

Columbia River Water Use Plan

Arrow Lakes Reservoir Operations Management Plan

Monitoring Program

Annual Report: 2018

Implementation Period: June 2017 – May 2018

- **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 29, 2018

BC Hydro Columbia River Project Water Use Plan Arrow Lakes Reservoir Operations Management Plan Monitoring Programs Annual Report: 2018

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 31, 2018, 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 Comptroller of Water Rights (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	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, 2018

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		✓	✓	✓	✓	✓F							
CLBMON-32 Arrow Lakes Reservoir: Tributary Fish Migration Study		✓	✓	✓	✓	✓	✓F						
CLBMON-36 Kinbasket and Arrow Lakes Reservoir: Nest Mortality of Migratory Birds due to Reservoir Operations		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓F		
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		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓F		
CLBMON-40 Arrow Lakes Reservoir: Arrow Lakes Reservoir Shorebird and Waterbird Monitoring Program		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓F		
CLBMON-41 Arrow Lakes Reservoir: Recreational Demand Study			✓	✓	✓	✓	✓F						
CLBMON-58 Mica Addendum to CLBMON 37 Amphibians and Reptiles					✓		✓		✓		✓F		

Legend: ■ = 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
✓F = All field work for this project is complete. No further field work is planned.
PCR = Project Completion Report submitted

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

The objective of this study was to assess the potential effects of winter drawdown of Arrow Lakes Reservoir to spawning Burbot. 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

The objective of this study was to assess passage conditions for fish at tributaries to Arrow Lakes Reservoir under a range of operating levels and streamflow conditions. This monitoring program was initiated in 2008 and was completed in 2014. All reports have been submitted.

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 and Arrow Lakes Reservoir. The study was initiated in 2008 and was carried out annually over ten years. The study was completed in 2017.

In Year 10, field work was completed again in Bush Arm and Revelstoke Reach. Both reservoirs were relatively high throughout the nesting season compared to historic levels, which led to greater nest flooding impacts.

Attached is the data report for Year 9 dated February 8, 2017 and Year 10 dated May 3, 2018. The final comprehensive report will be submitted with the 2019 Annual Report.

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 (2018 is the final year).

As no work was completed in 2017, no report will be prepared.

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 was carried out annually over ten years. The study was completed in 2017.

In 2017, two sites in the drawdown zone (Airport Islands and Machete Island) and one site outside of the drawdown zone (Jordan River) were monitored by constant effort mist netting. The water levels of Arrow Lakes Reservoir at the beginning of the fall migration season (August 1) were higher than the long-term average for that time of year, but water levels gradually dipped below the long-term average in September.

Attached is the data report for Year 10 dated May 23, 2018. The final comprehensive report will be submitted with the 2019 Annual Report.

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 was carried out annually over ten years. The study was completed in 2017.

Attached are the data reports for Year 9 dated March 31, 2017 and Year 10 dated May 31, 2018. The final comprehensive report will be submitted with the 2019 Annual Report.

5.7 CLBMON-41 Arrow Lakes Reservoir: Recreational Demand Study

The objective of this study is to establish a functional link between recreational use and water levels on Arrow Lakes Reservoir. This monitoring program was initiated in 2009 and field work was completed in 2013, with additional data analysis completed in 2016. No further work is required.

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 predicted 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 (2017 was the final year of field data collection year and 2018 is the final reporting year).

The Year 4 report is in the process of being finalized and will be submitted with the 2019 Annual Report.

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, 2018.

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	\$10,059	\$2,947	\$13,006	\$451		
C06M31A ARROW: Burbot Life - ONR	\$114,277	\$116,683		\$116,683	(\$2,406)	Project is complete. Final completion report is outstanding.	
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	\$858,503	\$1,785	\$860,287	\$110,238	Project is complete. Final completion report is outstanding.	
C06M31A ARROW: Burbot Life - OR DM	\$67,022	\$56,792	\$1,785	\$58,577	\$8,445		
C06M31A ARROW: Burbot Life - OR Imp	\$903,503	\$801,710		\$801,710	\$101,793		
C06M32A ARROW:Tributary Fish	\$439,574	\$368,383	\$1,785	\$370,167	\$69,407	Project is complete. Final completion report is outstanding.	
C06M32A ARROW:Tributary Fish - OR DM	\$81,842	\$45,171	\$1,785	\$46,956	\$34,886		
C06M32A ARROW:Tributary Fish - OR Imp	\$357,732	\$323,212		\$323,212	\$34,520		
C06M36A ARROW & KIN: Nest	\$4,256,071	\$3,898,392	\$101,657	\$4,000,049	\$256,022	Efficiencies found during implementation	
C06M36A ARROW & KIN: Nest - OR DM	\$204,722	\$129,806	\$56,475	\$186,281	\$18,441		
C06M36A ARROW & KIN: Nest - OR Imp	\$4,051,349	\$3,768,586	\$45,182	\$3,813,768	\$237,581		
C06M37A ARROW & KIN: Amphib	\$1,166,608	\$1,006,038	\$157,437	\$1,163,475	\$3,133		
C06M37A ARROW & KIN: Amphib - OR DM	\$127,889	\$96,018	\$24,759	\$120,778	\$7,111		
C06M37A ARROW & KIN: Amphib - OR Imp	\$1,038,719	\$910,020	\$132,678	\$1,042,698	(\$3,979)		
C06M39A ARROW: Neotropical	\$2,150,992	\$1,990,660	\$16,527	\$2,007,187	\$143,805	Project is complete. Final completion report is outstanding.	
C06M39A ARROW: Neotropical - OR DM	\$189,932	\$135,280	\$9,728	\$145,008	\$44,924		
C06M39A ARROW: Neotropical - OR Imp	\$1,961,060	\$1,855,381	\$6,799	\$1,862,179	\$98,881		
C06M40A ARROW: Shore&Wat	\$2,890,326	\$2,580,705	\$70,105	\$2,650,810	\$239,516	Project is complete. Final completion report is outstanding.	
C06M40A ARROW: Shore&Wat - OR DM	\$189,388	\$153,483	\$11,245	\$164,728	\$24,660		
C06M40A ARROW: Shore&Wat - OR Imp	\$2,700,938	\$2,427,223	\$58,860	\$2,486,082	\$214,856		
C06M41A ARROW: Recreation	\$755,561	\$707,513	\$1,153	\$708,666	\$46,895	Project is complete. Final completion report is outstanding.	
C06M41A ARROW: Recreation - OR DM	\$71,661	\$45,729	\$1,153	\$46,883	\$24,778		
C06M41A ARROW: Recreation - OR Imp	\$683,900	\$661,784		\$661,784	\$22,116		
C06M58A ARROW Amphibs & Rep	\$497,676	\$417,801	\$19,442	\$437,243	\$60,433	Project is complete. Final completion report is outstanding.	
C06M58A ARROW Amphibs & Rep - ONR DM	\$68,894	\$19,404	\$8,042	\$27,446	\$41,448		
C06M58A ARROW Amphibs & Rep - ONR Imp	\$428,782	\$398,397	\$11,400	\$409,797	\$18,985		

OR - Ordered Remissible
ONR - Ordered Non-Remissible

* Red values in parentheses denote overage.