Columbia River Project Water Use Plan

KINBASKET AND ARROW LAKES RESERVOIRS

Arrow Lakes Reservoir: Revelstoke Reach Spring Songbird Effectiveness Monitoring

Implementation Year 7

Reference: CLBMON-11B2

Study Period: 2016

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CLBMON 11B2: Arrow Lakes Reservoir: Revelstoke Reach Spring Songbird Effectiveness Monitoring Year 7 - 2016

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Cover photo: Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*), Revelstoke Reach, 2016. Photo: Catherine Craig, CBA Ltd.

EXECUTIVE SUMMARY

In 2009, BC Hydro implemented CLBMON 11B, a program monitoring a diversity of terrestrial taxa as well as wetland and riparian habitat in the lower and upper sections of the Arrow Lakes Reservoir. CLBMON 11B2 (this study) was initiated as a component of CLBMON 11B and is focussed on the spring monitoring of neotropical migrant songbirds in relation to the effectiveness of revegetation and wildlife physical works projects in Revelstoke Reach. CLBMON 11B2 was incorporated into CLBMON 39 from 2012-2015, but now has been transferred back to CLBMON 11B. This report summarizes the work that was conducted in Year 7 (2016) of field studies.

To monitor the response of migrant songbirds to revegetation projects, weekly surveys of 23 effectiveness monitoring plots were conducted - 14 treatment plots (planted with cottonwood stakes) and 9 control plots (untreated area in similar habitat). A total of 137 effectiveness monitoring surveys were conducted, however only 16 migrant songbirds of 7 species were detected on plot. There were 7 migrant songbirds of 6 species (0.084 birds/plot survey) detected on cottonwood treatment plots, and 9 individuals of 4 species (0.167 birds/plot survey) detected on control plots.

To quantify migrant songbird use of Cartier Bay prior to the implementation of WPW 15A, four weekly encounter transects were completed along the shoreline of the main pond, adding a second year to a dataset begun in 2011. A total of 37 migrant songbirds were detected of two species (American Pipit and Savannah Sparrow).

Weekly surveys for migrant songbirds were conducted at 23 permanent plots to examine annual variation in songbird abundance and diversity. In total, 130 plot surveys were completed and 60 migrant songbirds of 15 species were detected on plot. The most frequently recorded migrant songbird species on plot were Yellow-rumped Warbler, White-crowned Sparrow, and Savannah Sparrow. The average number of migrants on plot was greatest on plots from higher elevation bands (436-439 m). Only one migrant was recorded on plots in the lowest elevation bands (431–435 m).

To monitor habitat use in the drawdown zone by spring songbird migrants, randomly selected plots from five broad habitat strata were surveyed. In total, 94 random plots were surveyed and 117 individual migrant songbirds of 17 species were detected on plot with an average density of 1.24 migrants per plot. Forested plots had the highest relative density of songbirds (2.70 birds/plot), followed by shrub plots (1.14 birds/plot), wetland plots (0.95 birds/plot), grassland plots (0.3 birds/plot) and unvegetated plots (0.0 birds/plot).

Habitat data were collected at random plots immediately following the bird surveys. Habitat data collection was also repeated this year at effectiveness monitoring and permanent plots. These data will be compared to data collected in 2011 and 2012 to determine whether the habitat at these plots has changed over time.

Recommendations for future years of CLBMON 11B2 are to: 1) Discontinue monitoring of treatment plots where cottonwood stakes have failed to establish; 2) Collect “after” data at WPW 6A and WPW 15A sites; 3) Continue monitoring annual variation using permanent plot surveys; 4) Continue random plot surveys, targeting under-sampled vegetation communities; 5) Start random plot surveying in early April (instead of mid-April), provided the habitat is snow-free.

KEYWORDS

Reservoir operations, effectiveness monitoring, neotropical migrants, songbirds, spring migration, stopover habitat, habitat use, Revelstoke Reach, Arrow Lakes Reservoir, British Columbia, BC Hydro

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CBA collaborates with the Okanagan Nation Alliance (ONA) for delivery of CLBMON 11B2, with ONA biologists and technicians providing field and technical support, and insight into the perspectives of the Syilx (Okanagan) people. Bruce Weaver of the Okanagan Indian Band contributed to field studies. Al Peatt managed the ONA's involvement.

Field studies were completed by Devon Anderson, Corey Bird, Catherine Craig, and Bruce Weaver. Catherine Craig coordinated the field study program and conducted the data analysis for this report. Ryan Gill provided GIS support throughout the study. John Cooper acted as Project Manager. Suzanne Beauchesne provided supervisory and technical assistance throughout the project.

Catherine Craig and John Cooper prepared this report.

We also thank the community of Revelstoke for providing an enjoyable home base for the field crew during the field season.

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1 INTRODUCTION

Riparian habitats in British Columbia and North America have been disproportionately degraded or destroyed by human activities (Campbell et al. 2001, Noss et al. 2001). The Columbia River system in Canada and the U.S. is one of the more altered river systems in the world, with numerous dams constructed over the last century (Nilsson et al. 2005). Dams and reservoir operations have played a significant role in the estimated loss of 87% of high wildlife-value riparian habitat within the Columbia Basin (Moody et al. 2006, Utzig and Schmidt 2011). In the Canadian portion of the Columbia Basin that lies between the Hugh Keenleyside Dam and the north end of Kinbasket Reservoir (~450 km in length), most of the valley bottom riparian habitat has been lost due to the creation of reservoirs (Moody et al. 2006, Utzig and Schmidt 2011).

Many migratory songbirds follow valleys during their annual migrations, and find food and cover in riparian vegetation along the way (Wiebe and Martin 1998, Skagen et al. 2004, Skagen et al. 2005a, 2005b). Reductions in the availability of stopover habitat may lead to increased competition for limited food resources, and the increased stress and reduced refuelling rates can result in increased mortality during migration, thus negatively impacting migratory songbird populations (Alerstam and Hedenström 1998). Research has demonstrated that mortality rates during migration are 15 times higher than mortality rates on breeding or wintering grounds (Sillett and Holmes 2002), but the extent to which mortality is affected by loss of suitable stopover habitat is not well known.

Today, migratory songbirds travelling along the Arrow Lakes Reservoir encounter very few extensive tracts of riparian valley-bottom vegetation (Bonar 1979). Revelstoke Reach provides a substantial amount of riparian habitat, and there are significant movements of migrating songbirds through the area each spring and fall (AXYS 2002, Boulanger et al. 2002, Jarvis and Woods 2002, MCA 2003, Boulanger 2005, Green and Quinlan 2007, MCA 2009, CBA 2010a, 2010b, 2011a, 2011b, 2013a). This habitat is partly a result of revegetation programs undertaken to control dust in Revelstoke Reach (McPhee and Hill 2003). However, the availability and quality of riparian habitat in Revelstoke Reach is heavily dependent on reservoir operations. Because conditions at migratory stopover sites can affect bird populations (Newton 2006), stewardship of Revelstoke Reach should consider the needs of migratory songbirds during this vulnerable time of their life cycle. As such, management of habitat for migrating birds was identified as a priority by the Water Use Planning Consultative Committee for the Columbia River. Recent initiatives to manage habitat in the drawdown zone of Revelstoke Reach include revegetation physical works (RPW) projects (e.g., CLBWORKS 2), wildlife physical works (WPW) projects (e.g., CLBWORKS 30), and the Arrow Soft Constraints on reservoir operations. These projects vary in scope from the planting of sedge seedlings to the construction of dykes for managing wetlands.

In 2009, BC Hydro implemented CLBMON 11B, a program monitoring a diversity of terrestrial taxa as well as wetland and riparian habitat in the lower and upper sections of the Arrow Lakes Reservoir. CLBMON 11B2 (this study) was initiated as a component of CLBMON 11B and is focussed on the spring monitoring of neotropical migrant songbirds in relation to the effectiveness of RPW and WPW projects in Revelstoke Reach. CLBMON 11B2 was incorporated into CLBMON 39 from 2012-2015, but now has been transferred back to CLBMON 11B. No field work was completed in 2015.

This report summarizes the work that was conducted in Year 7 (2016) of field studies.

1.1 Scope and objectives

The objectives of CLBMON 11B2 are to:

1) Conduct a monitoring program to assess the effectiveness of the revegetation physical works program and wildlife physical works projects at enhancing wildlife habitat in the drawdown zone of Arrow Lakes Reservoir.
2) Monitor the appropriate biological indicators and response variables to assess the effectiveness of the revegetation and wildlife physical works programs at enhancing wildlife habitat in the drawdown zone.
3) Provide recommendations on the effectiveness of the revegetation and wildlife physical works projects on improving habitat for wildlife in the drawdown zone.

1.2 Management questions

The four specific management questions to be addressed are:

1) What is the annual variation in the abundance and species richness of spring neotropical migrants in Revelstoke Reach?
2) Which habitats within the drawdown zone in Revelstoke Reach are used by spring neotropical migrants and what are their characteristics?
3) Are the ongoing revegetation physical works projects effective at maintaining or increasing habitat for neotropical migrants in the drawdown zone in spring?
4) Are the wildlife physical works effective at maintaining or increasing habitat for neotropical migrants in the drawdown zone in spring?

1.3 Management hypotheses

The two primary hypotheses to be tested by this study are:

H_1: Revegetation physical works do not affect use of the drawdown zone by neotropical migrants in spring as measured by species richness and relative abundance; and

H_2: Wildlife physical works do not affect use of the drawdown zone by neotropical migrants in spring as measured by species richness and relative abundance

The relationships between the relevant management hypotheses and the management questions and study objectives is outlined in Appendix 1.

1.4 Study area

The CLBMON 11B2 study area is defined as the drawdown zone of Revelstoke Reach - the northernmost arm of the Arrow Lakes Reservoir south of Revelstoke, BC, between the Monashee and Selkirk Mountains (Figure 1). This hydroelectric reservoir, regulated by the Hugh Keenleyside Dam near Castlegar, BC, is licensed to operate between 420 m and 440.1 m elevation under constraints imposed by the Columbia River Treaty. The reservoir is typically operated to store water in spring and summer, and occasionally into the fall, and to release water through Keenleyside Dam during the winter months, creating a cyclical annual pattern of reservoir elevations (Figure 2, Appendix 2).

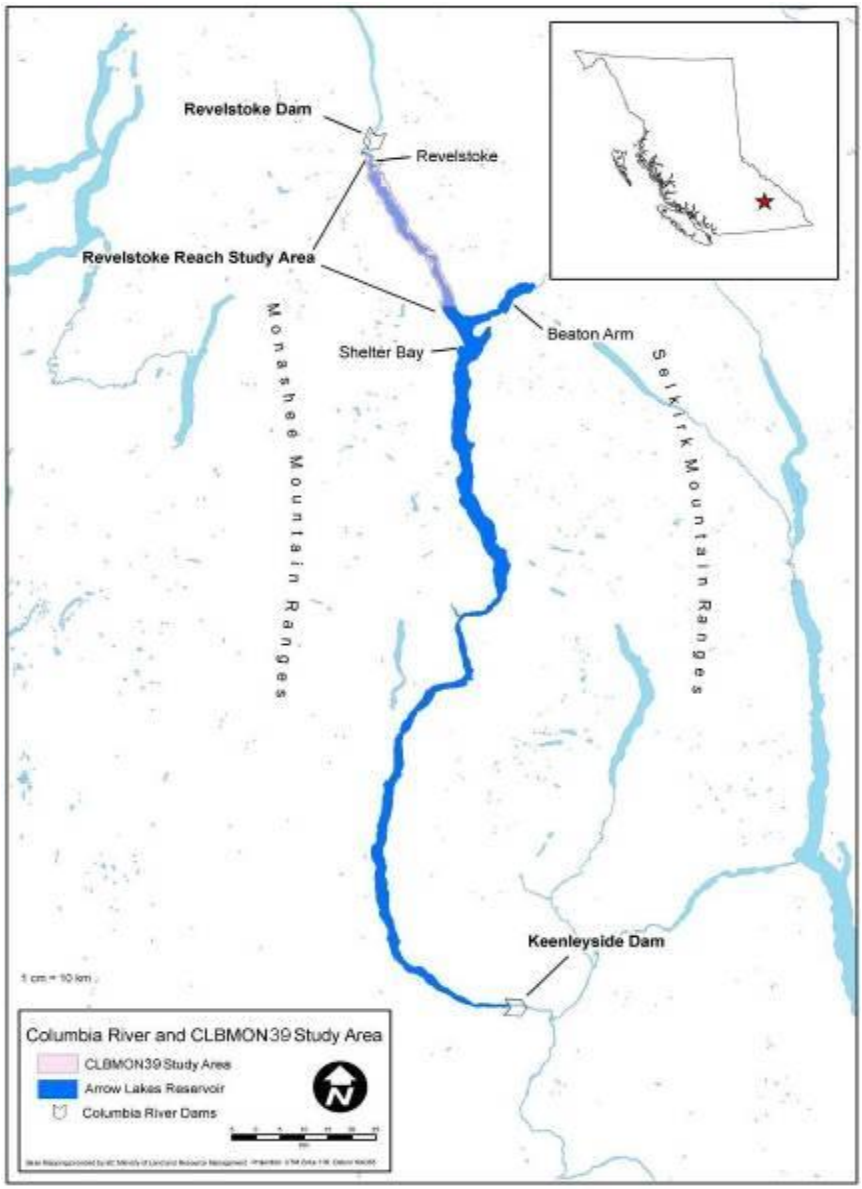

Figure 1: CLBMON 11B2 Revelstoke Reach Study Area, Arrow Lakes Reservoir

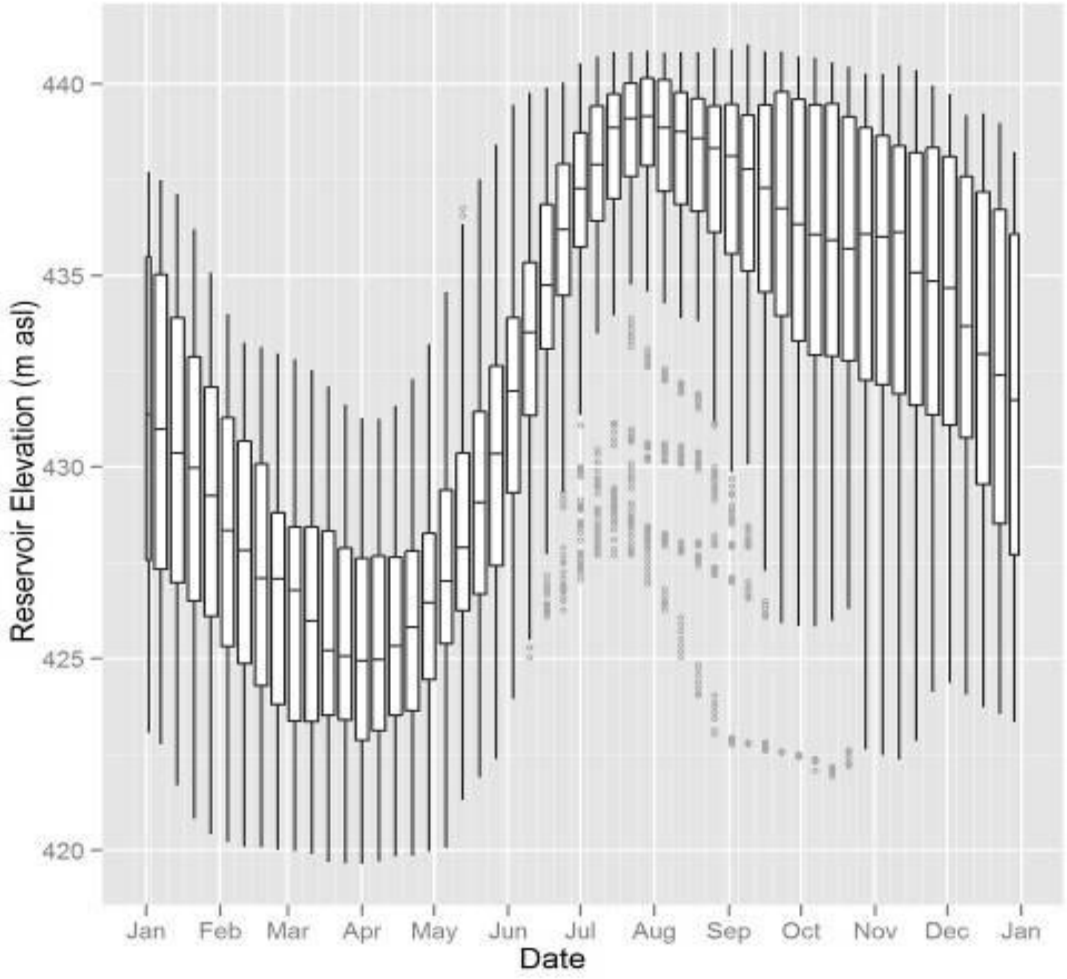

Figure 2: **Historical hydrological data from Arrow Lakes Reservoir (1968–2008) plotted in weekly intervals**

Revelstoke Reach contains the Columbia River as it flows south from the Revelstoke Dam, and the drawdown zone includes most of the level valley-bottom habitat in the area. The drawdown zone is a sandy-soiled floodplain with subtle topography shaped by the erosion and deposition of material from the Columbia River, including oxbow lakes, old backchannels, and sand bars.

Revelstoke Reach lies within the Interior Cedar Hemlock (ICH) biogeoclimatic zone and consists of two subzones (ICHmw2 and ICHmw3) (Meidinger and Pojar 1991). The valley bottom habitats in the area were naturally vegetated with old-growth stands dominated by western redcedar (*Thuja plicata*), Englemann spruce (*Picea engelmannii*) and black cottonwood (*Populus balsamifera*). As the area was settled, much of the valley bottom area was cleared for farming and ranching. Prior to dam completion in 1968, Revelstoke Reach consisted of productive farm lands, and contained a transportation network of roads, cable ferries, and the Arrowhead branch of the Canadian Pacific Railway.

The present-day vegetation of the Revelstoke Reach drawdown zone is influenced mostly by elevation (Korman 2002), which reflects the timing and extent of annual flooding. The lowest elevation drawdown habitats (below 433 m) are unvegetated. The substrate typically consists of sand, gravel, or silt, and sites become submerged early in the season and usually remain flooded for most of the growing season (Figure 3). Tree stumps are a common feature in some of these habitats.

Figure 3: Example of unvegetated habitat in Revelstoke Reach, 12 Mile area, April 21, 2016

Above 433 m, the Revelstoke Reach drawdown zone is vegetated extensively by reed canarygrass (*Phalaris arundinacea*) and sedges (*Carex* spp.), particularly lenticular sedge (*C. lenticularis*) and Columbia sedge (*C. aperta*) (Figure 4). Although reed canarygrass and sedges dominate the drawdown zone grasslands, bluejoint grass (*Calamagrostis canadensis*), water horsetail (*Equisetum fluviatile*), scouring rush (*Equisetum hyemale*) and several species of forbs are locally dominant (Moody 2002). Above 436 m, willow shrubs (typically *Salix sitchensis*) have become established both naturally and as a result of planting efforts in the past (Figure 5). At the lower extent of their distribution in the drawdown zone (around 436 m), willows usually grow as sparsely distributed solitary shrubs, but above 437 m they commonly grow in dense clusters of varying sizes. Cottonwood saplings and other species of willow (e.g., *Salix scouleriana*) are abundant in many of these patches.

Figure 4: Example of grassland habitat in Revelstoke Reach, June 5, 2015

Figure 5: Example of shrub habitat in Revelstoke Reach, September 22, 2012

Near the full-pool elevation (439 m to 440 m), some patches of mature cottonwood riparian habitat occur, most extensively at Machete Island and on the banks of rivers entering the drawdown zone (e.g., the Illecillewaet and Columbia Rivers) (Figure 6). In these patches, black cottonwood is usually a dominant canopy species, and there can be a diversity of other tree and shrub species, such as twinberry (*Lonicera involucrata*), hardhack (*Spiraea douglasii*), snowberry (*Caprifoliaceae* sp.), red-osier dogwood (*Cornus stolonifera*), willow (*Salix* spp.), alder (*Alnus* sp.), trembling aspen (*Populus tremuloides*), Engelmann spruce, western white pine (*Pinus monticola*), western redcedar, Sitka mountain-ash (*Sorbus sitchensis*) and paper birch (*Betula papyrifera*).

Figure 6: Example of riparian forest habitat in Revelstoke Reach, April 21, 2014

1.5 Revegetation physical works projects

As part of the CLBWORKS 2 project, cottonwood stakes were planted extensively in Revelstoke Reach in spring 2010 and 2011 (Figure 7). Several areas at elevations above 438 m were planted with stakes approximately 1.5 m–2 m in length and 5 cm–15 cm in diameter. Treated sites typically contained no shrubs or trees, and reed canarygrass was the dominant ground cover (Keefer and Moody 2010). The treatment protocol in 2010 was to plant the stakes at least 1.5 m apart; average spacing was 2 m (Keefer and Moody 2010).

If successful, this treatment could provide habitat for migrating songbirds. With the exception of 2015, migrant songbird effectiveness monitoring has been conducted annually at treatment and control sites since 2010.

Figure 7: **Example of site planted with cottonwood stakes (revegetation physical works project) in Revelstoke Reach (elevation ~438 m), McKay creek area, April 29, 2014**

1.6 Wildlife physical works projects

More than 40 WPW projects were initially identified in the Columbia Water Use Plan (BC Hydro 2005). Two projects have been completed in Revelstoke Reach during this study.

WPW 6A involved installing a gravel blanket and rip-rap to reinforce the eastern branch of an erosion channel to prevent it from cutting in towards habitat further upstream (i.e., Airport Marsh). Songbird monitoring plots directly at the erosion channel were sampled in 2010 and 2011, but that monitoring was discontinued when CLBMON 11B2 was integrated with CLBMON 39 (CBA 2013b). Random plot sampling (described below Section 2.2) of songbirds in the area protected by the installation has continued.

WPW 15A was completed in fall 2016. The original intention was remove an old collapsed box culvert at the southern breach of Cartier Bay, and rebuild and fortify the rail bed. The dike was also to be elevated to create an additional shallow water habitat (ponds). However, that plan was later modified (based on further study) to only include the reinforcement of the box culvert by installing rock rip rap on the river side of the culvert. This will result in no change in the flow of water between the ponds in the bay and the river and thus no change in the depth of the ponds. A weekly songbird monitoring transect was completed along the shoreline of the main Cartier Bay pond in 2011, when the plan was to raise the elevation of that pond. The weekly transects were repeated in 2016 prior to the final implementation of the project.

1.7 Annual variation and habitat selection

In addition to monitoring the effectiveness of the physical works projects mentioned above, CLBMON 11B2 studies the annual variation in numbers of migrating songbirds and habitat use by migrating songbirds. The objective is to provide baseline data on the annual use of the drawdown zone by songbird migrants and to determine which drawdown zone habitats are selected by migrating songbirds so that recommendations can be made for future WPW or RPW projects. Surveys of permanent plots to monitor annual variation began in 2012 when CLBMON 11B2 was a part of CLBMON 39. The habitat use component was initiated in 2009 (Year 1), and an early analysis provided strong evidence that shrubs are used disproportionately by migrating songbirds (CBA 2010a). Future analyses will examine how plant species composition influences habitat use by migrating songbird species.

2 METHODS

An overview of approaches used to answer CLBMON 11B2 management questions and hypotheses is provided in Appendix 1. A summary of the surveys conducted in each year is provided in Table 1.

Table 1: Surveys conducted in the spring for CLBMON 11B2/CLBMON 39 (o – surveys conducted under CLBMON 11B2, x- surveys conducted under CLBMON 39, EM = effectiveness monitoring, WPW = wildlife physical works). Note that no fieldwork took place in 2015.

Survey type	2009	2010	2011	2012	2013	2014	2015	2016
Random plots (habitat use)	o	o	o	x	x	x		o
EM plots - cottonwood stakes		o	o	x	x	x		o
Vegetation surveys of cottonwood stakes			o					o
EM plots - water sedge plantings		o	o					
EM plots - mixed sedge plantings		o						
EM plots - WPW 6A		o	o					
EM plots - WPW 14/15A		o						
Encounter transect - WPW 14/15A			o					o
Permanent plots (annual variation)				x	x	x		o
Vegetation surveys of permanent plots			o	x				o

A summary of the methods for 2016 is provided below. Additional information is found in the Monitoring Protocols for CLBMON 39, Year 7 (CBA 2014b) and CLBMON 11B2, Year 3 (CBA 2011c).

2.1 Effectiveness monitoring of cottonwood stakes

To determine whether RPW projects are effective at maintaining or increasing habitat for neotropical migrants in the drawdown zone in spring (MQ3), effectiveness monitoring (EM) plots were established in 2010. The plots are located at Cartier Bay, McKay Creek, 9 Mile, and 12 Mile. Established plots were 50 x 50 m when possible, but other irregularly shaped plots were of a similar size (2,500 m^2).

Plots were monitored for spring migrant use in spring 2010 and 2011 under CLBMON 11B2 (CBA 2010a, CBA 2011a) and in 2012-2014 under CLBMON 39 (2013b, 2014a, 2015). In

2013, surveys of four plots (two treatment plots and two control plots) were discontinued due to their smaller sizes and irregular shapes. No surveys were completed in 2015. In 2016, 23 EM plots were surveyed, 14 treatment plots and 9 control plots.

Both treatment and control plots were sampled once per week during the survey period (mid-April through May), typically all on the same day and within six hours after sunrise, if possible. The order in which the plots were surveyed was changed every week to minimize bias related to the time of the day when surveys were conducted.

At the beginning of each survey, weather conditions were recorded. At each plot, the start time, the percent of the plot that was flooded, the average water depth of the flooded portion of the plot, and whether the plot was completely underwater (no vegetation available) were recorded. If the plot was completely underwater and no vegetation was visible, the observer recorded the general plot survey data (e.g., date, weather, the percent of the plot that was flooded) and surveyed the plot for at least one minute or until census saturation time (CST—the shortest time interval in which the observer can count all birds on the plot) was reached, and then moved to the next plot. If the plot was completely flooded but some vegetation was visible (e.g., willow shrubs extending above the water surface), the observer conducted a regular survey.

During the survey period, one observer moved slowly around the entire plot to ensure the area was well-covered. The survey was complete after a minimum of 10 minutes or continued until CST was reached. Bird observations were recorded by minute (minutes from start). Data recorded included CST; whether a bird detection was before or after CST; bird species; number of individuals; sex; age; migratory status; behaviour; location (on plot, off plot, overhead); whether a bird detection included visual confirmation and/or involved flushing the bird from the vegetation; the type of substrate the bird was detected on; the height of the bird above the ground when it was first detected; and the distance from the observer when first detected.

2.2 Effectiveness monitoring of WPW 15A

First completed in 2011, the encounter transect monitors the usage of the shoreline of Cartier Bay by migrant songbirds. It was intended to provide “before” data for WPW 15A and allow an assessment of how songbird usage of the shoreline might change with reservoir elevation. This would provide insight in to whether WPW projects are effective at maintaining or increasing habitat for neotropical migrants in the drawdown zone in spring (MQ4). This survey was repeated in 2016 to collect additional “before” data. WPW 15A was completed in the fall of 2016.

An encounter transect following the inside shoreline of Cartier Bay (Figure 8) was surveyed almost every week. The transect began and ended at approximately the same location each week, but the route was modified to stay within 1 m of the shoreline and never cross water deeper than 30 cm. Each week, the route taken was tracked using a GPS unit and waypoints were taken for all birds detected. The following information was recorded for all birds seen or flushed up along the route: time, distance from shoreline (categories: <1 m, 1-5 m, 5-10 m, >10 m) and bird species. The survey typically took three hours to complete.

Figure 8: Example of an encounter transect used to survey the shoreline of Cartier Bay.

2.3 Permanent plot sampling

Permanent plot surveys were incorporated into the CLBMON 39 study design in 2011 to determine seasonal and annual variation in the diversity and abundance of migratory songbirds and the effect of water levels (reservoir operations) on songbird stopover habitat availability and quality. We retained part of this study design when spring migratory songbird sampling was moved back within CLBMON 11B2 for 2016. Data from permanent plots will be used to assess the annual variation in the abundance and species richness of spring neotropical migrants in Revelstoke Reach (MQ1).

Permanent plots were established in five broad habitat strata (wetland, grassland, shrub, forest, and unvegetated) both in and outside of the drawdown zone. Plots were selected based on habitat and elevation. The location of permanent plots was determined through a GIS analysis (based on digital elevation models, CLBMON 33 data, and orthophotos) and field inspection. In the drawdown zone, the total habitat available within each habitat stratum was classified based on 1-m elevation bands (e.g., 439 = 439 m–440 m, 438 = 438 m–439 m, 437 = 437 m–438 m), and permanent plots were selected so that each habitat stratum contained plots of similar vegetation at multiple elevation bands, if possible. In some habitat strata (e.g., shrub), habitat within elevation bands greatly varied. We tried to select plots with similar vegetation at multiple elevation bands, but for elevations at which there was greater habitat heterogeneity, multiple plots were selected.

Prior to the 2012 field season, all permanent plots were reclassified based on data collected in 2011 (habitat data and in-field water depth observations). The following corrections were made:

1. Habitat strata for all permanent plots were adjusted based on collected habitat data, as follows:

- Forest: plots with ≥ 5% tree cover (>5 m high)
- Shrub: plots with ≥ 5% shrub cover and < 5% tree cover
- Grassland: plots with ≥ 10% grass/herbaceous cover and < 5% shrub cover
- Unvegetated: plots with < 10% grass/herbaceous cover

2. Plots from the wetland stratum were reclassified into forest, shrub, grassland, and unvegetated strata. Due to heterogeneity of the wetland stratum (plots with herbaceous vegetation only, as well as plots with shrub and/or trees) and the fact that the whole drawdown zone is basically a large, seasonally-flooded wetland, the difference between a plot from the wetland stratum and a flooded grassland or shrub plot was not always apparent. Therefore, we decided to classify all permanent plots into strata based only on vertical habitat structure (since this data will not be used specifically for determining habitat associations).

The permanent plots were established for monitoring neotropical migrants in fall (under CLBMON 39), but a subset of 23 plots has been surveyed once a week in spring since 2012 (Table 2). Since water levels in the spring are usually low (Figure 2), the subset includes the lowest elevation plots that are more likely to be affected at that time of year.

Table 2: Stratification of permanent plots and number of plots within each habitat stratum and elevation band (DDZ = drawdown zone) surveyed.

Stratum	In DDZ (m)									Total
	440–439	439–438	438–437	437–436	436–435	435–434	434–433	433–432	432–431	
Forest	3	-	-	-	-	-	-	-	-	2
Shrub	1	1	4	3	-	-	-	-	-	9
Grassland	1	1	1	2	2	1	1	-	-	9
Unvegetated	-	-	-	-	-	1	1	-	1	3
Total	4	2	5	5	2	2	2	-	1	23

The field methods for surveying permanent plots are the same as those for surveying EM plots and are outlined in Section 2.1.

2.4 Random plot sampling

Random plot surveys will primarily be used to examine habitat use by neotropical migrants in the drawdown zone and determine the characteristics of the habitat used (MQ2). This data may also provide a secondary source of information regarding the annual variation in the abundance and species richness of spring neotropical migrants in Revelstoke Reach (MQ1), in conjunction with the permanent plot data.

To facilitate random plot selection and sampling, the Revelstoke Reach study area was stratified into six broad habitat strata to ensure that the primary habitats were all represented in each week of sampling. Various data sources were used to stratify habitats, including CLBMON 33 data, the digital elevation model and orthophoto data provided by BC Hydro, Google Earth orthoimagery, other existing reports (e.g., Korman 2002), and

personal observation. Using GIS, we overlaid a 50-m grid on the study area and assigned each 50 x 50 m plot to one of six habitat strata: (1) wetland, (2) forest, (3) shrub, (4) grass-dominated, (5) non-vegetated and (6) open water. When multiple strata were present in a plot, the plot was assigned to the habitat stratum with the lowest number (in the list above). For example, a plot with both wetland and grass habitat was assigned as a wetland plot. During each field day, an effort was made to survey at least one plot from each of the habitat strata (stratified random sampling). Open water plots were not surveyed since they provide no potential habitat for migratory songbirds.

In spring 2013, in addition to the above-mentioned broad stratification, the study area was overlaid with the vegetation community map of Revelstoke Reach (CBA 2013d) and the area covered by each vegetation community was determined for all random plots. Random plots were assigned to the dominant vegetation community on the plot. In 2014, we focused on sampling the random plots assigned to under-sampled vegetation communities, to ensure that the sampling effort was balanced and that each vegetation community had at least five samples.

Prior to conducting a survey, observers familiarized themselves with the plot boundary by walking around the plot and, as necessary, marking the corners or edges with flagging tape or pin-flags. Random plot sampling followed almost the same field methods as were used for EM and permanent plots (Section 2.1), however each random plot is only ever surveyed once. Thus, to guarantee the plot is well-covered, the bird survey is 30 minutes long. Vegetation data are collected immediately following the bird survey.

2.5 Habitat sampling

In 2016, vegetation data were collected at all surveyed random plots immediately following the bird survey. We also repeated vegetation data collection at the cottonwood stake EM plots and permanent plots for future comparison with 2011 and 2012 data. For a detailed vegetation sampling protocol see the CLBMON 39 monitoring protocol (CBA 2014b).

2.6 Data collection and management

All field data recorded on datasheets and in field notebooks were entered into spreadsheets (MS Excel) or an online application on a regular basis. The entered data were proofed for errors or inconsistencies relative to the original datasheets and field notebooks.

Records of provincially listed birds were entered in to the Wildlife Species Inventory (WSI) data template. The WSI is managed by the Ecosystem Information Section within the Environmental Stewardship Division of the B.C. Ministry of Environment. This WSI database was submitted directly to the B.C. Ministry of Environment.

2.7 Data summary and analysis

The purpose of this report is to summarize work conducted in Year 7 (2016). The results include summaries of the numbers of songbirds and numbers of species of songbirds detected during field surveys in 2016.

All data was exported from CBA's online data entry application and summarized using the program R (R Development Core Team 2016).

3 RESULTS

3.1 Operation of Arrow Lakes Reservoir in 2016

During the spring survey season (April–May), the reservoir levels rose higher than the long-term average (Appendix 2). On April 1st, the water level was 426.7 m ASL and by May 31st the water level reached 435.8 m ASL.

The reservoir water level for 2016 peaked on June 12th when it reached an annual maximum of 437.2 m ASL.

3.2 Effectiveness monitoring of cottonwood stakes

In 2016, 23 effectiveness monitoring plots (14 treatment and 9 control plots) were surveyed once per week from April 18th to May 24th for a total of 137 plot surveys. Sampling at one plot at McKay Creek was unintentionally missed on May 24th.

In total, 133 individuals of 28 species were recorded, including 111 neotropical migrant songbirds of 19 species (Appendix 6). Of the migrant songbirds, 16 individuals of 7 species were recorded on plot, 77 individuals of 16 species were recorded off plot and 18 individuals of 4 species were recorded flying overhead (Appendix 6). There were 7 migrant songbirds of 6 species (0.084 birds/plot survey) detected on cottonwood treatment plots, and 9 individuals of 4 species (0.167 birds/plot survey) detected on control plots (Table 3).

Lincoln Sparrow (*Melospiza lincolnii*) was most frequently detected species, followed by Yellow-rumped Warbler (*Setophaga coronata*), and Yellow Warbler (*Setophaga petechia*) (Table 3). These species were detected on both treatment and control plots (Table 3). Three species - American Robin (*Turdus migratorius*), Chipping Sparrow (*Spizella passerina*), and Western Meadowlark (*Stella neglecta*) - were detected only on cottonwood treatment plots; one species - White-crowned Sparrow (*Zonotrichia leucophyrus*) - was recorded only on control plots (Table 3).

Table 3: Species and number of neotropical migrant songbirds detected on cottonwood treatment (CT) and control (CC) plots during effectiveness monitoring surveys in spring 2016

Common Name	CC	CT	Total
Lincoln's Sparrow	4	1	5
Yellow-rumped Warbler	1	2	3
Yellow Warbler	2	1	3
White-crowned Sparrow	2	0	2
American Robin	0	1	1
Chipping Sparrow	0	1	1
Western Meadowlark	0	1	1
Total	9	7	16

More neotropical migrants were detected on plot at 12 Mile than at Cartier Bay and 9 Mile, and no birds were detected on plot at McKay Creek (Table 4).

Table 4: Number of neotropical migrant songbirds detected on cottonwood treatment (CT) and control (CC) plots at each survey site during effectiveness monitoring surveys in spring 2016

Site	CC	CT	Total
12 Mile	5	3	8
Cartier Bay	4	0	4
9 Mile	0	2	2
9 Mile Point	0	2	2
McKay Creek	0	0	0
Total	9	7	16

Substantially fewer birds and species were detected during effectiveness monitoring surveys (including detections on plot, off plot, or overhead) in 2016 compared to previous years (Table 5).

Table 5: Number of individual birds and species detected during effectiveness monitoring surveys in 2016, 2014, and 2013 (years in which 23 plots were surveyed weekly)

	2016	2014	2013
Total individuals detected	133	490	924
Number of species detected	28	35	57
Number of neotropical migrants on plot	16	193	98
Number of neotropical migrant species on plot	7	13	9

3.3 Effectiveness monitoring of WPW 15A

In 2016, four transects were completed (roughly once a week from mid-April through May. The first survey was conducted on April 21st; the last was conducted on May 18th. Thirty-seven migrating songbirds of two species (and seven unidentified individuals) were observed. Of the 28 American Pipit (*Anthus rubescens*) observed, only one was more than 10 m from shore. All two of the Savannah Sparrow (*Passerculus sandwichensis*) observed were within 10 m of the shoreline.

Most of the birds were observed during the first survey on April 21st (26) and no birds were observed during the final survey on May 18th. Songbirds detected were either in the mud or grass and sedge along the shoreline and all flushed up as the observer approached.

3.4 Permanent plot sampling

Between April 21 and May 24, 2016, 23 permanent plots were surveyed once per week for a total of 130 plot surveys. Some plots were not surveyed in later weeks because they were inaccessible due to the higher reservoir level.

In total, 321 birds of 51 species were recorded. Neotropical migrant songbirds accounted for 185 individuals and 31 species. Of these, 60 individuals of 15 species were recorded on plot, 100 individuals of 26 species were recorded off plot and 25 individuals of 6 species were recorded flying overhead (Appendix 3).

The average number of on plot neotropical migrant songbirds was highest on plots from the shrub stratum (0.94 birds per plot survey), followed by forested plots (0.83 birds per plot survey), and grassland plots (0.02 birds per plot survey) (Appendix 4).

The most common species of neotropical migrant songbirds recorded on plot were Yellow-rumped Warbler (12 individuals), White-crowned Sparrow (11 individuals), and Savannah Sparrow (11 individuals). These species were detected primarily on plots in the shrub stratum, although one Yellow-rumped Warbler was on a forest plot and one Savannah Sparrow was on a grassland plot.

The average number of migrants on plot was higher on plots from higher elevation bands (439-436 m, Appendix 5). Only one migrant, a Western Meadowlark, was recorded on plots in the lowest elevation bands (431-435 m, Appendix 5).

The substrates (plants) most frequently used by neotropical migrant songbirds on permanent plots were willow (40 individuals) and cottonwood (10 individuals).

3.5 Random plot sampling

In spring 2016, 94 random plot surveys were completed between April 18th and May 26th; 24 plots were forest stratum, 22 plots were shrub stratum, 20 plots were grassland stratum, 6 plots were unvegetated, and 22 were wetland stratum (Table 6).

In total, 681 birds of 66 species were detected, including 474 neotropical migrant songbirds of 36 species, of which 117 were observed on plot, 87 were off plot, and 270 were overhead (Appendix 7). There was an average density of 1.24 migrants on plot. Forested plots had the highest relative density of songbirds (2.71 birds/plot), followed by shrub plots (1.14 birds/plot), wetland plots (0.95 birds/plot), grassland plots (0.3 birds/plot), and unvegetated plots (0.0 birds/plot) (Appendix 8).

Table 6: Number of random plots surveyed each week in Revelstoke Reach in spring 2016

Strata	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Total
Forest	4	3	5	6	2	4	24
Grassland	3	6	7	2	2	0	20
Shrub	2	9	3	3	5	0	22
Unvegetated	3	3	0	0	0	0	6
Wetland	2	3	5	3	4	5	22
Total	14	24	20	14	13	9	94

The most frequently detected neotropical migrant songbird species on plot was American Pipit, with an overall average density of 0.34 birds per plot (Appendix 8). Other abundant species were Yellow-rumped Warbler (overall average density of 0.25 birds/plot), Song Sparrow (*Melospiza melodia,* overall average density of 0.14 birds/plot), and Savannah Sparrow (overall average density of 0.13 birds/plot).

In 2016, we increased the sample size of several under-sampled vegetation communities, adding additional surveys to Upland Conifer, Rocky Bank, Floating Bog, and Submerged Buoyant Bog (Appendix 10).

The substrates most frequently used by neotropical migrant songbirds on plot were reed canarygrass (mainly used by American Pipit) and willow (mainly used by Yellow-rumped Warbler) (Appendix 9).

4 DISCUSSION

This section provides insight regarding field studies completed in 2016. An overview of the management questions and approaches is presented in Appendix 1.

4.1 Effectiveness monitoring of cottonwood stakes

2016 was the sixth year of spring effectiveness monitoring surveys and we detected fewer migrants on plot and fewer birds overall than in previous years (Table 5). We did not observe the flocks of songbirds (e.g., Mountain Bluebird, *Sialia currucoides*) that have previously been detected moving through. It could be that these migrants came through the study region prior to the survey period due to the relatively warmer spring temperatures this year.

Nonetheless, we found a greater abundance of birds on control plots than treatment plots, but there was a higher species richness on treatment plots. Given the low numbers of birds detected, these results are not that informative.

To date we have conducted 928 spring effectiveness monitoring surveys and there has not been much evidence for greater use by migrants of treatment plots relative to control plots. However, many of the cottonwood stakes have not established successfully, and are therefore not providing the expected habitat to migrating birds. Thus, we suggest that we only continue monitoring the plots where groups of cottonwood stakes have successfully established and discontinue monitoring the failed plantings.

4.2 Effectiveness monitoring of WPW 15A

In 2016, relatively few birds were detected on these transects compared with the high numbers (100s) detected during surveys in 2011 (CBA 2011a). The timing of the 2011 surveys was slightly different (late April to early June), but the timing of the largest numbers of birds detected in 2011 (early May) overlapped the 2016 survey period. In 2016, the reservoir water level was relatively lower than it was in 2011 prior to the end of April, and then rose above the 2011 level during May. This could have affected bird numbers, but it seems equally likely that the lower numbers are simply due to lower numbers of pipits passing through since plenty of shoreline habitat was still available.

4.3 Permanent plot sampling

Relative to other years of this study, the water level was lower than usual in early April, but rose to a higher level than usual by May 1st (Appendix 2). Since spring permanent plot surveys were initiated in spring 2012, 571 surveys have occurred under a variety of reservoir water levels throughout the spring and the number of migrants detected has been variable.

Fewer neotropical migrants were detected on plot in 2016 than in previous years (60 observations in 2016 vs. 349, 197, and 219 in 2014, 2013, and 2012, respectively; CBA 2013b, 2014a, 2015). Consistent with previous years, Yellow-rumped Warbler was the most frequently detected species.

Spring 2016 was the third year in which migrant use of plots from lower elevation bands (433-435 m) was recorded (one Western Meadowlark). As in previous years, the average

number of migrants on plot was higher on plots from higher elevation bands (439-436 m) and fewer migrants was recorded on plots in the lower elevation bands (431–435 m).

4.4 Random plot sampling

Since 2014, we have focused on surveying under-sampled vegetation communities to increase our sample sizes for them. All vegetation communities have been sampled in spring except for three: urban, steep bedrock, and coarse rocks. These communities cover a very small area of the drawdown zone and are only present as extremely narrow bands along the edges of the reservoir.

The remaining 27 vegetation communities have all been sampled at least twice (Appendix 10). Three communities with sample sizes of less than five (swamp, cattail, and upland conifer) either cover a very limited area in Revelstoke Reach (swamp, cattail) or are positioned above the drawdown zone (upland conifer). However, there are some additional plots within these communities that could still be sampled.

4.5 Multi-year progress

This section provides an overview of our progress toward answering the management questions, and recommendations for the final years of the project. Solid progress has been made towards answering the management questions. More details on the progress of each aspect of the study is presented below. A summary table of the management questions, approaches, and Year 7 (2016) status is in Appendix 1.

4.5.1 Annual variation in songbird migrant abundance and diversity (MQ1)

Four years of spring permanent plot surveys (2012-2014 and 2016) have been conducted. During the spring sampling period (mid-April through May), the number of migrants detected has been variable (only 60 migrants detected on plot in 2016 versus 349 in 2014). We recommend continuing data collection to ensure a more complete picture of the annual variation in the abundance and species richness of neotropical migrant songbirds. Random plot data can also contribute towards answering this MQ. We will be able to answer this MQ by the completion of the study.

4.5.2 Songbird migrant habitat use (MQ2)

To date, we have conducted 458 spring random plot surveys over seven years and all available vegetation communities have been sampled at least twice. However, there remain a few communities which may be used by neotropical migrants that are under-sampled. To increase our knowledge of which migrant songbird species may be using these less common habitats, we recommend targeting these communities in the next field season. We will have sufficient data to answer this MQ by the end of the study.

We also recommend beginning the field season earlier in April to ensure we collect data on habitat use by songbird species that may migrate earlier in the spring. Random plot surveys were begun earlier in three previous years and we suspect some migrants may have been missed in 2016 due to the mid-April start, especially given the warmer weather.

4.5.3 Effectiveness monitoring of RPW projects (MQ3)

Two years of spring monitoring was conducted at sedge planting sites in 2010 and 2011, but the plantings became obscured by the natural sedge, thus the effectiveness monitoring was discontinued.

We have conducted six years (2010-2014, 2016) of spring effectiveness monitoring surveys at three cottonwood stake revegetation locations (12 Mile, 9 Mile, McKay Creek) and found little evidence for a difference in use between the treatment and control plots (2013c). At 9 Mile and McKay Creek, the cottonwood stakes have largely failed to establish, so it is unlikely that there will be a change in their use by songbirds in future years. At 12 Mile, where the stakes have been more successful, more growing time may be required for the stakes to provide a detectable benefit to migrating songbirds. We recommend discontinuing monitoring of the failed cottonwood stake treatment plots.

Although it will be possible to provide an answer to the MQ, the results may not be as informative as they could have been if more of the stakes had established successfully.

4.5.4 Effectiveness monitoring of WPW projects (MQ4)

We completed an encounter transect survey along Cartier Bay in 2011 and 2016 as "before" data for WPW 15A and WPW 14. The vastly different numbers of birds detected between these two years mean that it may be difficult to attribute the results of future surveys to the WPW project.

Four permanent plots at the site of WPW 6A were surveyed in 2010 and 2011 as "before" data for that project, but "after" sampling was not completed when CLBMON 11B2 was integrated into CLBMON 39. We recommend collecting "after" data at these plots to assist with addressing MQ4.

In addition, annual random plot survey data for the areas protected by the WPW projects (Cartier Bay and Airport Marsh) will assist with monitoring any changes to songbird use of the area, and should allow us to provide an answer to MQ4.

4.6 Summary of recommendations for future field seasons

- Discontinue monitoring of treatment plots where cottonwood stakes have failed to establish successfully
- Collect "after" data at WPW 6A permanent plots
- Collect "after" data for WPW 15A encounter transect
- Continue monitoring annual variation using permanent plot surveys
- Continue random plot surveys, targeting under-sampled vegetation communities
- Start random plot surveying in early April (instead of mid-April), provided the habitat is snow-free

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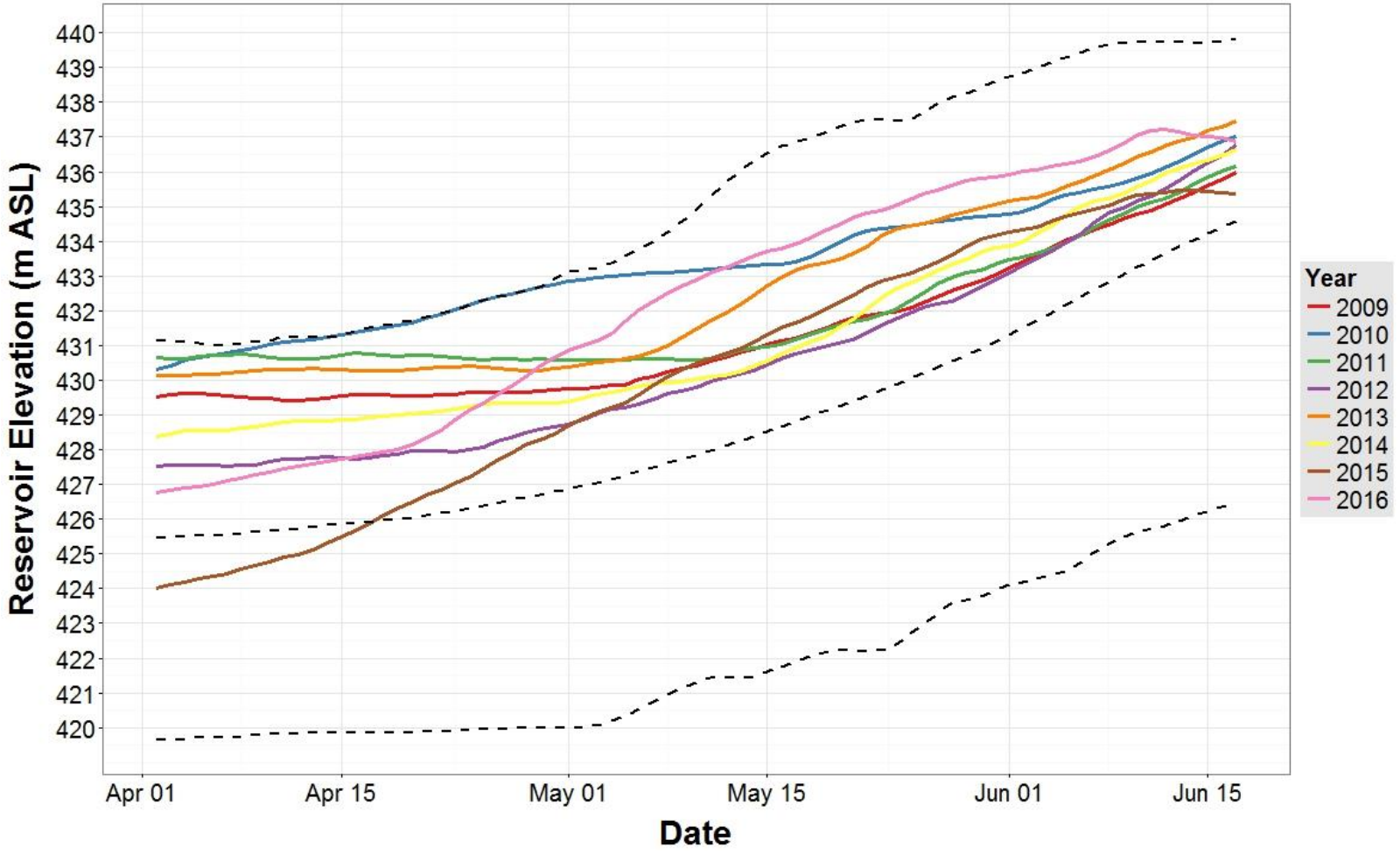
6 APPENDICES

Appendix 1: Study objectives, management questions, management hypotheses, approaches, and status of CLBMON 11B2 after Year 7 (2016)

Study Objective	Management Question	Management Hypothesis	Approach	Year 7 (2016) Status
1. Monitor the appropriate biological indicators and response variables to assess the effectiveness of the revegetation and wildlife physical works programs at enhancing wildlife habitat in the drawdown zone. 2. Provide recommendations on the effectiveness of the revegetation program and wildlife physical works projects on improving habitat for wildlife in the drawdown zone.	1. What is the annual variation in the abundance and diversity of neotropical migrants in Revelstoke Reach?		Permanent plot surveys Random plot surveys	In progress. We are on track to answer this MQ and should have sufficient data by the end of the study. These surveys will continue in upcoming field seasons.
	2. Which habitats within the drawdown zone in Revelstoke Reach are used by neotropical migrants and what are their characteristics?		Random plot surveys	In progress. We are on track to answer this MQ and should have sufficient data by the end of the study. Future years will focus on adding more samples to vegetation communities with lower sample sizes.
3. Conduct a monitoring program to assess the effectiveness of the revegetation program (CLBWORKS 2) and wildlife physical works projects (CLBWORKS 30) at enhancing wildlife habitat in the drawdown zone of Arrow Lakes Reservoir.	3. Are the ongoing revegetation projects effective at enhancing habitat for neotropical migrants in the drawdown zone in spring?	H1: Revegetation does not affect the use of the drawdown zone by neotropical migrants in spring as measured by species richness and relative abundance.	Effectiveness monitoring surveys	In progress. Six years of data has provided little evidence of a difference in use of treatment versus control plots. We will be able to provide an answer the MQ for the cottonwood stakes RPW, but given that the stakes didn't successfully establish at all sites, the results may not be as informative as hoped for.
	4. Are the wildlife physical works effective at maintaining or increasing habitat for neotropical migrants in the drawdown zone in spring?	H2: Wildlife physical works do not affect the use of the drawdown zone by neotropical migrants in spring as measured by species richness and relative abundance.	Effectiveness monitoring surveys Encounter transect Random plot surveys	In progress. In 2017, we will re-survey plots at WPW 6A to provide additional "after" data. Random plots will continue to be surveyed in the areas affected by each project to provide data regarding whether these projects have impacted neotropical migrant songbirds.

Appendix 2: **Water levels (m) in Arrow Lakes Reservoir from 2009-2016 during field survey period. Dashed lines show mean, minimum, maximum elevation (1968–2008)**



Appendix 3: Species and number of neotropical migrant songbirds recorded during permanent plot surveys in Revelstoke Reach in spring 2016

Common Name	On plot	Off plot	Overhead	Total
Yellow-rumped Warbler	12	10	1	23
Yellow Warbler	5	14		19
American Pipit		2	16	18
Tree Swallow		12	2	14
Chipping Sparrow	3	10		13
Savannah Sparrow	11	2		13
White-crowned Sparrow	11	2		13
American Robin	2	8		10
Least Flycatcher	5	3		8
Warbling Vireo		7		7
Western Meadowlark	3	4		7
Northern Rough-winged Swallow		1	3	4
Western Wood-Pewee		4		4
Wilson's Warbler	1	3		4
Common Yellowthroat	1	2		3
MacGillivray's Warbler		3		3
American Goldfinch		2		2
Lincoln's Sparrow		2		2
Orange-crowned Warbler	1	1		2
Tennessee Warbler	1	1		2
American Redstart	1			1
Barn Swallow		1		1
Cedar Waxwing		1		1
Dark-eyed Junco	1			1
Lazuli Bunting		1		1
Pine Siskin		1		1
Ruby-crowned Kinglet	1			1
Song Sparrow		1		1
Swainson's Thrush		1		1
Unidentified Empidonax Flycatcher	1			1
Unidentified Sparrow			1	1
Unidentified Swallow		1		1
Violet-green Swallow			1	1
Western Tanager			1	1
Total	60	100	25	185

Appendix 4: Average number of on-plot neotropical migrant songbirds detected per permanent plot in each habitat stratum in Revelstoke Reach in spring 2016. No birds were detected on unvegetated plots (n=13).

Common Name	Habitat Strata	Forest	Shrub	Grassland	Overall
	N	12	53	52	130
Yellow-rumped Warbler	12	0.08	0.21		0.09
Savannah Sparrow	11		0.19	1	0.08
White-crowned Sparrow	11		0.21		0.08
Least Flycatcher	5	0.33	0.02		0.04
Yellow Warbler	5	0.33	0.02		0.04
Chipping Sparrow	3		0.06		0.02
Western Meadowlark	3		0.04	1	0.02
American Robin	2	0.08	0.02		0.02
American Redstart	1		0.02		0.01
Common Yellowthroat	1		0.02		0.01
Dark-eyed Junco	1		0.02		0.01
Orange-crowned Warbler	1		0.02		0.01
Ruby-crowned Kinglet	1		0.02		0.01
Tennessee Warbler	1		0.02		0.01
Unidentified Empidonax Flycatcher	1		0.02		0.01
Wilson's Warbler	1		0.02		0.01

Appendix 5: Average number of on-plot neotropical migrant songbirds detected per permanent plot in each elevation band in spring 2016

	Elev. Band (m ASL)	431	433	434	435	436	437	438	439
Common Name	**N**	**5**	**11**	**9**	**11**	**29**	**23**	**12**	**30**
Yellow-rumped Warbler	12					0.07	0.35		0.07
Savannah Sparrow	11					0.07	0.39		
White-crowned Sparrow	11						0.48		
Least Flycatcher	5							0.08	0.13
Yellow Warbler	5					0.03			0.13
Chipping Sparrow	3					0.03	0.04	0.08	
Western Meadowlark	3		0.09				0.09		
American Robin	2						0.04		0.03
American Redstart	1					0.03			
Common Yellowthroat	1							0.08	
Dark-eyed Junco	1							0.08	
Orange-crowned Warbler	1							0.08	
Ruby-crowned Kinglet	1					0.03			
Tennessee Warbler	1					0.03			
Unidentified Empidonax Flycatcher	1							0.08	
Wilson's Warbler	1								0.03

Appendix 6: Species and number of neotropical migrants detected during effectiveness monitoring surveys in spring 2016

Common Name	On plot	Off plot	Overhead	Total
Yellow Warbler	3	20		23
American Robin	1	11	6	18
Yellow-rumped Warbler	3	9		12
Chipping Sparrow	1	7		8
Least Flycatcher		8		8
Western Meadowlark	1	6		7
Lincoln's Sparrow	5	1		6
American Pipit			5	5
Northern Rough-winged Swallow		1	2	3
Tree Swallow			3	3
Unidentified songbird		1	2	3
Orange-crowned Warbler		2		2
Song Sparrow		2		2
Warbling Vireo		2		2
Western Wood-Pewee		2		2
White-crowned Sparrow	2			2
Barn Swallow		1		1
Hammond's Flycatcher		1		1
MacGillivray's Warbler		1		1
Savannah Sparrow		1		1
Unidentified Warbler		1		1
Total	16	77	18	111

Appendix 7: Species and number of neotropical migrants detected during random plot surveys in Revelstoke Reach in spring 2016

Common Name	On plot	Off plot	Overhead	Total
American Pipit	32	15	189	236
Yellow-rumped Warbler	24	4	4	32
Northern Rough-winged Swallow		6	16	22
Savannah Sparrow	13	9		22
Song Sparrow	14	5		19
Red Crossbill			17	17
Tree Swallow	2	1	9	12
Yellow Warbler	3	7		10
Evening Grosbeak			9	9
American Robin		8		8
Brown-headed Cowbird	1	4	2	7
Red-winged Blackbird	5	2		7
Ruby-crowned Kinglet	6	1		7
Common Yellowthroat	4	2		6
Pine Siskin		1	5	6
Chipping Sparrow	1	3	1	5
White-crowned Sparrow	3	2		5
Violet-green Swallow		1	3	4
Yellow-headed Blackbird	4			4
Barn Swallow			3	3
Eastern Kingbird		1	2	3
European Starling			3	3
Orange-crowned Warbler	1	2		3
American Goldfinch			2	2
Bank Swallow			2	2
Cedar Waxwing		2		2
Least Flycatcher		2		2
Lincoln's Sparrow	1	1		2
Pacific Wren	2			2
Unidentified Swallow			2	2
Warbling Vireo		2		2
Western Meadowlark	1	1		2
Cliff Swallow		1		1
Dark-eyed Junco		1		1
Unidentified Warbler			1	1
Western Tanager		1		1
Western Wood-Pewee		1		1
Wilson's Warbler		1		1
Total	117	87	270	474

Appendix 8: Average number of on-plot neotropical migrant songbirds detected per random plot in each stratum in spring 2016. No birds were detected on unvegetated plots (n=6).

	Habitat Strata	Forest	Shrub	Grassland	Wetland	Overall
Common Name	**N**	**24**	**22**	**20**	**22**	**94**
American Pipit	32	1.33				0.34
Yellow-rumped Warbler	24	0.25	0.82			0.26
Song Sparrow	14	0.29	0.09		0.23	0.15
Savannah Sparrow	13	0.04	0.14	0.25	0.18	0.14
Ruby-crowned Kinglet	6	0.25				0.06
Red-winged Blackbird	5				0.23	0.05
Common Yellowthroat	4				0.18	0.04
Yellow-headed Blackbird	4		0.05		0.14	0.04
White-crowned Sparrow	3	0.08	0.05			0.03
Yellow Warbler	3	0.12				0.03
Pacific Wren	2	0.08				0.02
Tree Swallow	2	0.08				0.02
Brown-headed Cowbird	1	0.04				0.01
Chipping Sparrow	1	0.04				0.01
Lincoln's Sparrow	1	0.04				0.01
Orange-crowned Warbler	1	0.04				0.01
Western Meadowlark	1			0.05		0.01
All species	117	2.71	1.14	0.3	0.95	

Appendix 9: Number of all birds and migrant songbirds detected using each substrate type on random plots in spring 2016

Substrate	Total Number of Birds	Number of Migrant Songbirds
Reed Canarygrass	36	35
Willow sp.	30	29
Cattail	9	9
Graminoid	13	9
Unknown	7	6
Birch	6	5
Bulrush	5	5
Alder sp.	4	4
Hardhack	4	4
Red Cedar	4	4
Hemlock	3	2
Compacted bare	1	1
Cottonwood	3	1
Leaf litter	1	1
Red Osier Dogwood	1	1
Aspen	1	0
Flooded Graminoid	6	0
Forbs	1	0
Mountain Ash	2	0
Mud	2	0
Sand	1	0
Sedge sp.	5	0
Water	18	0

Appendix 10: Number of random plots surveyed by dominant vegetation community

Strata	Code	Vegetation community	Spring		
			2009-2014	2016	Total
Forest	RF	Riparian Forest	42	4	46
	UC	Upland conifer	2	1	3
	UM	Upland mixed	15	6	21
Grassland	EG	Horsetail grassland	13	5	18
	MG	Mixed grassland	77	6	83
	PG	Sparse grassland	14	7	21
	RC	Reed canarygrass	17		17
	SG	Sedge grassland	37	5	42
Shrub	SH	Shrub savannah	133	24	175
	SR	Riparian shrub	10	9	19
Unvegetated	BE	Steep bedrock			
	RB	Rocky bank	7	1	8
	SB	Sand bank	2		2
	TH	Thalweg	29	2	31
	CR	Coarse Rocks			
	GR	Gravel	11	6	17
	SA	Sand	19		19
	SI	Silt	11	1	12
	UR	Urban			
Wetland	BF	Floating bog	7	1	8
	BR	Bulrush	8	2	10
	BS	Submerged buoyant bog	6	1	7
	CK	Creek	12		12
	CT	Cattail	2		2
	CW	Shrub wetland complex	12	1	13
	LD	Low elevation draw	18	5	23
	PO	Pond	57	5	62
	SW	Swamp	4		4
	WM	Wet meadow	29		29
	WS	Water Sedge	18	2	20