

Columbia River Water Use Plan

Arrow Lakes Reservoir Operations Management Plan

Monitoring Program

Annual Report: 2016

Implementation Period: June 2015 – May 2016

- **CLBMON-31 Arrow Lakes Reservoir: Burbot Life History Study**
- **CLBMON-32 Arrow Lakes Reservoir: Tributary Fish Migration Study**
- **CLBMON-36 Kinbasket and Arrow Lakes Reservoir: Nest Mortality of Migratory Birds due to Reservoir Operations**
- **CLBMON-37 Kinbasket and Arrow Lakes Reservoir: Amphibian and Reptile Life History and Habitat Use Assessment**
- **CLBMON-39 Arrow Lakes Reservoir: Neotropical Migrant Use of the Drawdown Zone**
- **CLBMON-40 Arrow Lakes Reservoir: Arrow Lakes Reservoir Shorebird and Waterbird Monitoring Program**
- **CLBMON-41 Arrow Lakes Reservoir: Recreational Demand Study**
- **CLBMON-58 Monitoring of Impacts on Amphibians and Reptiles from Mica Units 5 and 6 in Kinbasket Reservoir**

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

June 30, 2016

BC Hydro Columbia River Project Water Use Plan Arrow Lakes Reservoir Operations Management Plan Monitoring Programs Annual Report: 2016

1 Introduction

This document represents a summary of the status and the results of the Arrow Lakes Reservoir Operations Management Plan Water Use Plan (WUP) monitoring programs to May 2016, as per the Columbia River Order under the *Water Act*, dated January 26, 2007. There are eight monitoring programs.

2 Status

The following table outlines the dates that Terms of Reference (TOR) for the Arrow Lakes Reservoir Operations Management Plan WUP monitoring programs were submitted to and approved by the CWR.

Table: 2-1: Dates of Arrow Lakes Reservoir Operations Management Plan WUP TOR Submissions and Approvals by the Comptroller of Water Rights

Monitoring Program & Physical Works TOR	Order Clause	Original ToR Submission		Most Recent ToR Resubmission	
		Date Submitted	Date Approved	Date Submitted	Date Approved
CLBMON-31 Arrow Lakes Reservoir: Burbot Life History Study	Schedule D: 5.a	Oct 24, 2007	Dec 03, 2007		
CLBMON-32 Arrow Lakes Reservoir: Tributary Fish Migration Study	Schedule D: 5.b	Oct 24, 2007	Dec 03, 2007		
CLBMON-36 Kinbasket and Arrow Lakes Reservoir: Nest Mortality of Migratory Birds due to Reservoir Operations	Schedule A: 6.a Schedule C: 5.c	Jan 25, 2008	Mar 03, 2008	Dec 18, 2014	Feb 04, 2015
CLBMON-37 Kinbasket and Arrow Lakes Reservoir: Amphibian and Reptile Life History and Habitat Use Assessment	Schedule A: 6.b Schedule C: 5.d	Jan 25, 2008	Mar 03, 2008	Jan 04, 2011	Apr 12, 2011
CLBMON-39 Arrow Lakes Reservoir: Neotropical Migrant Use of the Drawdown Zone	Schedule C: 5.f	Jan 25, 2008	Mar 17, 2008	Jun 22, 2015	Jul 16, 2015
CLBMON-40 Arrow Lakes Reservoir: Arrow Lakes Reservoir Shorebird and Waterbird Monitoring Program	Schedule C: 5.e, 5.g	Jan 25, 2008	Mar 03, 2008	Dec 23, 2015	Jan 26, 2016
CLBMON-41 Arrow Lakes Reservoir: Recreational Demand Study	Clause 6.c Ordered Jan 26, 2007 and Clause 6.c Ordered by CWR Apr 24, 2007	Jul 31, 2008	Sep 11, 2008		
CLBMON-58 Monitoring of Impacts on Amphibians and Reptiles from Mica Units 5 and 6 in Kinbasket Reservoir	Augment to Schedule A: 6.b Schedule C: 5.d	Jan 04, 2011	Apr 12, 2011		

3 Schedule

The following table outlines the current schedule for the monitoring programs being delivered for the Arrow Lakes Reservoir Operations Management Plan WUP.

Table 3-1: Monitoring Programs Schedule as of May 31, 2016

Monitoring Programs	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	WLR YR1	WLR YR2	WLR YR3	WLR YR4	WLR YR5	WLR YR6	WLR YR7 Interim Review	WLR YR8	WLR YR9	WLR YR10	WLR YR11	WLR YR12	WLR YR13
CLBMON-31 Arrow Lakes Reservoir: Burbot Life History Study		✓	✓	✓	✓	✓							
CLBMON-32 Arrow Lakes Reservoir: Tributary Fish Migration Study		✓	✓	✓	✓	✓	✓						
CLBMON-36 Kinbasket and Arrow Lakes Reservoir: Nest Mortality of Migratory Birds due to Reservoir Operations		✓	✓	✓	✓	✓	✓	✓	✓	u/w	■		
CLBMON-37 Kinbasket and Arrow Lakes Reservoir: Amphibian and Reptile Life History and Habitat Use Assessment		✓	✓	✓		✓		✓		u/w		■	
CLBMON-39 Arrow Lakes Reservoir: Neotropical Migrant Use of the Drawdown Zone		✓	✓	✓	✓	✓	✓	✓	✓	■	■		
CLBMON-40 Arrow Lakes Reservoir: Arrow Lakes Reservoir Shorebird and Waterbird Monitoring Program		✓	✓	✓	✓	✓	✓	✓	✓	u/w	■		
CLBMON-41 Arrow Lakes Reservoir: Recreational Demand Study			✓	✓	✓	✓	✓						
CLBMON-58 Mica Addendum to CLBMON 37 Amphibians and Reptiles					✓		✓		✓		■		
Legend: <ul style="list-style-type: none"> ■ = Program to be undertaken/initiated in identified year u/w = Project is underway ✓ = Program completed for the year x = Program started, but encountered operational or hydrological delays 													

4 Monitoring Programs Terms of Reference

The monitoring programs being implemented under the Arrow Lakes Reservoir Operations Management Plan WUP are described in Terms of Reference. These Terms of Reference and the reports for work completed to date can be found here:

http://www.bchydro.com/about/sustainability/conservation/water_use_planning/southern_interior/columbia_river/arrow-operations.html

5 Status of Monitoring Programs

5.1 CLBMON-31 Arrow Lakes Reservoir: Burbot Life History Study

This monitoring program was initiated in 2008 and was completed in 2013. All reports have been submitted.

5.2 CLBMON-32 Arrow Lakes Reservoir: Tributary Fish Migration Study

This monitoring program was initiated in 2008 and was completed in 2014. All reports have been submitted.

Training on the usage of the fish passage risk matrix and model will be provided to BC Hydro's field services team.

5.3 CLBMON-36 Kinbasket and Arrow Lakes Reservoir: Nest Mortality of Migratory Birds due to Reservoir Operations

This monitoring program researches the impacts that reservoir operations have on the productivity of birds breeding in the reservoir drawdown zones of Kinbasket (KIN)

and Arrow Lakes Reservoirs (ALR). The study was initiated in 2008 and will be carried out annually over ten years.

BC Hydro resubmitted a TOR on December 18, 2014 and received CWR approval on February 4, 2015. The study team was successful in implementing the changes that were associated with the revised TOR in 2015.

2015 was the first year during the WUP study period where no nests failed due to flooding, likely due to unusually low water levels that peaked early and did not inundate nesting habitat during the breeding season.

Attached is the report for Year 8 dated February 4, 2016.

5.4 CLBMON-37 Kinbasket and Arrow Lakes Reservoir: Amphibian and Reptile Life History and Habitat Use Assessment

This monitoring program is intended to address the relative influence and importance of the current reservoir operating regime on the life history and habitat use of amphibians and reptiles occurring in the drawdown zones of each reservoir. The study was initiated in 2008 and will be carried out every other year for eleven years.

Implementation did not occur in 2015.

5.5 CLBMON-39 Arrow Lakes Reservoir: Neotropical Migrant Use of the Drawdown Zone

This monitoring program was designed to determine the effects of reservoir operations on neotropical migrant songbirds in Revelstoke Reach during fall migration. The study was initiated in 2008 and will be carried out annually over ten years.

BC Hydro resubmitted a TOR on June 22, 2015 and received CWR approval on July 16, 2015. The study team is implementing the changes associated with the revised TOR.

In 2015, mist net surveys were conducted at Machete Island, Airport Marsh, and Jordan River.

Data collected during the first three years of the CLBMON-39 monitoring showed that around Revelstoke, the peak of songbird migration occurs from mid-August to early September. In 2015, the fall migration was well underway by August 5, suggesting that significant southward movements began earlier than in previous years.

Attached is the report for Year 8 dated March 2016.

5.6 CLBMON-40 Arrow Lakes Reservoir: Arrow Lakes Reservoir Shorebird and Waterbird Monitoring Program

This monitoring program studies the use of the Revelstoke Reach wetlands during spring and fall migration, the importance of these wetlands for breeding waterbirds, and how ecological functions are impacted by reservoir operations. The study was initiated in 2008 and will be carried out annually over ten years.

BC Hydro resubmitted a TOR on December 23, 2015 and received CWR approval on January 26, 2016. The study team is implementing the changes associated with the revised TOR.

The wetlands thawed relatively early in 2015. The ALR filled aggressively during the early part of the spring draw, but reached the annual maximum elevation unusually early in the year (June 16). Given the early peaking date, the high pool elevation, at 435.5 m asl, was the lowest yet observed during the course of the study. During the relatively warm spring, the migration of waterfowl was observed to be an ephemeral event, with waterfowl moving through the study area primarily in early April.

In a year with unusually low fall reservoir elevations, there was an unusually large shorebird presence during the fall migration in 2015, with 16 shorebird species observed, many in relatively large numbers.

Attached is the report for Year 8 dated March 31, 2016.

5.7 CLBMON-41 Arrow Lakes Reservoir: Recreational Demand Study

This monitoring program was initiated in 2009 and was completed in 2015. Results from the 2015 final report suggest that frequency, volume, and different types of public use of Arrow Lakes Reservoir are not substantively influenced by fluctuating water levels, suggesting factors other than water levels (*i.e.*, total precipitation, maximum daily temperature, type of day, and season) dominate people's decision to visit the Arrow Lakes for recreation activities. Where water levels do account for a variation in use, a minority of visitors are affected. However, variables such as season, maximum daily temperature, and reservoir levels are correlated with one another and a secondary analysis of existing data is necessary to ensure that BC Hydro operations have a minimal effect on recreation use of the Arrow Lakes Reservoir. The results of a secondary analysis will be included in next year's annual report and will fit within the existing, approved budget for this project.

5.8 CLBMON-58 Monitoring of Impacts on Amphibians and Reptiles from Mica Units 5 and 6 in Kinbasket Reservoir

This monitoring program addresses the potential predicted impacts of the installation of Units 5 and 6 (and the consequential increase of 0.6 m in maximum reservoir elevation) at Mica Dam on amphibian and reptile populations in Kinbasket Reservoir. The study was initiated in 2011 and will be carried out every other year over seven years (2018 is the final year).

2015 was a slightly different year for reservoir operations with reservoir levels not reaching full pool; thus habitat was available for a longer period of time during the amphibian breeding season. The continued presence of Western Toad and Columbia Spotted Frog of all life stages in the drawdown zone in consecutive years suggests that these species are not adversely affected by reservoir operations. However, we do not know if the populations of Columbia Spotted Frog and Western Toad are affected relative to non-reservoir populations.

Radiotelemetry results obtained suggest that Western Toad migrate to the drawdown zone to breed between late April and early May. Toads stay in the drawdown zone for two to three weeks and following breeding, most move to adjacent upland (*i.e.*, non-drawdown zone) summer habitat.

Attached is the report for Year 3 dated May 13, 2016.

6 Monitoring Programs Costs

The following table summarizes the Arrow Lakes Reservoir Operations Management Plan WUP monitoring programs approved by the Comptroller and the Actual Costs to May 31, 2016.

Table 6-1: Arrow Lakes Reservoir Operations Management Plan WUP Monitoring Programs Costs

Monitoring Programs	Costs approved by CWR	Life to Date Actuals (LTD)	Estimated to Complete (Forecast)	Total Forecast (LTD and Forecast)	Variance Total to Approved	Explanation	Corrective Action
CLB MP6 Arrow Res Ops Annual Report	\$13,457	\$8,441	\$4,481	\$12,922	\$535	Efficiencies found during project implementation.	No corrective action
C06M31A ARROW: Burbot Life - ONR	\$114,277	\$116,683		\$116,683	(\$2,406)	Project is complete.	
C06M31A ARROW: Burbot Life - ONR DM	\$0	\$73		\$73	(\$73)		
C06M31A ARROW: Burbot Life - ONR Imp	\$114,277	\$116,610		\$116,610	(\$2,333)		
C06M31A ARROW: Burbot Life - OR	\$970,525	\$857,802	\$1,725	\$859,527	\$110,998	Project is complete. Final completion report is outstanding.	
C06M31A ARROW: Burbot Life - OR DM	\$67,022	\$56,092	\$1,725	\$57,817	\$9,205		
C06M31A ARROW: Burbot Life - OR Imp	\$903,503	\$801,710		\$801,710	\$101,793		
C06M32A ARROW: Tributary Fish	\$439,574	\$368,344	\$7,408	\$375,752	\$63,822	Project is substantially complete. Final completion report and training on usage of the model is outstanding.	
C06M32A ARROW: Tributary Fish - OR DM	\$81,842	\$45,132	\$1,725	\$46,857	\$34,985		
C06M32A ARROW: Tributary Fish - OR Imp	\$357,732	\$323,212	\$5,683	\$328,895	\$28,837		
C06M36A ARROW & KIN: Nest	\$4,256,071	\$3,113,745	\$834,501	\$3,948,246	\$307,825	Efficiencies found during project implementation.	No corrective action
C06M36A ARROW & KIN: Nest - OR DM	\$204,722	\$117,368	\$20,410	\$137,778	\$66,944		
C06M36A ARROW & KIN: Nest - OR Imp	\$4,051,349	\$2,996,377	\$814,091	\$3,810,468	\$240,881		
C06M37A ARROW & KIN: Amphib	\$1,166,608	\$804,612	\$306,259	\$1,110,871	\$55,737	Efficiencies found during project implementation.	No corrective action
C06M37A ARROW & KIN: Amphib - OR DM	\$127,889	\$66,893	\$29,017	\$95,909	\$31,980		
C06M37A ARROW & KIN: Amphib - OR Imp	\$1,038,719	\$737,720	\$277,242	\$1,014,962	\$23,757		
C06M39A ARROW: Neotropical	\$2,150,992	\$1,557,699	\$448,817	\$2,006,516	\$144,476	Efficiencies found during project implementation.	No corrective action
C06M39A ARROW: Neotropical - OR DM	\$189,932	\$123,386	\$19,882	\$143,268	\$46,664		
C06M39A ARROW: Neotropical - OR Imp	\$1,961,060	\$1,434,313	\$428,935	\$1,863,248	\$97,812		
C06M40A ARROW: Shore&Wat	\$2,890,326	\$2,064,543	\$599,539	\$2,664,082	\$226,244	Efficiencies found during project implementation.	No corrective action
C06M40A ARROW: Shore&Wat - OR DM	\$189,388	\$178,663	\$19,601	\$198,263	(\$8,875)		
C06M40A ARROW: Shore&Wat - OR Imp	\$2,700,938	\$1,885,880	\$579,939	\$2,465,819	\$235,119		
C06M41A ARROW: Recreation	\$755,561	\$696,518	\$11,586	\$708,104	\$47,457	Project is substantially complete. Secondary analysis to be done. Final completion report is outstanding.	
C06M41A ARROW: Recreation - OR DM	\$71,661	\$43,734	\$1,586	\$45,320	\$26,341		
C06M41A ARROW: Recreation - OR Imp	\$683,900	\$652,784	\$10,000	\$662,784	\$21,116		
C06M58A ARROW Amphibs & Rep	\$497,676	\$305,232	\$160,880	\$466,112	\$31,564	Efficiencies found during project implementation.	No corrective action
C06M58A ARROW Amphibs & Rep - ONR DM	\$68,894	\$16,372	\$24,251	\$40,623	\$28,271		
C06M58A ARROW Amphibs & Rep - ONR Imp	\$428,782	\$288,860	\$136,629	\$425,489	\$3,293		

OR - Ordered Remissible
ONR - Ordered Non-Remissible

* Red values in parentheses denote overage.