in the fall of 2011, which corresponded approximately to the timing of data collected during earlier study years (2007 to 2010) and to data collected between 2001 and 2006 as part of the Lower Columbia River Large River Fish Indexing Program. Fishes were sampled by boat electroshocking at night within nearshore habitats. In 2011, a Generalized Random Tessellation Stratified (GRTS) survey was conducted in addition to the standard mark-recapture program. All captured mountain whitefish, rainbow trout, and walleye were measured for fork length, weighed, and implanted with a Passive Integrated Transponder (PIT) tag. Hierarchical Bayesian Models (HBM) were used to estimate temporal and spatial variations in species abundance, spatial distribution, growth, size-at-age, survival, and body condition.

The effect of inter-annual variability in the whitefish and rainbow trout flow regimes on the abundance, growth rate, survival rate, body condition, and spatial distribution
of sub-adult and adult mountain whitefish, rainbow trout and walleye was not determined.

Population levels of whitefish have changed over the course of the monitoring period. Sub-adult mountain whitefish abundance decreased by approximately 65% between 2001 and 2005 and remained relatively stable between 2005 and 2011. Adult mountain whitefish abundance has also varied between years with no obvious long-term trends. The 2011 mean size-at-age of the sub-adult mountain whitefish cohort was similar to other study years. Annual MW survival estimates were variable and uncertain for both the sub-adult and adult mountain whitefish cohorts. The HBM will be further refined in 2012. Sub-adult and adult mountain whitefish densities were generally consistent between study years.

Population levels of sub-adult rainbow trout have changed over the course of the monitoring period. Sub-adult rainbow trout abundance decreased by approximately 60% between 2001 and 2005, remained relatively stable between 2005 and 2010, and increased substantially between 2010 and 2011. Adult rainbow trout abundance, however, has remained stable between 2001 and 2011. Annual survival estimates for sub-adult and adult rainbow trout were relatively stable between 2001 and 2011. Sub-adult and adult rainbow trout densities were generally consistent between study years.

Population levels of walleye have changed over the course of the monitoring period. Abundance increased substantially between 2002 and 2003 and gradually decreased between 2003 and 2006. The abundance of this species has remained relatively constant between 2006 and 2011. Walleye annual growth estimates were variable and uncertain. Limited data prevented the HBM from properly converging and thus making any conclusion about change in walleye survival.

Flow variability will be included as an explanatory variable in the HBMs in future years.

Recommendations include refining the survival-based HBM to provide more accurate estimates, explore the use of body condition to identify sexually mature mountain whitefish and test whether sexually mature fish are recaptured less frequently than their non-spawning equivalents, refine movement models to take into account the date and distance travelled by fish between encounters, continue with a GRTS-based survey design, conduct a spring mark-recapture program, and expand the HBM datasets to include fish capture data collected in the 1990s along with discharge, water temperature, and other habitat variables.

4.5 CLBMON-46 Lower Columbia River Rainbow Trout Spawning and Habitat Assessment

4.5.1 Management Questions

The key management questions addressed by this monitoring program are:

1) Does the implementation of rainbow trout spawning protection flows over the course of the monitoring period lead to an increase the relative abundance of rainbow trout spawning in the lower Columbia River downstream of Hugh L. Keenleyside (HLK) Dam?
2) Does the implementation of rainbow trout spawning protection flows over the course of the monitoring period lead to an increase in the spatial distribution of locations (and associated habitat area) that rainbow trout use for spawning in the lower Columbia River downstream of Hugh L. Keenleyside Dam?

3) Does the implementation of rainbow trout spawning protection flows over the course of the monitoring period protect the majority of rainbow trout redds (as estimated from spawning timing) from being dewatered in the lower Columbia River downstream of Hugh Keenleyside Dam?

### 4.5.2 Overview

The primary objective of this monitoring program is to continue the collection of annual rainbow trout data to qualitatively and quantitatively assess changes in the relative abundance, distribution and spawn timing of rainbow trout in the lower Columbia River. Secondary objectives include: 1) determining whether an earlier transitioning from mountain whitefish flows to rainbow trout spawning protection flows reduces the number of early spawning rainbow trout redds that dewater, and 2) to identify whether spawning habitat in the lower Columbia River is fully utilized.

Since 1993, BC Hydro has successfully negotiated Non-Power Use Agreements with the U.S. with the aim of providing more stable flow regimes for rainbow trout spawning below HLK Dam than would normally occur under Columbia River Treaty operations. In the past, BC Hydro has secured these flow changes by storing an additional 1 million acre feet (MAF) in Arrow Lakes Reservoir for release from July to August for U.S. salmon flow augmentation.

The Columbia River WUP Consultative Committee (CC) recommended that BC Hydro continue to pursue the rainbow trout protection flows through negotiations with the U.S., and continue annual discussions with regulatory agencies as to timing of transition from whitefish flows to rainbow trout protection flows (typically April 1).

The CC also recommended that annual monitoring be undertaken to monitor the status of the rainbow trout population in the lower Columbia River in response to the continued implementation of the protection flows to better understand the link between the flow management strategy during the spring spawning period and population abundance.

### Monitoring Indicators:

a) Program will monitor the relative abundance of rainbow trout observed each year.

b) Program will monitor the relative abundance of rainbow trout redds observed each year.

c) Program will compare rainbow trout population trend data from the Lower Columbia River Indexing program to the relative abundance of rainbow trout and trout redds over the same time period.

This monitoring program involves the use of aerial and boat surveys to track the abundance, distribution and spawn timing of rainbow trout in the lower Columbia River. During these surveys, the number of redds and trout in different sections of the river are documented. In addition, redds that are identified in shallow water are...
measured for their depth in the water column. This helps to estimate the number of redds at risk of dewatering under different spawning flows scenarios (e.g., variation in timing of implementation).

4.5.3 Status

This monitoring program began under WUP in 2008, and will end in 2017. The second year report was completed in January 2010, the third year in January 2011. The last report (Year 4) was completed in February 2012.

4.5.4 Interpretation of Data

Each spring, large numbers of rainbow trout spawn in the lower Columbia River (LCR) below Hugh L. Keenleyside Dam (HLK) as well as in the lower Kootenay River (LKR) below Brilliant Dam (BRD). Prior to 1992, the spring discharge below HLK typically involved decreasing flows during the March to May period which resulted in substantial numbers of rainbow trout redds being dewatered. In order to minimize the number of rainbow trout redds dewatered, BC Hydro has since 1992 stabilized the spring flow releases from HLK. However, these Rainbow Trout Spawning Protection Flows (RTSPF) are achieved by storing an additional 1 million acre feet (MAF) of water in Arrow Lakes Reservoir which has negative consequences for riparian vegetation, littoral productivity and wildlife habitat. Consequently, the current monitoring program, which commenced in 2008, was implemented to better understand the links between the spring flow regime and the abundance of the rainbow trout population.

The 2011 peak count-based estimate suggests that spawner abundance fell by over 30% compared to the previous three years. Although potentially concerning, the 2011 abundance estimate is likely to be less reliable than those from the previous 12 years for two reasons. Firstly, the estimate is based on a single count and secondly as a result of the changes to the BC Hydro safety regulations the helicopter pilot did not have previous experience of conducting spawner counts on the Lower Columbia River.

The spawner and redd count data indicate that the spatial distribution and habitat area of spawning has increased but only in the past three years. As RTSPF have been implemented since 1992 it is unclear why they would be responsible. A more likely explanation is that as the spawner abundance has increased, particular areas have become saturated, and as a result fish have begun to utilize additional locations.

It appears that the implementation of RTSPFs does protect the majority of rainbow trout redds. Since 1999 on average less than 0.5% of the total egg deposition has been dewatered.

Although it is possible to at least partially answer the three management questions, (cf. above) additional research is required to address the primary objective of the program. The required information includes a better understanding of the link between flow management strategy and population abundance. One possible approach involves the use of habitat suitability curves (HSCs), substrate maps, two dimensional hydrodynamic models and a stock-recruitment relationship. HSCs have been constructed and the stock-recruitment relationship is under investigation.
4.6 CLBMON-47 Lower Columbia River Whitefish Spawning Ground Topographic Survey

4.6.1 Management Questions

The key management questions for this monitoring program are associated with uncertainties related to how changes in dam releases influence the area of wetted channel area at key whitefish spawning locations. These questions are:

1) What are the topographic characteristics of the key spawning locations for mountain whitefish in the lower Columbia and Kootenay rivers?

2) What is the hydraulic response of the river to discharge fluctuations at these key spawning locations? How do changes in river discharge influence river stage, and how does river stage relate to wetted channel area at these key spawning locations?

3) How do daily flow changes contribute to cumulative channel dewatering in key spawning areas over the whitefish reproductive period?

4.6.2 Overview

The Columbia River WUP CC supported the implementation of an adaptive management program for evaluating the effectiveness of the whitefish flow management (WFM) to conserve mountain whitefish populations of the lower Columbia River. An objective of the adaptive management program was to collect better information on the topographic characteristics of whitefish spawning locations, and utilize that information to achieve better understanding of how regulated flow changes create potential risks for egg dewatering in the lower Columbia and Kootenay rivers.

Monitoring confirmed that whitefish eggs are dewatered by flow changes in the lower Columbia River. However, egg losses estimates derived from field data were not precise enough to support trade-off decision making processes related to WFM implementation. In 2003, a process-based whitefish egg loss model (ELM) was developed based on limited field data to improve estimates of the relative risk of egg loss under alternative flow scenarios for WFM planning purposes. The whitefish ELM is now the primary analytical tool for quantifying egg losses that occur as a consequence of changing flow patterns. The model utilizes daily flow data and river cross-section information to model river stage at index spawning areas during spawning and egg development periods. Biological assumptions of the seasonal timing of spawning, development rates of ova and the vertical distribution of deposited eggs in the river channel are incorporated to estimate daily losses of eggs resulting from flow changes. The model provides a transparent quantitative framework for evaluating egg loss risk. However, the WUP CC expressed concern about the reliability of the ELM for quantifying egg losses resulting from regulated flow changes during the adaptive management program.

A key data gap identified by the WUP CC was the low quality and quantity of topographic data to describe characteristics of whitefish spawning locations. Limited availability of relevant topographic data resulted in the use of as few as one channel cross-section per representative whitefish spawning area to predict flow dependent changes in river stage and areas of channel dewatering. Limited topographic
information at spawning areas contributed to reduced confidence in the degree to which existing data represented the habitats of concern, and overall reliability of egg loss estimates. To reduce this uncertainty, the WUP CC recommended implementing a monitoring program to: a) document topographic characteristics of representative whitefish spawning locations; and b) update the existing whitefish ELM to include new topographic and biological data collected in the whitefish adaptive management program (via CLBMON-48 Lower Columbia River Whitefish Life History and Egg Mat Monitoring, and CLBMON-44 Lower Columbia River Physical Habitat and Ecological Productivity Monitoring).

**Monitoring Indicators:**

a) Program will monitor for the topographic characteristics at the key spawning locations for mountain whitefish in the lower Columbia and Kootenay rivers.

b) Program will monitor the hydraulic response of the river to discharge fluctuations at these key spawning location (i.e., how will changes in river discharge influence river stage, and how does river stage relate to wetted channel area at these key spawning locations?)

c) Program will monitor how daily flow changes contribute to cumulative channel dewatering in key spawning areas over the whitefish reproductive period.

There are two primary components to the work: 1) field surveys to document topographic characteristics of whitefish spawning habitats, and 2) the updating of the physical and biological assumptions of the ELM.

**4.6.3 Status**

This monitoring program began in November 2010 and will be carried out over three years. Detailed surveys of Lower Columbia River flows were not carried out until August 2011 due to the high flows from the Kootenay River system in the Spring and Summer of 2011. A report for Year 1 (2011) was produced in March 2012 due to this delay in sampling.

**4.6.4 Interpretation of Data**

The existing HEC-RAS model for the Columbia River below HLK and the Kootenay River below BRD was updated using the topographic survey data collected in April and May 2011. The current Mountain Whitefish Egg Loss model includes HEC RAS transects from Kinnaird and Tin Cup Rapids. These areas were not selected for topographic or ADCP surveys in the present study (Year 1) based on the very low number of stranded eggs found in these areas during previous studies. The updated HEC RAS model adequately represents the river hydraulic situations of the upper Columbia River and Kootenay River reaches where Mountain Whitefish spawning is prevalent. The accuracy of the simulated water levels from the HEC RAS model was estimated, based on a sensitivity analysis, to be approximately ±0.2 m for the Columbia River and ±0.4 m for the Kootenay River.

In total, 40 cross sections were surveyed at the CPR Island spawning area. The data from these transects will be included in the RIVER-2D hydraulic model that will be developed in Year 2. Topographical features of interest included steep gradient
banks along the right downstream bank, a channel between the left downstream bank and CPR Island that remained wetted at higher water elevations, shallow depths in the downstream portion of the spawning area, and relatively gentle nearshore gradients along the mainstem side of CPR Island.

Thirty cross sections were surveyed for inclusion into the RIVER-2D hydraulic model in the Kootenay River spawning area. The area was divided into three separate sections based on topography and documented egg depositional rates. Topographical features included a large shallow bar that deflects and constricts the Kootenay River flow in the upper section, low gradient banks in the middle section, a relatively wide thalweg with consistent depth, and a large backwater area downstream of two islands along the southern shore. The upstream section exhibits greater thalweg depths, and steep shorelines, with a shallow shoal and a bedrock outcrop along the north bank, and an island off the south bank.

The data analyses did not identify any concerns that would affect the creation of the RIVER-2D hydraulic model as proposed; therefore, the development of this model will proceed as planned.

4.7 CLBMON-48 Lower Columbia River Whitefish Egg Monitoring and Life History Study

4.7.1 Management Questions

There are six key management questions addressed by this monitoring program. The first four are aimed at creating an understanding of the general life history, reproductive biology and habitat use by adult whitefish. This information is required to validate and/or refine key assumptions used in the egg loss model. The last two management questions relate to interpretation and measurement of the response of the whitefish population using adult and juvenile index monitoring approaches.

The management questions are:

1) What is the spatial distribution of whitefish spawning activities in the lower Columbia and lower Kootenay rivers? Is there inter-annual variation in spawning habitat use? Is the spatial distribution of spawning locations associated with flow management?

2) What are the physical and hydraulic characteristics of whitefish spawning and egg incubation habitats?

3) What is the seasonal timing of whitefish spawning in the lower Columbia and lower Kootenay rivers? To what extent does the timing and intensity of spawning vary from year to year? Is the timing or intensity of spawning associated with flow management?

4) What is the pattern of egg dispersal at spawning locations? What is the vertical distribution of eggs in the river channel? Is the spatial distribution of eggs related to flow management?
5) What are the pre-spawning and post-spawning seasonal movement patterns of whitefish? How do patterns of sub-adult and adult migration affect the interpretation of annual index monitoring programs?

6) What habitats are juvenile whitefish using in the lower Columbia and lower Kootenay rivers? Is it possible to develop and implement a reliable program for indexing the young of the abundance as a measure of fish cohort strength?

4.7.2 Overview

The Columbia River WUP CC supported the implementation of an adaptive management program to evaluate the effectiveness of the whitefish flow management (WFM) to conserve mountain whitefish populations of the lower Columbia River. A goal of this adaptive management program is to address outstanding biological uncertainties associated with the life history and habitat use of different life stages of whitefish in the lower Columbia and Kootenay rivers.

The purpose of this monitoring program is to collect and refine data on the location, timing and depth distribution of mountain whitefish spawning in the lower Columbia River below HLK Dam to improve the annual estimate of egg mortality. Specifically, the key objectives are to: a) improve the understanding of whitefish life history and reproductive ecology; b) document topographic characteristics of representative whitefish spawning locations; and, c) improve the understanding of seasonal changes in the distribution of eggs in the river channel. This information is required in the adaptive management program for the refinement of the WF Egg Loss Model, and to provide auxiliary data and information to support the interpretation of the more systematically collected population time series data obtained through the ongoing Lower Columbia Fish Population Index Surveys (CLBMON-45). Physical data collection and actions to refine the egg loss model are being undertaken through CLBMON-47, Lower Columbia River Mountain Whitefish Spawning Ground Topographic Survey.

Monitoring Indicators:

a) Program will monitor the spatial and timing distribution of whitefish spawning activities in the lower Columbia and lower Kootenay Rivers to see if there is there inter-annual variation in spawning habitat use or if the spatial distribution of spawning locations is associated with flow management.

b) Program will monitor the physical and hydraulic characteristics of whitefish spawning and egg incubation habitats, the patterns of egg dispersal and the pre and post-spawning seasonal movements of whitefish.

c) Program will monitor juvenile whitefish use of the lower Columbia and Kootenay Rivers.

The monitoring includes: (1) a radio/acoustic tagging program to track mountain whitefish movements to spawning locations; and, (2) a field sampling program to evaluate the biology, habitat use, relative abundance, and distribution of pre-adult mountain whitefish life stages. This portion of the program will be repeated for a period of five years to identify key spawning periods and spawning locations and to assess other life history characteristics.
Results from the first year of monitoring were used to begin assessing egg dispersal patterns at key spawning locations.

4.7.3 Status

This monitoring program was initiated in August 2008, and will be carried out over a 5-year period. The first program report was completed in April 2009. Monitoring in Years 2 and 3 of the program focused on spawning locations to observe activity and delineate egg distribution at key locations. The Year 3 report was finalized in September 2011. The Year 4 report was still pending at the time of this writing. Detailed analyses and in-depth discussion of study results will be provided in the Year 5 report.

4.7.4 Interpretation of Data

Mountain whitefish (MW; *Prosopium williamsoni*) are the most abundant sportfish in the lower Columbia River (defined as the Columbia River from Hugh L. Keenleyside Dam [HLK] to the Canada-US Border) and use this area for all life history functions. Although mountain whitefish do not support a recreational fishery in the lower Columbia River, they do represent an important indicator species in the Columbia River ecosystem.

Year 4 had a data gap analysis component on the current state of knowledge on MW life history in the Columbia River and how it is affected by flow management. Sampling occurred from November 2011 to April 2012 and involved egg mat (for egg deposition) and MW egg and larvae stranding surveys. Adult MW were obtained from CLBMON-45 to assess maturity and egg fecundity. There was no electroshocking.

The data gap analysis concluded that there was very little information on all aspects of MW spawning in the lower section of the study area (Columbia River from Trail downstream to the Canada/US border). Therefore, an exploratory egg collection mat sampling was conducted in the lower section to identify spawning areas and to document timing, intensity, and habitat characteristics within those areas.

Egg catch rates were very low in the lower section of the study area. The majority of the eggs were captured near Beaver Creek Park south of Trail, suggesting that low levels of spawning occur at this area. At this time it is unknown if spawning occurs at this area on a yearly basis.

The low egg deposition rate documented at CPR Island in 2010 – 2011 continued into the 2011 – 2012 spawning season. Egg catch rates steadily increased from the onset of the study, peaked in early January, and subsequently declined through the end of January and into February 2012.

Very low densities of stranded eggs (1.5 eggs/m²) were documented at Tin Cup Rapids whereas high densities of stranded eggs (40.6 eggs/m²) were recorded at Kinnaird Rapids. This is the opposite of last year. The amount of potential MW egg deposition area dewatered during the flow reductions for Rainbow Trout Protection Flow was low, as the majority of MW egg deposition appeared to have occurred in deeper portions of spawning areas.
No emerged larvae were observed during the surveys prior to the flow reductions at HLK, which resulted in the cancellation of the remainder of the larval sampling study component. This may have reflected the lower than usual water temperatures in late spring which resulted in delayed hatching.

Of the 90 fish examined, 48 were female and 42 were male, two of the females and three of the males were immature.

4.8 CLBMON-49 Lower Columbia River Effects of Whitefish Flows on Great Blue Heron and Winter Use of Waldie Island by Great Blue Heron

4.8.1 Management Questions

This monitoring program is designed to address the following management questions as they pertain to a small wintering refuge area (Waldie Island) for Great Blue Heron (GBH) in the lower Columbia River and to the breeding colony of GBH near Revelstoke, BC.

1) Do GBH use Waldie Island as an overwintering area or as a short-term stopover migrating elsewhere?

2) Does the current early winter flow regime in the lower Columbia River affect the quality and quantity of overwintering habitat (e.g. foraging, roosting) for GBH and influence foraging ecology of GBH on Waldie Island?

3) Are there operational changes that could provide for protection of overwintering habitat to ensure that it can support dependent winter GBH aggregations?

4) Are there ‘physical works’ alternatives in lieu of operational changes that would benefit GBH overwintering at Waldie Island?

5) Do GBH nesting at the Revelstoke colony use Waldie Island as a winter refuge site or as a stopover site during migration?

6) What is the regional importance of Waldie Island as a winter refuge area for GBH that nest at the Revelstoke colony?

7) Does operation of Arrow Lakes Reservoir affect foraging opportunity and success for GBH breeding at the Revelstoke colony?

4.8.2 Overview

From late October until late February, Great Blue Heron (GBH) are known to aggregate in the vicinity of Waldie Island, near Castlegar, BC downstream of HLK Dam. Data collected over a 3-year period suggests high river flows and water elevations during the early winter period limits the availability of suitable shallow-water foraging habitat downstream of HLK Dam. From late November to mid December, outflows from Arrow Lakes Reservoir are increased to provide stable flows during the late December to late January period in order to protect spawning whitefish and egg incubation. As there are few other ice-free shoreline areas downstream of HLK Dam, protracted periods of higher flow releases may be negatively affecting GBH by reducing available foraging habitat, which in turn is
increasing GBH dependency on Waldie Island and increasing localized competition for food and resting sites. The island is relatively well protected from predators, weather and disturbance, and provides suitable roost trees and access to nearby shallow water foraging habitat. Based on observations, Machmer (2003) recommended that BC Hydro modify the flow regime of HLK Dam in years of high flows to ensure that some parts of CPR Island and Waldie Island foreshore remain exposed and usable by GBH during the early winter period. A maximum elevation of 421 m was recommended for the period of November 15 to December 21.

During the Columbia River WUP, the CC sought to address concerns related to the impacts that the flow regime of HLK Dam has on the availability of shallow-water foraging habitat downstream of the dam, and whether GBH that breed in the Revelstoke Colony overwinter on Waldie Island. Two related studies were recommended to (1) confirm the importance of Waldie Island as a winter refuge area; (2) address uncertainty related to the potential impact of high early winter flows on survival of overwintering GBH at Waldie Island; (3) determine whether modifications to the current flow regime should be considered to minimize flow-related impacts on this winter GBH aggregation, (4) determine whether GBH that breed in the Revelstoke Colony overwinter on Waldie Island, and (5) assess whether the operation of Arrow Lakes Reservoir affects the foraging opportunities of GBH breeding at the Revelstoke colony.

**Monitoring Indicators:**

a) Program will monitor the response of winter GBH populations on Waldie Island to potential impacts of high flows/river stage during the winter period on foraging habitat.

b) Program will address whether GBH from the Revelstoke nesting colony are the same individuals as those observed at Waldie Island.

c) Program will monitor whether the foraging ecology of these birds is being negatively affected by operation of Arrow Lakes Reservoir during the breeding season.

This monitoring program will employ the use of GPS telemetry data loggers to obtain a sufficient number of data points to determine habitat selection of GBH and assess the effects of river flow and stage on habitat use (e.g., foraging). The GPS data loggers will be fitted to GBH captured during the fall as they begin to arrive at Waldie Island. Observational data will also be gathered to determine the timing of the arrival and departure of GBH from Waldie Island over the course of the winter. Data loggers will be affixed to animals every fall and retrieved the following summer. In addition, it will be important to monitor the attendance and foraging activity of GBH at Waldie Island (and area) over the course of the winter to detect changes in use patterns in relation to changing river flows and environmental conditions.

In addition to the Waldie Island surveys, there will be monitoring of habitat use during the breeding season in the Revelstoke Reach area of the upper Columbia River. Surveys will be conducted weekly to obtain information on use and location of important feeding areas by GBH at the Revelstoke colony. The surveys should be conducted throughout the nesting season (April to June) until the majority of adults have dispersed from the colony.
4.8.3 Status

Due to concerns regarding the consequences of radio-collaring GBH, the Terms of Reference for this monitoring program will be resubmitted in the fall of 2012.

4.8.4 Interpretation of Data

At this time there are no data to interpret for this monitoring program.

5 Lower Columbia River Fish Management Plan- Monitoring Program Costs

The following table summarizes the approved costs of the monitoring programs and physical works under the Lower Columbia River Fish Management Plan of the Columbia River WUP, as well as the Actual Costs to July 31, 2012.
<table>
<thead>
<tr>
<th>Monitoring Programs</th>
<th>Activity</th>
<th>Costs approved by CWR</th>
<th>Total Forecast (Life to Date Actuals and Forecast)</th>
<th>Variance Total to Approved</th>
<th>Explanation</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columbia River: Lower Columbia River Fish Management Plan Annual Report</td>
<td>OR</td>
<td>$8,978</td>
<td>$9,539</td>
<td>($561)</td>
<td>Annual reports to date have taken longer than anticipated to create.</td>
<td>Resubmit Annual Report costs pending discussion with CWR in September 2012 regarding annual reporting activity.</td>
</tr>
<tr>
<td>CLBMON#42 LOW COL FISH STRANDING ASSESSMENT AND RAMPING PROTOCOL</td>
<td>OR</td>
<td>$1,515,971</td>
<td>$1,471,990</td>
<td>$43,981</td>
<td>Efficiencies found during project implementation.</td>
<td>Budget to be reassessed following stranding reassessment as a result of high waters in 2012 in the fall of 2012.</td>
</tr>
<tr>
<td>CLBMON#42 Direct Management 001</td>
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<td>$210,073</td>
<td>$37,837</td>
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<td></td>
</tr>
<tr>
<td>CLBMON#42 Implementation 002</td>
<td>OR</td>
<td>$1,268,061</td>
<td>$1,261,917</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>CLBMON#43 LOW COL SCULPIN &amp; DACE LIFE HISTORY ASSESSMENT</td>
<td>OR</td>
<td>$990,546</td>
<td>$971,545</td>
<td>$19,001</td>
<td>Efficiencies found during project implementation.</td>
<td>Contingency. No corrective action required.</td>
</tr>
<tr>
<td>CLBMON#43 Direct Management 001</td>
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<td>$64,043</td>
<td>$63,924</td>
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<tr>
<td>CLBMON#44 LOW COL PHYSICAL HABITAT &amp; ECOLOGICAL PRODUCTIVITY</td>
<td>OR</td>
<td>$2,162,010</td>
<td>$2,096,320</td>
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<td>Efficiencies found during project implementation.</td>
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<tr>
<td>CLBMON#44 Direct Management 001</td>
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<td>($15,721)</td>
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<td>CLBMON#44 Implementation 002</td>
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<td>$1,990,691</td>
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<tr>
<td>CLBMON#45 LOW COL FISH POPULATION INDEXING</td>
<td>OR</td>
<td>$2,744,109</td>
<td>$2,096,320</td>
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<td>CLBMON#46 LOW COL RAINBOW TROUT SPAWNING HABITAT ASSESSMENT</td>
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<td>Contingency. No corrective action required.</td>
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<td>CLBMON#47 LOW COL WHITEFISH SPAWNING GROUND TOPOGRAPHIC SURVEY</td>
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<td>CLBMON#48 LOW COL WHITEFISH EGG MONITORING &amp; LIFE HISTORY STUDY</td>
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<td>$912,415</td>
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<td>CLBMON#49 LOW COL EFFECTS ON GREAT BLUE HERON</td>
<td>OR</td>
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* Red values in parentheses denote overage.