Columbia River Project Water Use Plan

Arrow Reservoir Operations Management Plan

Arrow Neotropical Migrant Use of Arrow

Implementation Year 6

Reference: CLBMON-39

Arrow lakes Reservoir: Neotropical Migrant use of the Drawdown Zone

Study Period: 2013

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

Year 6 (2013)

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Cover photo: Yellow-rumped Warbler (*Setophaga coronata*), Machete Island Banding Station, Revelstoke Reach, 2013. Photo: Michal Pavlik, CBA Ltd.

EXCUTIVE SUMMARY

In 2008, BC Hydro implemented CLBMON 39, a 10-year monitoring program designed to determine the effects of reservoir operations on neotropical migrant songbirds in Revelstoke Reach during fall migration. In the first three years of this study, research focused on the migration monitoring station at Machete Island. In 2011, monitoring in other habitats in Revelstoke Reach was implemented to assess the impacts of reservoir operations across the diversity of habitats throughout the Reach. In addition, spring monitoring of neotropical migrant songbirds in relation to the effectiveness of Wildlife Physical Works projects in Revelstoke Reach (CLBMON 11B-2) was incorporated into CLBMON 39 in 2011. This report summarizes the work that was conducted in Year 6 (2013).

In 2013, the CLBMON 39 study consisted of five major components: permanent plot surveys, effectiveness monitoring plot surveys, randomly selected plot surveys, constant effort mist netting and migrant physiology assessments.

In fall 2013, 98 permanent plots both in and outside of the drawdown zone were monitored. In total 882 surveys were conducted and 2,643 neotropical migrant songbirds of 53 species were recorded. The most frequently recorded migrant species on plot were Common Yellowthroat (*Geothlypis trichas*: 258 records) and Savannah Sparrow (*Passerculus sandwichensis*, 184 records). When controlling for the number of plots in each elevation band, the highest density of migrants was documented on plots from the 439 m elevation band (439–440 m). No migrants were recorded on plots in the three lowest elevation bands (431–433 m). A subsample of permanent plots was surveyed in spring 2013 (23 plots). In total, 160 surveys were conducted and 514 migrants of 32 species were recorded. The most often recorded species on plot was Yellow-rumped Warbler (*Setophaga coronata*: both Audubon's and Myrtle subspecies combined), with 55 records.

To monitor the response of migrants to BC Hydro revegetation projects, surveys of 23 effectiveness monitoring plots were conducted—14 treatment plots (planted with cottonwood stakes) and 9 control plots (untreated area located in similar habitat). In spring, 159 effectiveness monitoring surveys were conducted and 98 migrants of 9 species were recorded on plot. Of these, 23.5% of individuals and 8 species were recorded on cottonwood treatment plots and 76.5% of individuals and 4 species were recorded on control plots. In fall, 238 effectiveness monitoring surveys were conducted and 167 migrants of 13 species were recorded on plot. In fall, 75% of individuals and 11 species were recorded on cottonwood treatment plots and 25% of individuals and 10 species were recorded on control plots.

To monitor habitat use in the drawdown zone by migrants, randomly selected plots from five broad habitat strata were surveyed. In spring, 109 random plots were surveyed and 192 migrants (18 species) were recorded on plot, with an average density of 1.76 migrants per plot. The highest relative density (5.00 migrants/plot) was recorded in forest plots, followed by wetland plots (1.00) and shrub plots (0.93). No birds were detected on grassland or unvegetated plots. In fall, 100 random plots were surveyed and 86 migrants (22 species) were recorded on plot, with an average density of 0.86 migrants per plot. The highest relative density (1.67 migrants/plot) was recorded in wetland plots, followed by forested plots (1.45), grassland plots (0.81), shrub plots (0.16) and unvegetated plots (0.13). Habitat data were collected from 204 random plots.

In 2013, 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 for a total of 44 surveys and 2,400.0 net-hours. Airport Islands had an overall capture rate of 0.4051 birds/net-hour and a recapture rate of 17.6%. In total, 255 individuals from 14 species were captured, with Common Yellowthroat being the most frequently captured species (0.2129). At the Machete Island Banding Station, 1324 individuals from 38 species were captured, with an overall capture rate of 1.6015 birds/net-hour and a recapture rate of 16.9%. The most frequently captured species was Common Yellowthroat (0.4729). At Jordan River, 660 individuals of 46 species were captured, with an overall capture rate of 0.6993 birds/net-hour and a recapture rate of 16.1%. The most commonly captured species was Warbling Vireo (*Vireo gilvus*; 0.1505).

In 2013, 156 plasma samples were analysed (57 Common Yellowthroat, 42 Swainson's Thrush, 31 Yellow-rumped Warbler and 26 Yellow Warbler). No significant variation in estimated fattening rate (triglyceride) or glycerol among sites was found for any species in 2013. A multiyear analysis of data from 2011 and 2013 was also performed. There was no effect of year or site on variation in estimated fattening rate, supporting our results from 2008-2010. There was support for an effect of water level on glycerol for only one between-site comparison (Common Yellowthroat, pooled data from 2011 and 2013) but overall these data do not confirm a relationship between residual glycerol and water levels. All our data suggests that reservoir water levels do not significantly impact estimated fattening rates of neotropical migrants in Revelstoke Reach.

KEYWORDS

reservoir operations, neotropical migrants, songbirds, spring migration, fall migration, stopover habitat, Revelstoke Reach, Arrow Lakes Reservoir, British Columbia, BC Hydro, Common Yellowthroat, Yellow Warbler, Swainson's Thrush, Yellow-rumped Warbler, fattening rate

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Lesley-Anne Howes and Louise Laurin (Canadian Wildlife Service [CWS] Bird Banding Office) processed bird banding and capture permits. Dr. David Green and Dr. Tony Williams (Simon Fraser University) prepared text and figures on blood metabolite and feather isotope analyses. We also thank the community of Revelstoke for providing a safe and enjoyable home base for the field crew during the field season.

Michal Pavlik and John Cooper prepared this report.

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1 INTRODUCTION

Since the late 1980s, neotropical migrant birds have become a focus of wildlife managers due to population declines and threats to habitats in their breeding and wintering ranges (Terborgh 1989, DeSante and George 1994, Sherry and Holmes 1996). Neotropical migrant birds in North America include more than 200 species that generally breed north of the Tropic of Cancer, and at least 5% of the population winters south of that latitude (U.S. Fish & Wildlife Service 2011). This group of birds is comprised mainly of songbirds such as flycatchers, swallows, vireos, thrushes, warblers, sparrows and tanagers, but it also includes some species of waterfowl, raptors, gulls, terns, shorebirds, hummingbirds, swifts and others (DeGraaf and Rappole 1995). This report focuses on neotropical migrant songbirds.

Early research on the decline of neotropical migrant songbirds focused on the fragmentation of breeding habitat and destruction of tropical forests on wintering grounds (e.g., Robinson and Wilcove 1994). In the 1990s, however, attention turned to the importance of stopover habitat use during migration (e.g., Yong et al. 1998, Moore 2000). Neotropical migrant songbirds need to replenish energy reserves during migration and may stop at one or more sites during migration to refuel (e.g., Skagen et al. 2004). 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 less well known. Reductions in the availability of stopover habitat may lead to increased competition for limited food resources, thereby increasing stress levels or reducing the ability of migratory birds to gain the weight necessary to continue along their migration route. Both increased stress and reduced refuelling rates can lead to increased mortality during migration, thus resulting in a negative impact on migratory songbird populations (Alerstam and Hedenström 1998). To accommodate the needs of all migrant songbird species a wide variety of habitat types are needed (Suomala et al. 2010).

Revelstoke Reach is unique in the Columbia River reservoir network because it has a relatively flat floodplain with vegetated areas that are often inundated by water for only a few weeks each year. Vegetated areas include riparian cottonwood forest, willow scrublands, wetlands and grasslands, all of which provide habitat for neotropical migrant birds. Most of the rest of the Columbia River reservoir network has steep shorelines and long periods of high water levels, which precludes persistent vegetation (Bonar 1979) and provides little habitat for neotropical migrant birds. The wetlands, riparian forest and shrub-savannah areas of the upper portion of Revelstoke Reach provide high quality habitat for breeding and migratory birds (Tremblay 1993, AXYS 2002, Boulanger et al. 2002, Jarvis and Woods 2002, MCA 2003, Boulanger 2005, Green and Quinlan 2007, MCA 2009, CBA 2011a, 2012, 2013b, 2013c). In part, this habitat is the result of revegetation programs undertaken by BC Hydro to control dust in Revelstoke Reach (McPhee and Hill 2003).

CLBMON 39 Arrow Lakes Reservoir Neotropical Migrant Use of the Drawdown Zone Monitoring Program is one of several wildlife monitoring programs initiated by BC Hydro in 2008 as a result of the water use planning process. Many factors determine reservoir water levels during any given time period (BC Hydro 2005). The soft constraint developed for Arrow Lakes Reservoir relevant to songbird migration was to:

- ensure that the availability of migratory bird habitat in the fall is as good as or better than that which has been provided on average over recent history (1984–1999). Draft the reservoir quickly after full pool (defined as 440.1 m under the

Columbia River Treaty) is reached, targeting a reservoir level of 438 m or lower by August 7.

The Columbia River Water Use Planning Consultative Committee (BC Hydro 2005) recommended that monitoring be conducted to determine how variation in reservoir levels and the implementation of soft constraints affects the abundance and habitat use of neotropical migrant songbirds in Revelstoke Reach during the fall migration by capitalizing on data gathered at the long-term migration monitoring station on Machete Island (Jarvis and Woods 2002, MCA 2009, CBA 2010c, CBA 2011b). More than 60 species of neotropical migrants have been recorded at the migration monitoring station during fall migration (Jarvis and Woods 2002, Easton 2007, MCA 2009).

In 2008–2011 in addition to population monitoring, indicators of physiological health were measured through analyses of blood metabolites. Plasma metabolite assays provide a means of assessing fattening rates of neotropical migrants (Jenni-Eiermann and Jenni 1994). Feather samples were also taken from four focal species for isotope analysis. These isotopes can be used to determine the latitude at which a migratory bird spent the breeding season, and will allow us to distinguish between birds that spent the summer relatively near the study area and those that were migrating from farther north of the area.

In 2011, monitoring of neotropical migrant songbirds in other habitats throughout Revelstoke Reach was implemented to assess the impacts of reservoir operation across the diversity of habitats throughout the reach. Further, monitoring of spring songbird migration under CLBMON 11B-2 has been incorporated into CLBMON 39.

CLBMON 39 is designed to provide information that will support future decisions about how to manage the operating regime of the Arrow Lakes Reservoir in order to protect neotropical migrant songbird populations during migration. The results of this monitoring program will influence the selection of an operating regime for the Arrow Lakes Reservoir that balances ecological health with recreational opportunities, flood control, power generation and other water use plan requirements.

This report provides results of Year 6 of the 10-year study and discusses progress made from 2008-2013 towards answering management questions posed in the Terms of Reference for the project.

1.1 Scope and Objectives

CLBMON 39 is a 10-year program specifically designed to:

1) Determine the migration patterns of migratory songbirds in Revelstoke Reach (within season, across seasons, and across years).
2) Determine habitat use by neotropical migrants in the drawdown zone of Revelstoke Reach over time (within season, across seasons, and across years) and the impacts of reservoir operations on habitat availability and quality.
3) Assess whether reservoir operations affect populations of neotropical migrants that use the area as a stopover site.
    a) Examine the effects of reservoir operation on the abundance, diversity, habitat availability, and physiological health of neotropical migrants in Revelstoke Reach.

b) Identify species or populations including endangered or threatened species (provincially or federally listed species) that have a higher likelihood of being affected by reservoir operations.

4) Determine whether there are specific times during the migratory seasons when minor adjustments to flow rates or water levels will enhance the ability of the drawdown area to support neotropical migrants.

5) Evaluate and inform physical works or revegetation designed to mitigate reservoir operations by enhancing riparian habitat for neotropical migrants.

1.2 Management Questions

BC Hydro has provided nine specific management questions that are to be addressed at the completion of CLBMON 39. These are repeated verbatim below:

1) What is the seasonal and annual variation in the abundance and diversity of neotropical migrants in Revelstoke Reach?

2) Which habitats within the drawdown zone in Revelstoke Reach are utilized by neotropical migrants and what are their characteristics?

3) Does the operation of Arrow Lakes Reservoir impact the availability or quality of stopover habitat in Revelstoke Reach for neotropical migrants?

4) Do reservoir operations influence the diversity or abundance of neotropical migrants using stopover habitat within the drawdown area during migration? If so, how do reservoir operations influence the species richness or abundance?

5) Which neotropical migrants (e.g., species or guilds) are most affected by reservoir operations?

6) Do reservoir operations affect the physiological health of neotropical migrants using the drawdown zone during fall migration?

7) Can operational adjustments be made to reduce impacts on neotropical migrants during migration or are mitigation measures required to minimize the loss of stopover habitat?

8) Are the revegetation and the wildlife physical works projects effective at enhancing habitat for neotropical migrants in the drawdown zone?

9) Are some methods or techniques more effective than others at enhancing habitat for neotropical migrates in the drawdown zone? (e.g., the planting or enhancement of certain riparian vegetation).

1.3 Management Hypotheses

The primary hypotheses to be tested by this study are as follows:

H1: Annual and seasonal variation in reservoir levels and the implementation of soft operational constraints do not influence neotropical migrants using riparian habitat in the drawdown zone of Revelstoke Reach during spring or fall migration.

H_{1A}: Changes in the diversity of neotropical migrants in Revelstoke Reach are not attributable to reservoir operations.

H_{1B}: Changes in the abundance of neotropical migrants in Revelstoke Reach are not attributable to reservoir operations.

H2: Annual and seasonal variation in reservoir levels and the implementation of soft operational constraints do not influence the availability or quality of stop-over habitat for neotropical migrants.

H3: Annual and seasonal variation in reservoir water levels and the implementation of the soft constraints do not affect the health or population fitness of neotropical migrants as measured by plasma metabolite levels, abundance of riparian species, and age class ratios.

H4: Revegetation does not change the utilization of the drawdown zone by neotropical migrants as measured by diversity or abundance.

H5: Wildlife physical works projects do not change the utilization of the drawdown zone by neotropical migrants as a measure of increased species diversity or abundance.

The manner in which the relevant management hypotheses are related to the management questions and objectives is outlined in Appendix 1.

1.4 Study Areas

The CLBMON 39 study area was defined as the drawdown zone of Revelstoke Reach. Revelstoke Reach is the northernmost arm of the Arrow Lakes Reservoir south of Revelstoke, B.C., between the Monashee and Selkirk Mountains (Figure 1). This hydroelectric reservoir, regulated by the Hugh Keenleyside Dam near Castlegar, B.C., is licensed to operate between 420 m and 440.1 m elevation under constraints imposed by the Columbia River Treaty. The drawdown zone is the area between these reservoir elevation extremes. 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).

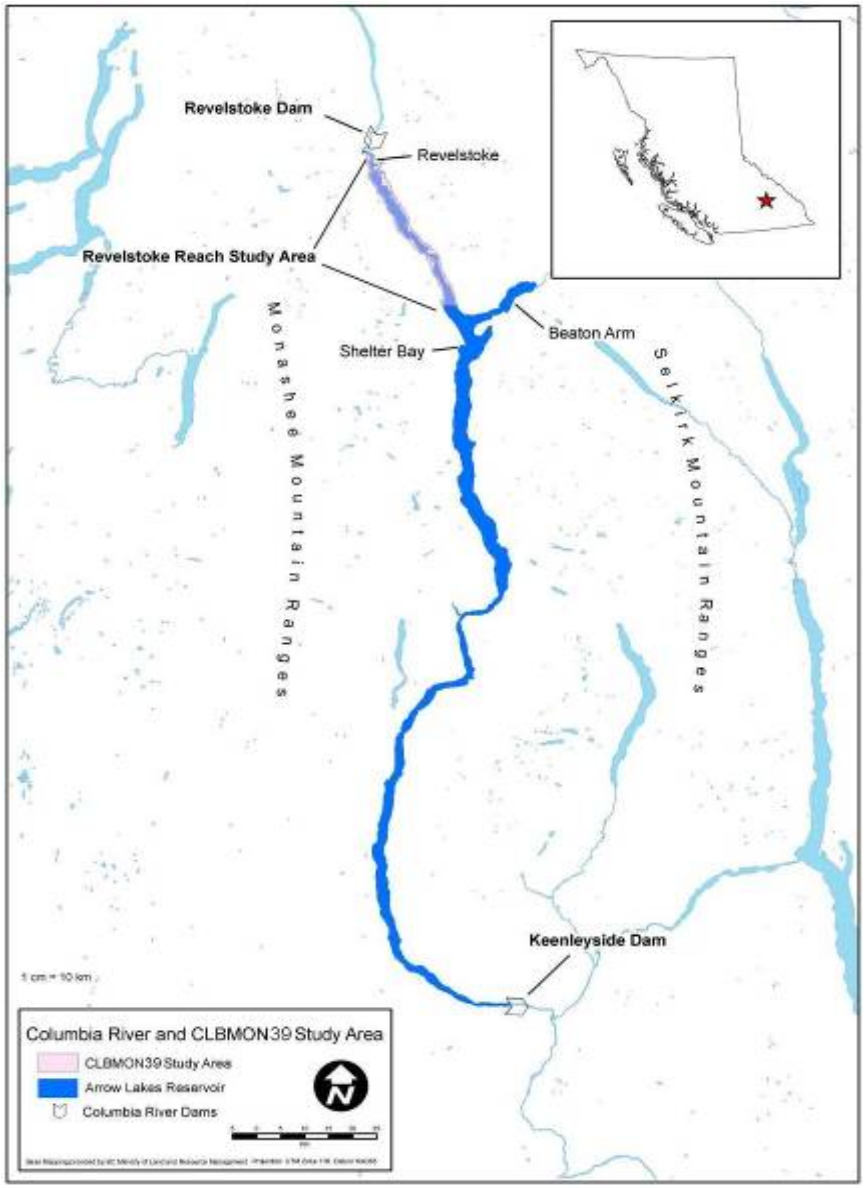

Figure 1: CLBMON 39 study area in Revelstoke Reach, Arrow Lakes Reservoir

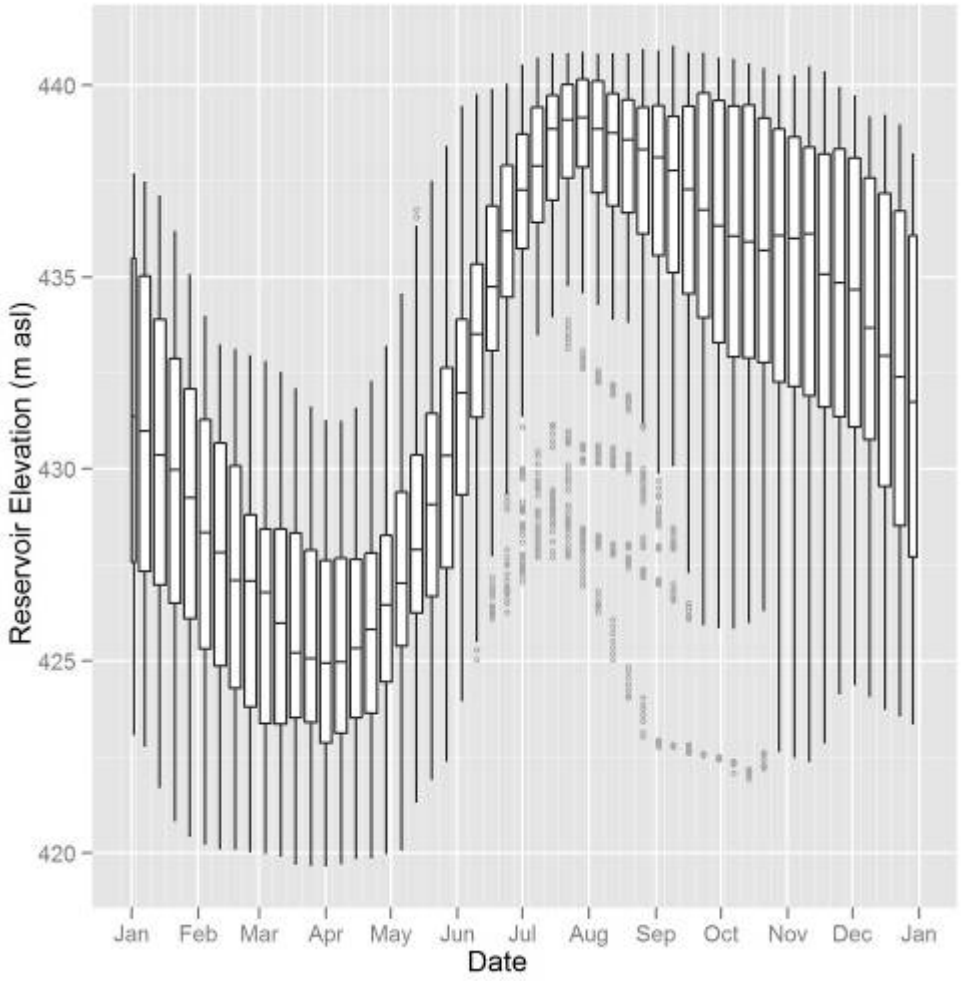

Figure 2: **Historical hydrological data from Arrow Lakes Reservoir (1968–2008) plotted in weekly intervals**

Revelstoke Reach contains the Columbia River as it flows south from the Revelstoke Dam towards the Arrow Lakes Reservoir, and is comprised almost entirely of drawdown zone habitats. The Revelstoke Reach drawdown zone includes most of the level valley bottom habitat in the area, which is characterized as a sandy-soiled floodplain with subtle topography shaped by the erosion and deposition of material from the Columbia River, and includes 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 is a reflection of 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 (elevation ~431 m), 12 Mile area, May 10, 2012

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 (elevation ~436 m), Airport West area, May 16, 2012**

Figure 5: **Example of shrub habitat in Revelstoke Reach (elevation ~438 m), Illecillewaet area, May 15, 2012**

Near the full pool elevation (439 m to 440 m), some patches of mature cottonwood riparian habitat occur, but this habitat type is uncommon throughout the Revelstoke Reach drawdown zone. The most extensive patches occur at Machete Island and on the banks of rivers entering the drawdown zone (e.g., the Illecillewaet and Columbia Rivers) (Figure 6).

Figure 6: Example of riparian forest habitat in Revelstoke Reach (elevation ~439 m), Illecillewaet area, May 15, 2012

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*).

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. Larger stakes were planted with the aid of a small excavator; smaller stakes were hand planted. 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).

Figure 7: Example of site planted with cottonwood stakes (Wildlife Physical Works project) in Revelstoke Reach (elevation ~438 m), 12 Mile area, May 2, 2012

In the first three years of CLBMON 39 (2008–2010), the main study site was confined to Machete Island, a treed upland area of about 30 ha located between the north end of the Revelstoke Airport and the confluence of the Columbia and Illecillewaet Rivers (MCA 2009). The migration monitoring station (Machete Island Banding Station) was established at the location of the former Columbia River Revelstoke migration monitoring station and was operated on a daily basis (MCA 2009). In addition to the main effort at the banding station, a census route at Machete Island was surveyed in 2009 and 2010, and two additional census routes were surveyed in 2010 at Cartier Point and 12 Mile (CBA 2011b). In 2011, in order to comply with the renewed Terms of Reference and to effectively address all management questions, the scope of CLBMON 39 was expanded, and new study sites were selected within and outside the drawdown zone.

2 METHODS

An overview of approaches used to answer CLBMON 39 management questions (MQ) and hypotheses is provided in Appendix 1. A brief overview of methods used in 2013 is provided below. For a detailed account of these methods, refer to the CLBMON 39 protocol report (CBA 2013d).

2.1 Permanent Plot Sampling

A permanent plot survey approach was incorporated into the CLBMON 39 study design in 2011 to determine seasonal and annual variation in diversity and abundance of migratory songbirds and the effect of water levels (reservoir operations) on songbird stopover habitat availability and quality (MQ 3). Data from permanent plots, combined with data from the banding station, will be used to:

- assess whether reservoir operations affect neotropical migrants that use the area as a stopover site (MQ 4 and MQ 5);
- determine the migration patterns of migratory songbirds in Revelstoke Reach over time (MQ 1); and
- determine whether there are specific times during the migratory season when minor adjustments to flow rates or water levels will enhance the ability of the drawdown area to support birds (MQ 7).

In 2011, permanent plots were established in five broad habitat strata (wetland, grassland, shrub, forest and unvegetated habitats) both in and outside of the drawdown zone. Permanent plots were 50 x 50 m (and in a few cases irregularly shaped following natural vegetation/terrain contours) and 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 was followed by 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. Because reservoir levels directly affect habitat only within the drawdown zone, permanent plots above the drawdown zone were classified into two elevation bands just above the full pool level (440 m and 441 m), and all plots above 442 m were pooled into one elevation band (≥ 442 m). 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 (e.g., willow-dominated shrub), but in cases where there was great habitat heterogeneity at certain elevation bands, 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). As a result, the following corrections to the permanent plot classification were made:

1. Elevation band was adjusted for three plots at Montana Bay. Although these plots are located in the 436 m elevation band (based on digital elevation models), they are situated on a floating peat island and remain afloat even during full pool water levels. Therefore, we reclassified them into the 440 m elevation band.
2. 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

3. 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.

In 2011, 97 permanent plots were established; in 2012, a shrub plot above the drawdown zone was added. The stratification of permanent plots surveyed in fall 2013 is shown in Table 1.

Table 1: Stratification of permanent plots and number of plots within each habitat stratum and elevation band (DDZ = drawdown zone) surveyed in fall 2013

Stratum	Above DDZ (m)			In DDZ (m)									Total
	≥ 442	442–441	441–440	440–439	439–438	438–437	437–436	436–435	435–434	434–433	433–432	432–431	
Forest	8	5	3	10	4	4	-	-	-	-	-	-	34
Shrub	4	-	5	-	7	8	5	-	-	-	-	-	29
Grassland	2	2	-	2	7	2	4	4	3	2	-	-	28
Unvegetated	1	-	-	-	-	-	-	-	1	2	1	2	7
Grand Total	15	7	8	12	18	14	9	4	4	4	1	2	98

In 2013, a subset of 23 permanent plots was surveyed in spring (Table 2). Since water levels in the spring are usually low (Figure 2), only the lowest elevation plots are likely to be affected at that time of year. We sampled these plots in spring primarily to document the use of the lower elevation plots (which are usually underwater during fall surveys) by neotropical migrants during dry conditions and to investigate changes in the use of these habitats based on the length of time they were flooded in the previous year.

Table 2: Stratification of permanent plots and number of plots within each habitat stratum and elevation band (DDZ = drawdown zone) surveyed in spring 2013

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	-	-	-	-	-	-	5
Shrub	-	1	2	3	-	-	-	-	-	6
Grassland	1	1	1	2	2	1	1	-	-	9
Unvegetated	-	-	-	-	-	1	1	-	1	3
Total	4	2	5	5	2	2	2	-	1	23

Plots were sampled once per week during the survey period, and surveys were conducted during the first 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 the survey, weather conditions were recorded. At each plot start time, the percent of the plot that was flooded, the average water depth and whether the plot was completely underwater (no vegetation available) were recorded. One observer then documented bird occurrence and behaviour within plot for at least 10 minutes or until census saturation time (CST—the shortest time interval in which the observer was able to count all birds on the plot) was reached. The observer then moved to the next plot. If the plot was completely underwater and no vegetation was visible, the observer recorded general plot survey data and surveyed the plot for at least 1 minute or until CST 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 10-minute survey. Bird observations were recorded by minute (minutes from start). Only one observer was required to sample the plots, but two observers usually worked in the same study area at the same time for safety reasons.

During the survey period, the observer moved slowly around the plot (on foot or in a kayak) to detect birds that may have been hidden within the plot. Data recorded included CST; bird detections before and after CST; bird species, number, sex, age, migratory status, behaviour and location (on plot, off plot, overhead); bird detections based on visual confirmation; bird detections based on flushing from the vegetation; substrate type being used; and height from the ground when the bird was first detected. For each bird observation, the distance from the observer was estimated.

2.2 Effectiveness Monitoring Plot Sampling

The permanent plot before and after control impact survey approach was selected to determine if revegetation and wildlife physical works (WPW) projects are effective at providing or enhancing stopover habitat for migratory neotropical songbirds. This approach will be used to evaluate and inform physical works and revegetation (MQ 8 and MQ 9) and provide guidelines for enhancing habitat for migrating songbirds.

To monitor the response of neotropical migrant songbirds to revegetation and WPW projects, 27 effectiveness monitoring plots were established. Sixteen treatment plots

(planted with cottonwood stakes) and 11 control plots (untreated area located in similar habitat) were monitored for spring migrant use in spring 2010 and 2011 under CLBMON 11B-2 (CBA 2010a, CBA 2011a) and in fall 2012 under CLBMON 39 (CBA 2012). In 2013, surveys of four plots (two treatment plots and two control plots) were discontinued due to their small sizes and irregular shapes. Therefore in 2013, 23 effectiveness monitoring plots were surveyed, 14 treatment plots and nine control plots.

Sampling of effectiveness monitoring plots followed the same protocols used for the permanent plot sampling. Both treatment and control plots were surveyed once per week. Typically, all effectiveness monitoring plots were surveyed on the same day.

2.3 Random Plot Sampling

A random plot survey approach was selected to determine habitat use by neotropical migrants in the drawdown zone (MQ 2), and data collected will help address MQ 1, MQ 3 and MQ 7. GIS will also be used to model seasonal habitat availability under varying reservoir levels. Habitat use data from both permanent and random plot surveys will then be compared to habitat availability to determine trends in habitat selection in response to reservoir levels.

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 well-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.

Sample plots were 50 x 50 m. Using GIS, we overlaid a 50-m grid on the study area and identified the primary vegetation categories on a presence-absence basis. Each plot was assigned to one of six habitat strata:

1. Wetland: Wetlands are a heterogeneous group of semi-aquatic habitats that occur in the vegetated elevations of the drawdown zone. For random plot surveys we identified these strata by the presence of shallow water with emergent vegetation, including grasses that are ephemerally flooded in spring. The edges of ponds or lakes could be assigned to this stratum.
2. Forest: Forested sites occur only in the upper part of the drawdown zone above 439 m. They include the CLBMON 33 classification CR (Cottonwood riparian), and are characterized by the presence of trees (> 10 m).
3. Shrub: Shrub sites do not contain trees, but saplings or shrubs are present, and grasses cover the ground. These sites occur above 436 m elevation. Sites with shrub growth include CLBMON 33 classifications PA (Redtop upland) and RS (Willow stream entry).
4. Grass-dominated: Grasslands occur above 433 m elevation and are vegetated by a sparse to thick covering of grass. They could be classified by CLBMON 33 as PC (Reed canary grass mesic), PE (Horsetail lowland), LO (Blue Wild rye log zone), or RR (Reed rill). In the absence of appropriate orthoimagery, we assumed that sites between 434 m and 436 m were vegetated by pure grass.
5. Non-vegetated: These sites have little or no vegetation, and may consist of mud, sand, gravel, boulders, bedrock, or cobbles. This stratum includes sites classified by CLBMON 33 as BB (Boulders, steep), BG (Gravelly beach), SS (Steep sand) and BE

(Beach). Some sites classified as CL (Cliffs and rock outcrops), or WR (Silverberry river entry) could also be classed as non-vegetated.

6. Open water: These sites were defined as being permanently covered in water and without emergent vegetation. Examples include plots located in the middle of a pond, lake, or river channel.

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 was assigned as a wetland plot. A plot with shrub and forest was assigned as a forest plot. In spring 2013, in addition to the above mentioned stratification, random plots composed of vegetation communities that have not yet been surveyed or have been surveyed with only a limited effort were prioritized.

Random plot sampling mainly followed methods developed for CLBMON 11B-2 (CBA 2009, 2010b). Every week at least one plot from each stratum was surveyed (Appendix 3), but due to high water levels, not all strata were available for survey. Plots containing 100% open water were not sampled. Cooper Beauchesne and Associates Ltd.'s (CBA) GIS specialist coordinated the random selection of sampling plots and provided centroid coordinates and plot boundaries for the plots. These were then uploaded to a GPS device. Field staff examined the centroid coordinates and plot boundaries using Google Earth in order to determine how best to access the sites, and how to sample them in a logistical manner (e.g., by working different regions on different occasions).

Prior to conducting each survey, observers familiarized themselves with the plot boundary by walking around the plot and flagging the corners or edges, as necessary, using flagging tape and/or pinflags. Sampling then followed the same procedures used for the permanent plot sampling. Because each plot was surveyed only once, surveys were conducted for 30 minutes. After the survey was completed, habitat and vegetation data were collected at each plot.

In 2013, random plot sampling was initiated at the beginning of April and at that time random plots to be surveyed were selected solely on their broad habitat strata classification. Mid way through the spring sampling effort, after the new stratification of the study area was completed, surveys of the plots containing undersampled vegetation communities were prioritized.

2.4 Constant Effort Mist Netting and Neotropical Migrant Physiology Sampling

Constant effort mist netting, with its largely consistent capture effort each year, provides a means of assessing seasonal and annual variation in the abundance, diversity, juvenile/adult ratio and stopover length of neotropical migrants within the banding station area. To investigate reservoir level effects, banding stations were set up at different elevations both in and outside of the drawdown zone. An advantage of the mark-recapture (banding) approach is that we can separate high detection rates caused by (small) populations that are using the site over an extended period of time (e.g., where individuals could be counted repeatedly over time) from high detections caused by (large) populations that spend very little time at the site.

Data from the migration monitoring station(s) will be used to:

- determine the migration patterns of migratory songbirds in Revelstoke Reach over time (MQ 1);
- assess whether reservoir operations affect neotropical migrants that use this area as a stopover site (MQ 4 and MQ 5); and

- determine whether there are specific times during the migratory season when minor adjustments to flow rates or water levels will enhance the ability of the drawdown area to support birds (MQ 7).

Data collected at the migration monitoring stations will also be used to interpret results from other aspects of the study.

In 2011-2012, five sites were surveyed by mist netting. In 2013, the survey effort was focused on three sites to allow for more frequent monitoring. Two sites were in the drawdown zone and one site was outside of the drawdown zone (Table 3). In 2013, each of the three study sites was sampled by mist nets at least once per week (if possible). At each site, net lines were prepared and net poles were installed to facilitate net opening in the morning. Usually, 9–13 mist nets were opened at a site, but the number of nets used varied depending on the number of birds being captured so that the crew of two people could safely handle and band all birds captured.

Table 3: CLBMON 39 constant effort mist netting and physiological health monitoring sites (DDZ = drawdown zone)

Site	Within DDZ?	Mean Elevation (m)	Description	Comments
Machete Island	Yes	439	Higher elevation riparian site	Machete Island Banding Station net lines
Airport Islands	Yes	437	Lower elevation riparian site	Mostly willow dominated with some cottonwood; lower elevation site; unique for its isolation—one of a few patches of shrubs in the middle of grassy flats
Jordan River	No	475	Control outside of the drawdown zone	Riparian shrub along Jordan River (willow and dogwood dominated) and under powerline; well outside of drawdown zone

Nets were opened 30 minutes before sunrise by putting them on the pre-installed poles. Special care was taken to keep the bottom trammels of the nets about 30 cm off the ground to prevent large birds caught in the bottom shelf from sagging into wet grass. If the net lane was partly flooded or there was standing water below the net, the bottom trammel of the net was kept about 60 cm off the water surface to ensure that no birds sagged into the water (Figure 8). The opening time was recorded as the time when the first net was opened, and nets remained open for 6 hours, unless it was necessary to close the nets due to rain, high winds, or too many birds being captured to process in a suitable time frame. Any net closures and reopening times were recorded so that an accurate count of “net-hours” could be made. Net-hours are the number of hours one 12-m mist net is open (one 12-m long mist net in operation for one hour = one net-hour).

Figure 8: **Net lane flooded by high water levels, Airport Islands Banding Station (elevation ~437 m), August 21, 2012**

To prevent data bias, no “pishing”, artificial lures, feeders, brush crashing or vegetation clearing was permitted closer than 10 m to open nets during migration monitoring periods.

Every 30 minutes after nets were opened, staff visited each net and extracted all birds. To carry the birds, staff used holding bags with uniquely coloured and numbered clothes pegs that identified which net the bird was captured in, and whether the bird was a focal species, a recaptured banded bird, or a “new” (unbanded) bird. After all nets were checked and all birds were removed from the net, staff returned directly to the banding location to band and process the birds. The bander-in-charge then removed each bird from its holding bag and began the banding process. The bird was examined and the species was determined. Birds were then banded, aged and sexed, and wing chord, tail length, degree of skull ossification, moult, fat score and weight were noted on the data sheet.

In order to ensure that each net was open for a similar length of time in each sampling session, nets were closed in the same order as they were opened. Nets at the Machete Island Banding Station were left on the poles, furled tightly closed, and tied with short pieces of string in three or four places along the length of the net. Nets at all other study sites were taken down and packed into mist net bags.

2.4.1 Neotropical migrant songbird physiology

Four species of neotropical migrants were preselected for studies on physiological health: Yellow Warbler (*Setophaga petechia*), Common Yellowthroat (*Geothlypis trichas*), Swainson's Thrush (*Catharus ustulatus*) and Yellow-rumped Warbler (*Setophaga coronata*).

2.4.1.1 Blood metabolite sampling

Focal species captured in the mist nets were retrieved and placed in specially marked (colour-coded) holding bags. The order in which individuals were blood sampled was prioritized by species (species with the fewest blood samples were processed first) and then extraction time. We attempted to obtain blood samples from four hatch year or juvenile (HY) birds, four after hatch year or adult (AHY) males and four AHY females of each species captured in every month, with the total number of samples being no more than 30 samples/location/species (total 90/species).

Numbers of samples per species/habitat

Within drawdown zone–higher elevation site (Machete Island): 30 blood samples per species

Within drawdown zone–lower elevation site (Airport Islands): 30 blood samples per species

Control site outside drawdown zone (Jordan River): 30 blood samples per species

Maximum total number of samples per species

Common Yellowthroat: 90 blood samples
Yellow Warbler: 90 blood samples
Swainson's Thrush: 90 blood samples
Yellow-rumped Warbler: 90 blood samples

Blood samples were not collected if:

- the bird was caught in the first hour of the day;
- the bird had already been captured and blood sampled at the migration station;
- the bird was injured or clearly stressed;
- the bird had been held captive for more than one hour; or
- the sampling quota for individuals of that species, sex and age class had been met.

Blood samples were collected before feather samples were collected and before birds were banded, sexed, aged and measured. Blood was collected in the field by puncturing the brachial vein and collecting the blood into heparinised capillary tubes (Owen 2011). Up to 1.5 hematocrit tubes for small warblers (Yellow Warbler, Common Yellowthroat and Yellow-rumped Warbler) and up to 3 hematocrit tubes for Swainson's Thrush (max 75 µl i.e. 10% of blood volume or 1% of body mass) were collected from an individual. Collected blood samples were packed in ice until the field accommodation was reached, Then they were processed in a hematocrit centrifuge spinning at 12,000 rpm for 6 minutes in order to separate the plasma from the red blood cells. The amount of blood, plasma and packed red blood cells in each tube was measured and recorded using digital callipers. The plasma was collected into sterile 0.6 ml micro-centrifuge tubes and

stored in a -20°C freezer. Plasma samples were packed in ice prior to being transported to the metabolite lab at Simon Fraser University (SFU), where they were stored in a

-80°C freezer prior to analysis.

Plasma samples were diluted 1:2 with ddH2O in order to increase plasma volume available for assay (concentrations of assayed metabolites diluted linearly). All assays were run in 400-µL, flat-bottom 96-weII microplates (NUNC, Denmark) and read with a microplate spectrophotometer (Biotec 340EL or Powerwave X 340), as previously described (e.g., Acevado Seaman et al., 2006, Williams et al., 2007). Not all metabolites could be determined for all individuals, because of small plasma volumes; on the basis of previous studies, we prioritized triglyceride and glycerol assays. Free glycerol and total glycerol were assayed via sequential color endpoint assay (Sigma-Aldrich Canada, Oakville, Ontario), using 5 µL of plasma with 240 and 60 µL of glycerol reagent (A) and triglyceride reagent (B), respectively, with a reading taken at 540 nm after 10 min of incubation at 37°C after the addition of each reagent. Plasma triglyceride concentration (mmol L–1) was calculated by subtracting free glycerol from total glycerol. Inter-assay coefficient of variation was 3.7% (n=5 assays).

2.4.1.2 Feather isotope sampling and preparation

Feather samples were collected from the same individuals that were sampled for blood. We attempted to collect feather samples from four HY birds, four AHY males and four AHY females of each species, with the total number of samples being no more than 30 samples/location/species (total 90/species).

Numbers of samples per species/habitat

Within drawdown zone–higher elevation site (Machete Island): 30 feather samples per species

Within drawdown zone–lower elevation site (Airport Islands): 30 feather samples per species

Control site outside drawdown zone (Jordan River): 30 feather samples per species

Maximum total number of samples per species

Common Yellowthroat: 90 feather samples
Yellow Warbler: 90 feather samples
Swainson's Thrush: 90 feather samples
Yellow-rumped Warbler: 90 feather samples

Feather samples were not collected if:

- the bird was caught in the first hour of the day;
- the bird had already been captured and feathers had been collected;
- the bird was injured or clearly stressed;
- the bird had been held captive for more than one hour; or
- the sampling quota for individuals of that species, sex and age class had been met.

Feather samples were collected after blood samples were taken and individuals had been assigned to a sex and age class (HY/AHY) but before they were banded and measured. Feathers were collected from two different feather blocks on each bird by

pulling two primary coverts and one tail rectrix. We attempted to collect the second right primary covert (pc2) and the fourth right tail rectrix (r3) from each individual. All the feather samples from each individual were placed together in a paper envelope. At the end of each day, the collected feather samples were transferred in a small plastic box to the field accommodation and were stored in a cool dark room until they were transferred to Simon Fraser University. The feather samples were sorted in the SFU lab and were prepared for shipping. They were then shipped to the University of California (Davis) for feather isotope analyses.

2.5 Habitat Monitoring

In 2013, vegetation data were collected at all surveyed random plots. For a detailed vegetation sampling protocol see CBA monitoring protocol (CBA 2013d).

2.6 Data Collection and Management

All field data recorded on data sheets and in field notebooks were entered into digital databases (MS Excel format) or an online app on a regular basis and were subsequently imported into an Access database, which was backed up weekly onto an external hard drive that was stored off site. Newly entered data were reviewed for inconsistencies, and at the end of the field season, all digital data were thoroughly proofed for errors or inconsistencies relative to the original data sheets and field notebooks.

Banding data were entered into Bandit 3.0 software, which the Bird Banding Office (CWS) uses for the submission of banding data. Banding data collected by CBA in 2013 were submitted to the Migratory Bird Populations Division–Bird Banding Office in Ottawa by December 15, 2013.

Records of provincially listed birds were entered into 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 review progress made in Year 6 (2013). The following summaries are provided:

- methods employed
- species and number of birds detected on permanent plots by season, habitat type and location
- species and number of birds detected on effectiveness monitoring plots by season, habitat type and location
- species and number of birds detected on random plots by season, habitat type and location
- vegetation and habitat data collected
- species and number of birds captured by constant effort mist netting

Capture rate (for newly captured birds) was calculated as the number of newly captured birds divided by the number of net-hours. Same-day recapture rate was calculated as the number of same-day recaptures divided by the number of newly captured birds.

Recapture rate was calculated as the number of recaptures (excluding same-day recaptures) divided by the number of newly captured birds. Total (overall) capture rate was calculated as the total number of captured birds (new, recaptures and unbanded birds) divided by the number of net-hours.

Blood metabolite analyses were performed using 'proc GLM' from SAS statistical software (v. 9.2; SAS Institute). Plasma metabolite (triglyceride or glycerol) was the dependent variable, year or site was a main effect, and body mass, handling time, time of day and Julian date were used as covariates. Concentration of metabolites were log10(+1) transformed. For all analyses sex and age were pooled together. Daily water depth at the banding station was calculated as the elevation of the banding stations minus current reservoir elevation such that negative values indicate that the site is inundated by water.

Unless otherwise state, all other data summaries were produced using MS Excel and the program R (R Development Core Team 2006).

3 RESULTS

3.1 Reservoir Operations of Arrow Lakes Reservoir in 2013

During the entire spring survey season (April–May), the reservoir levels were higher than the long-term average (Appendix 2). On April 1, 2013 water level was 430.2 m ASL and remained relatively stable for the rest of April. In May, water started to rise and by the end of May water level reached 435.0 m ASL.

During the 2013 fall study period, water levels of the Arrow Lakes Reservoir were lower than the long-term average. Year 2013 had the lowest observed water levels of the last 6-year fall survey period. At the beginning of the fall survey period, the reservoir levels were at 436.6 m ASL (on August 1, 2013), and gradually descended to 431.8 m ASL by the end of the fall season (September 30, 2013) (Appendix 2).

3.2 Permanent Plot Sampling

3.2.1 Spring surveys

Between April 19 and May 27, 2013, 23 permanent plots were surveyed once per week for a total of 160 surveys.

In total, 746 individual birds of 60 species were recorded (Appendix 4, Appendix 5). Neotropical migrant songbirds accounted for 514 individuals (68.9%) and 32 species (53.3%). Of these, 197 individuals were recorded on plot, 269 individuals were recorded off plot and 48 individuals were recorded flying over the plot (Appendix 5).

The most common species of neotropical migrant songbird recorded on plot was Yellow-rumped Warbler (Audubon's and Myrtle subspecies combined: 55 individuals). Other species with more than 10 records included Ruby-crowned Kinglet (*Regulus calendula*: 39 individuals), Savannah Sparrow (*Passerculus sandwichensis*: 36), White-crowned Sparrow (*Zonotrichia leucophrys*: 18) and Common Yellowthroat (12). In addition, 13 other species (38 individuals) were recorded; they had less than 10 records each (Appendix 5).

Fourteen species of neotropical migrant songbirds were recorded off plot and/or flying overhead but not on plot (Appendix 5). They included American Pipit *(Anthus rubescens*: 87), Tree Swallow (*Tachycineta bicolor*: 20), American Goldfinch (*Spinus tristis*: 20) another eleven species which had less than 10 records each: American Redstart (*Setophaga ruticilla*), American Robin (*Turdus migratorius*), Brown-headed Cowbird (*Molothrus ater*), Hammond's Flycatcher (*Empidonax hammondii*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*) , Orange-crowned Warbler (*Oreothlypis celata*), Townsend's Warbler (*Setophaga townsendi*), Violet-green Swallow (*Tachycineta thalassina*), Western Meadowlark (*Sturnella neglecta*), Western Wood-peewe (*Contopus sordidulus*) and Wilson's Warbler (*Cardellina pusilla*).

When controlling for the number of plots in each of the elevation bands, the number of on-plot neotropical migrant songbirds detected per plot over the entire spring season was highest in the 437 m elevation band (21.80 birds per plot over the season), followed by the 439 m elevation band (13.25 birds per plot over the season), 436 m elevation band (5.40), 438 m elevation band (4.00) and 435 m elevation band (0.50). No neotropical migrant songbirds were detected on plot in the 431 m–434 m elevation bands (Appendix 6).

3.2.2 Fall surveys

Between August 1 and September 27, 2013, 98 permanent plots were surveyed once per week for a total of 882 surveys.

In total, 3,931 birds of 110 species were recorded (Appendix 4, Appendix 7). Neotropical migrant songbirds accounted for 2,643 birds (67.2%) and 53 species (48.2%). Of these, 1,270 individuals were recorded on plot, 739 individuals were recorded off plot, and 634 individuals were recorded flying over the plot (Appendix 7).

The most frequently recorded species of neotropical migrant songbird on plot was Common Yellowthroat (258 individuals). Other species with more than 50 records each included Savannah Sparrow (184 individuals), Yellow-rumped Warbler (136), Song Sparrow (*Melospiza melodia*: 100), Cedar Waxwing (*Bombycilla cedrorum*: 81) and Lincoln's Sparrow (*Melospiza lincolnii*: 53). In addition, 39 other species (458 individuals) had less than 50 records each (Appendix 7).

Eight species of neotropical migrant songbirds were recorded off plot and/or flying overhead but not on plot (Appendix 7). They included Violet-green Swallow (56 individuals), Northern Rough-winged Swallow (27), Marsh Wren (*Cistothorus palustris*: 2), Swamp Sparrow (*Melospiza georgiana*: 2), Western Meadowlark (2), Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*: 2) and two other species which had only one record each: Northern Waterthrush (*Parkesia noveboracensis*) and Tree Swallow.

Of the 1,270 neotropical migrant songbirds recorded on plot, 63.3% (804 individuals) were recorded in the drawdown zone and 36.7% (466 individuals) were recorded outside of the drawdown zone (Appendix 8). Of the species with 10 or more individuals recorded, six species had more than 75% of observations on plots in the drawdown zone: Common Yellowthroat, Savannah Sparrow, Lincoln's Sparrow, Ruby-crowned Kinglet, Orange-crowned Warbler and Red-eyed Vireo (*Vireo olivaceus*). Conversely, six species had more than 75% observations on plots outside of the drawdown zone: Warbling Vireo (*Vireo gilvus*), Gray Catbird (*Dumetella carolinensis*), MacGillivray's Warbler (*Geothlypis tolmiei*), American Robin, American Goldfinch and Pine Siskin (*Spinus pinus*) (Appendix 8). Plots from the forest stratum accounted for most detections of neotropical migrant songbirds (547 individuals), followed by the shrub stratum (525) and the grassland stratum (198) (Appendix 8). No neotropical migrant songbirds were recorded on unvegetated plots. It should be noted that these are raw numbers and are not controlled for the number of plots in or outside of the drawdown zone or for the number of plots in each stratum.

The total number of on-plot neotropical migrant songbirds detected on all permanent plots in a survey week was highly variable, and ranged from 88 individuals in week 5 to 199 individuals in week 8 (Appendix 9).

When controlling for the number of plots in each elevation band, the number of on-plot neotropical migrant songbirds detected per plot over the entire season was the highest in the 439 m elevation band (18.83), followed by the 438 m elevation band (18.39), 440 m elevation band (18.38), ≥ 442 m elevation band (17.20), 436 m elevation band (11.89), 441 m elevation band (8.71), 437 m elevation band (8.57), 434 m elevation band (2.75) and 435 m elevation band (2.25) (Appendix 10). No birds were recorded on plot in the four lowest elevation bands (431–433 m).

3.3 Effectiveness Monitoring Plot Sampling

In 2013, 23 effectiveness monitoring plots (14 treatment and 9 control plots) were surveyed in both spring and fall. Plots were surveyed once per week for six weeks in spring and for nine weeks in fall.

3.3.1 Spring surveys

In spring, 159 surveys were conducted. The first survey was conducted on April 15, 2013; the last was conducted on May 28, 2013.

In total, 924 individuals of 57 species were recorded (Appendix 4, Appendix 11). Overall, 103 birds (11 species) were recorded on plot, 498 birds (53 species) were recorded off plot and 323 birds (22 species) were recorded overhead (Appendix 11). Of the 98 neotropical migrant songbirds (9 species identified) recorded on plot, 23.5% and 8 species were recorded on cottonwood treatment plots, and 76.5% and 4 species were recorded on control plots (Table 4).

Table 4: Species and number of neotropical migrant songbirds detected on cottonwood treatment (CT) and control (CC) plots during effectiveness monitoring surveys in spring 2013

Common Name	CT	CC	Total
American Pipit	.	65	65
Yellow-rumped Warbler	7	2	9
American Robin	4	3	7
Chipping Sparrow	2	4	6
American Goldfinch	3	.	3
Mountain Bluebird	3	.	3
Orange-crowned Warbler	2	.	2
Ruby-crowned Kinglet	1	.	1
Savannah Sparrow	1	.	1
Unidentified Sparrow	.	1	1
Grand Total	23	75	98

American Pipit was the species with the most individuals detected, followed by Yellow-rumped Warbler, American Robin and Chipping Sparrow (*Spizella passerina*) (Table 4). Five species were recorded on cottonwood treatment plots only, one species (American Pipit) was recorded on control plots only, and the remaining three species were detected on both cottonwood treatment and control plots (Table 4).

3.3.2 Fall surveys

In fall, 238 surveys were conducted. The first survey was conducted on August 2, 2013; the last was conducted on September 27, 2013.

In fall, 1,054 individuals of 60 species were recorded (Appendix 4, Appendix 12). Overall, 209 birds (24 species) were recorded on plot, 396 birds (47 species) were recorded off plot and 449 birds (25 species) were recorded overhead (Appendix 12).

Of the 167 neotropical migrant songbirds (13 species identified) recorded on plot, 75% and 11 species were recorded on cottonwood treatment plots, and 25% and 10 species were recorded on control plots (Table 5). Lincoln's Sparrow was the most frequently detected species, followed by Common Yellowthroat, Yellow-rumped Warbler and Savannah Sparrow (Table 5). Three species were recorded on cottonwood treatment plots only, two species were recorded on control plots only, and the remaining eight species were detected on both cottonwood treatment and control plots (Table 5).

Table 5: Species and number of neotropical migrating songbirds detected on cottonwood treatment (CT) and control (CC) plots during effectiveness monitoring surveys in fall 2013

Common Name	CT	CC	Total
Lincoln's Sparrow	44	6	50
Common Yellowthroat	29	14	43
Yellow-rumped Warbler	7	9	16
Savannah Sparrow	10	3	13
Dark-eyed Junco	10	.	10
Pine Siskin	9	1	10
Cedar Waxwing	5	2	7
Song Sparrow	4	2	6
White-crowned Sparrow	3	2	5
Swamp Sparrow	2	.	2
House Wren	.	1	1
Traill's Flycatcher	1	.	1
Unidentified *Empidonax* Flycatcher	1	.	1
Unidentified Sparrow	1	.	1
Yellow Warbler	.	1	1
Grand Total	126	41	167

The differences in neotropical migrant abundance and species richness on plot among different planted areas in 2013 are presented in Figure 9.

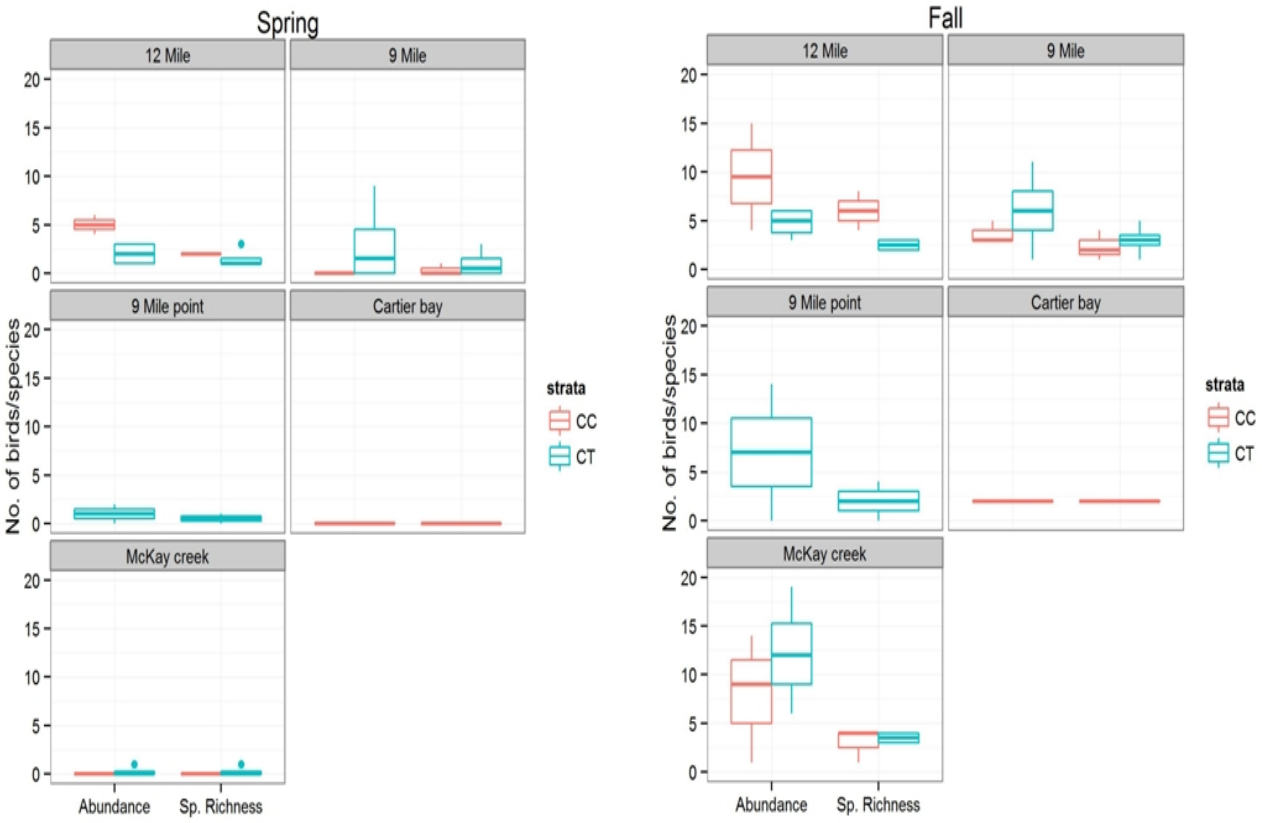

Figure 9: **Mean cumulative abundance and species richness of neotropical migrants on effectiveness monitoring plots in different planted areas in 2013 (CC = cottonwood control, CT = cottonwood treatment)**

3.4 Random Plot Sampling

3.4.1 Spring surveys

In spring 2013, the first random plot was surveyed on April 3; the last was surveyed on May 31. In total, 109 random plots were surveyed (Appendix 3): 29 plots were from each of the forest and shrub strata, 23 plots were from grassland stratum, 8 plots were unvegetated and 20 were from the wetland stratum (Table 6).

In total, 1,416 birds were recorded in spring: 301 (21.3%) were observed on plot, 810 (57.2%) were off plot and 305 (21.5%) were overhead (Appendix 13). Of the birds recorded on plot, neotropical migrant songbirds accounted for 192 birds (18 species), with an average density of 1.76 birds per plot (Appendix 14). Forested plots had the highest relative density (5.00 birds/plot), followed by wetland plots (1.00 birds/plot) and shrub plots (0.93 birds/plot) (Appendix 14). No neotropical migrant songbirds were detected on grassland or unvegetated plots.

Table 6: Number of random plots surveyed each week in Revelstoke Reach in spring 2013

Strata	Week 1 2□8.4.	Week 2 9□15.4.	Week 3 16□22.4.	Week 4 23□29.4.	Week 5 30.4.□6.5.	Week 6 7□13.5.	Week 7 14□20.5.	Week 8 21□27.5.	Week 9 28.5.□3.6.	Total
Forest	1	4	4	2	3	6	5	1	3	29
Grassland	3	4	2	2	3	2	4	1	2	23
Shrub	4	4	2	3	1	5	6	1	3	29
Unvegetated	2	1	.	.	.	1	4	.	.	8
Wetland	3	4	3	3	1	3	.	1	2	20
Total	13	17	11	10	8	17	19	4	10	109

The most frequently detected neotropical migrant species was American Robin, with an overall average density of 0.81 birds per plot (2.93 birds/plot for the forest stratum and 0.10 birds/plot for the shrub stratum) (Appendix 14). Other abundant species were Yellow-rumped Warbler with an overall average density of 0.27 birds/plot (1.00 birds/plot for the forest stratum), Tree Swallow (overall average density of 0.24 birds/plot; 0.75 birds/plot for the wetland stratum and 0.38 birds/plot for the shrub stratum) and Ruby-crowned Kinglet (overall average density of 0.14 birds/plot; 0.45 birds/plot for the forest stratum and 0.07 birds/plot for the shrub stratum).

In Year 6, we added two more vegetation communities (riparian shrub and creek) to the number which have been sampled at least five times. To date, out of all vegetation communities identified in Revelstoke Reach (CBA 2013e), 80 % have been sampled at least once (by a plot containing at least 2/3 of that community) and 47 % have been surveyed by five or more plots.

3.4.2 Fall surveys

In fall 2013, 100 random plots were surveyed (Appendix 3). The first plot was surveyed on July 30; the last was surveyed on September 25. Twenty-nine of these plots were forested, 16 were from the shrub stratum, 32 were from the grassland stratum, eight were unvegetated and 15 were from the wetland stratum (Table 7).

Table 7: Number of random plots surveyed each week in Revelstoke Reach in fall 2013

Strata	Week 1 28.7-3.8.	Week 2 4□10.8.	Week 3 11□17.8.	Week 4 18□24.8.	Week 5 25□31.8.	Week 6 1□7.9.	Week 7 8□14.9.	Week 8 15□21.9.	Week 9 22□28.9.	Total
Forest	1	4	7	6	1	1	4	4	1	29
Grassland	1	4	1	5	1	1	.	1	2	16
Shrub	1	3	6	6	2	2	6	2	4	32
Unvegetated	1	2	.	1	1	.	1	1	1	8
Wetland	1	4	1	2	.	1	2	2	2	15
Total	5	17	15	20	5	5	13	10	10	100

In total, 1,010 birds were recorded in the fall: 192 (19.0%) were observed on plot, 544 (53.9%) were off plot and 274 (27.1%) were overhead (Appendix 15). Neotropical migrant songbirds accounted for 86 birds (22 species), with an average density of 0.86 birds per plot (Appendix 16). Wetland plots had the highest relative density (1.67

birds/plot), followed by forested plots (1.45 birds/plot), grassland plots (0.81 birds/plot), shrub plots (0.16 birds/plot) and unvegetated plots (0.13 birds/plot) (Appendix 16).

The two most frequently detected neotropical migrant species were Savannah Sparrow and Common Yellowthroat. Savannah Sparrow had an overall average density of 0.26 birds per plot (0.87 birds/plot for the wetland stratum, 0.44 birds/plot for the grassland stratum, 0.17 birds/plot for the forest stratum and 0.03 birds/plot for the shrub stratum). Common Yellowthroat had the overall average density of 0.10 birds/plot (0.27 birds/plot for the wetland stratum, 0.19 birds/plot for the grassland stratum and 0.10 birds/plot for the forest stratum (Appendix 16).

In fall, we added seven vegetation communities (riparian shrub, gravel, thalweg, upland mixed forest, water sedge, sparse grassland and horsetail grassland) to the number which have been sampled at least five times. In addition, seven previously unsampled vegetation communities were sampled in Year 6 by at least one plot each. To date, out of all vegetation communities identified in Revelstoke Reach (CBA 2013e), 77 % have been sampled at least once (by a plot containing at least 2/3 of that community) and 37 % have been surveyed by five or more plots.

Substrate use in spring and fall

In spring, the substrate (plant) types most frequently used by neotropical migrant songbirds were cottonwood (69 observations), leaf litter (31) and willow (29) (Figure 10).

In fall, willow was used most frequently (20 observations), followed by cottonwood (14), reed canarygrass (13) and unidentified graminoids (10) (Figure 10).

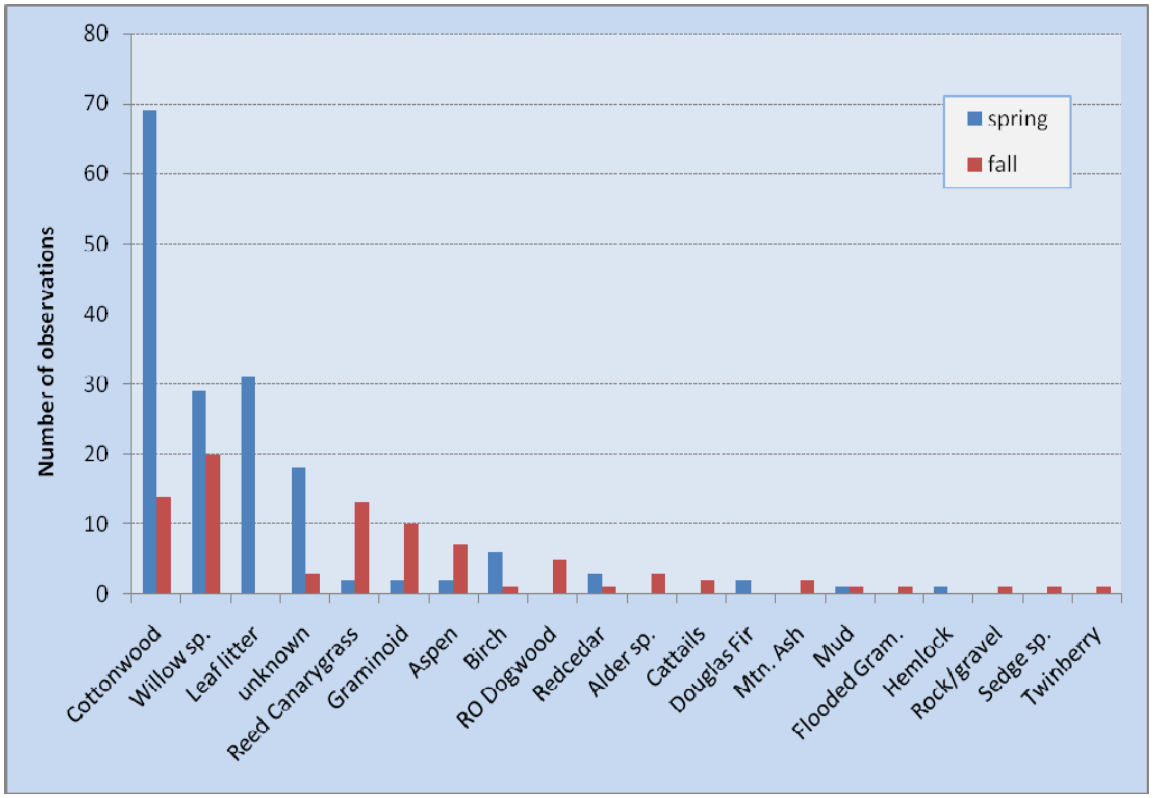

Figure 10: Substrate used by neotropical migrant songbirds during random plot surveys in spring and fall 2013

3.5 Constant Effort Mist Netting and Neotropical Migrant Physiology

3.5.1 Constant effort mist netting

In 2013, three sites were monitored for a total of 44 surveys and 2,400.00 net-hours (Table 8). The first survey was conducted on July 31, 2013 (Machete Island); the last was conducted on September 26, 2013 (Jordan River). Fifteen surveys were conducted at Jordan River and Machete Island, 14 at Airport Islands. The maximum number of mist nets used at a site varied from nine at Airport Islands to 11 at Jordan River to 13 at Machete Island.

Based on the location/strata of the sites and the capture rates in the Year 4 and Year 5, we focused our survey effort in 2013 on three sites: Jordan River (a control site outside of the drawdown zone with good capture rates and species richness), Airport Islands (a small riparian site in the drawdown zone and the lowest elevation site, therefore, presumably the most affected by reservoir operations) and Machete Island (a large riparian site in the drawdown zone with good capture rates and an available data set for 2008–2010).

The variation in the number of net-hours per week reflected the fact that the number of open nets varied from day to day depending on weather and capture rate–the number of nets was always adjusted to allow for the safe processing of captured birds.

Table 8: Mist netting survey effort (number of net-hours) per banding site in 2013

Banding Site	N of surveys	Week 1 28.7.–3.8	Week 2 4–10.8.	Week 3 11–17.8.	Week 4 18–24.8.	Week 5 25–31.8.	Week 6 1–7.9.	Week 7 8–14.9.	Week 8 15–21.9.	Week 9 22–29.9.	Grand Total
Airport Islands	14	.	51.75	54.00	105.75*	126.00**	85.00*	54.00	96.75*	56.25*	629.50
Jordan River	15	35.00	42.50	60.00	105.00*	115.00*	110.00*	120.00*	107.25*	132.00*	826.75
Machete Island	15	35.00	138.50*	78.00	152.75*	126.75**	156.00*	100.75*	78.00	78.00	943.75
Total	44	70.00	232.75	192.00	363.50	367.75	351.00	274.75	282.00	266.25	2400.00

* two surveys during the week

** three surveys during the week

Species richness and capture rates differed among the banding sites. At Airport Islands, the overall capture rate was 0.4051 birds/net-hour (Appendix 17). In total, 255 individuals from 14 species were captured. Common Yellowthroat was the most frequently captured species (0.2129 birds/net-hour), followed by Savannah Sparrow (0.0874 birds/net-hour), Willow Flycatcher (*Empidonax traillii*: 0.0397 birds/net-hour) and Yellow-rumped Warbler (0.0207 birds/net-hour). The capture rate for newly captured birds was 0.3066 birds/net-hour, and the recapture rate was 17.6%. The recapture rate for the same-day recaptures was 13.5%. Palm Warbler (*Setophaga palmarum*) was the only species captured exclusively at this site.

At Machete Island, 1324 individuals from 38 species were captured (Appendix 18). The overall capture rate was 1.6015 birds/net-hour, the capture rate for newly captured birds was 1.2229 birds/net-hour and the recapture rate was 16.9%. The six most frequently captured species at Machete Island were Common Yellowthroat (0.4729 birds/net-hour), Orange-crowned Warbler (0.1294 birds/net-hour), Yellow Warbler (0.1101 birds/net-hour), Yellow-rumped Warbler (0.1089 birds/net-hour), Gray Catbird (0.0822 birds/net-hour) and Warbling Vireo (0.0810 birds/net-hour). The recapture rate for the same-day recaptures was 8.7%. Eight species were captured only at Machete Island: Clay-colored Sparrow (*Spizella pallida*), American Tree Sparrow (*Spizella arborea*), Tennessee Warbler (*Oreothlypis peregrina*), Western Wood-Pewee, Blackpoll Warbler (*Setophaga striata*), Eastern Kingbird (*Tyrannus tyrannus*), Pacific Wren (*Troglodytes pacificus*) and Pacific-slope Flycatcher (*Empidonax difficilis*).

At Jordan River, 660 individuals of 46 species were captured (Appendix 19). The overall capture rate was 0.6993 birds/net-hour, the capture rate for newly captured birds was 0.5605 birds/net-hour and the recapture rate was 16.1%. The most commonly captured species was Warbling Vireo (0.1505 birds/net-hour), followed by Swainson's Thrush (0.1208 birds/net-hour), Ruby-crowned Kinglet (0.0551 birds/net-hour), American Redstart (0.0466 birds/net-hour), Dark-eyed Junco (*Junco hyemalis*: 0.0424 birds/net-hours), MacGillivray's Warbler (0.0360 birds/net-hour) and Red-eyed Vireo (0.0318 birds/net-hour). The recapture rate for the same-day recaptures was 7.0%. 17 species were captured exclusively at this site: Golden-crowned Kinglet (*Regulus satrapa*), American Robin, Hermit Thrush (*Catharus guttatus*), Cassin's Vireo (*Vireo cassinii*), Red-breasted Nuthatch (*Sitta canadensis*), Red-naped Sapsucker (*Sphyrapicus nuchalis*), Sharp-shinned Hawk (*Accipiter striatus*), White-throated Sparrow (*Zonotrichia albicollis*), Brown Creeper (*Certhia americana*), Chestnut-backed Chickadee (*Poecile rufescens*), Fox Sparrow (*Passerella iliaca*), Harry Woodpecker (*Picoides villosus*), Northern Flicker (*Colaptes auratus*), Steller's Jay (*Cyanocitta stelleri*), Townsend's Warbler, Varied Thrush (*Ixoreus naevius*) and Western Tanager (*Piranga ludoviciana*).

The species composition and capture rates of the four focal species for physiological analyses component (Common Yellowthroat, Yellow Warbler, Swainson's Thrush and Yellow-rumped Warbler) varied among banding sites.

In 2013, Common Yellowthroat was by far the most frequently captured species at both surveyed sites in the drawdown zone. The overall capture rate of Common Yellowthroat was 0.4729 birds/net-hour at Machete Island and 0.2129 at Airport Islands. At the site outside of the drawdown zone (Jordan River), Common Yellowthroat was very rare and only 3 individuals were captured (overall capture rate 0.0032 birds/net-hour).

Yellow Warbler was the third most frequently captured species at Machete Island (0.1101 birds/net-hour) and seventh most frequently captured at Airport Islands (0.0064 birds/net-hour). At Jordan River, Yellow Warbler was the eleventh most commonly captured bird with a capture rate of 0.0170 birds/net-hour.

In the drawdown zone, Swainson's Thrush was captured only at Machete Island, where it was the thirteenth most frequently captured species with a capture rate of 0.0375 birds/net-hour. No thrushes were captured at Airport Islands banding station in 2013. Outside of the drawdown zone, at Jordan River, Swainson's Thrush was the second most frequently captured species with the capture rate of 0.1208 birds/net-hour.

In 2013, Yellow-rumped Warbler was the fourth most frequently captured species both at Machete Island (0.1089 birds/net-hour) and at Airport Islands (0.0207 birds/net-hour).

Only two Yellow-rumped Warblers were captured at Jordan River outside of the drawdown zone and the capture rate there was 0.0021 birds/net-hour.

3.5.1.1 Injuries and mortalities

In 2013, one Pacific Wren died while being banded and one Dark-eyed Junco was found dead in the net. No other mortality was recorded. Two birds were released with a mild wing strain, one of which was recaptured later in the season in good condition. One bird had a leg injury and was released unbanded.

3.5.1.2 Species at Risk

No species at risk were captured or banded in 2013.

3.5.2 Plasma metabolite analyses – Year 6

In 2013, 166 blood samples were collected from three sites (Machete Island, Jordan River, Airport Islands). We collected blood samples from 61 Common Yellowthroats, 43 Swainson's Thrushes, 34 Yellow-rumped Warblers and 28 Yellow Warblers.

Of these, 156 samples were analysed and the number of samples analyzed for the four species at each site and the mean values of triglyceride and glycerol (BOH was not assayed in 2013) are provided in Table 9.

Table 9: Plasma triglyceride and glycerol levels (mmol.l^{-1}) by species and site in 2013. Values are raw means ± S.D. with sample sizes in parentheses

Metabolite	Species	Machete Island	Airport Islands	Jordon River
Triglyceride	COYE	0.922 ± 0.504 (29)	0.632 ± 0.254 (27)	1.13 (1)
	SWTH	1.397 ± 0.564 (13)	.	1.175 ± 0.643 (29)
	YRWA	0.819 ± 0.540 (24)	0.769 ± 0.370 (7)	.
	YWAR	0.907 ± 0.503 (22)	2.037 (1)	0.798 ± 0.216 (3)
Glycerol	COYE	0.906 ± 0.230 (29)	0.766 ± 0.181 (27)	1.053 (1)
	SWTH	1.115 ± 0.165 (13)	.	1.012 ± 0.234 (29)
	YRWA	0.846 ± 0.231 (24)	0.843 ± 0.209 (7)	.
	YWAR	0.886 ± 0.265 (22)	1.309 (1)	0.891 ± 0.123 (3)

For Common Yellowthroat there was no significant difference in estimated fattening rate comparing Airport Islands and Machete Island ($F_{1,53}$ = 2.66, P = 0.11), although estimated fattening rate was higher at Machete Island compared with Airport Islands (Table 10). In this model time of day was the only significant covariate (P < 0.01). Glycerol was higher at Machete Island compared to Airport Islands and the effect of site was marginally significant ($F_{1,53}$ = 3.72, P = 0.06; no covariates were significant).

Table 10: Variation in estimated fattening rate (triglyceride) among sites for different species in 2013 (COYE = Common Yellowthroat, YRWA = Yellow-rumped Warbler, SWTH = Swainson's Thrush). Values are least-square means log_{10} metabolite ± S.E., controlling for body mass, handling time, time of day and Julian date

Species	Site A		Site B		Stats
COYE	Machete Island	0.894 ± 0.039	Airport Island	0.794 ± 0.040	$F_{1,53}$ = 2.66, P = 0.11
YRWA	Machete Island	0.839 ± 0.034	Airport Island	0.869 ± 0.067	$F_{1,30}$ = 0.15, P = 0.70
SWTH	Machete Island	1.161 ± 0.062	Jordan River	1.110 ± 0.040	$F_{1,41}$ = 2.05, P = 0.16

For Swainson's Thrush there were no differences in either triglyceride ($F_{1,41}$ = 2.05, P = 0.16; Table 10) or glycerol ($F_{1,41}$ = 0.51, P = 0.48) comparing Machete Island and Jordon River in 2013; though samples sizes were small (n = 29 and 13 respectively). No covariates were significant in either model.

For Yellow-rumped Warbler there were no differences in either triglyceride ($F_{1,30}$ = 0.15, P = 0.70; Table 10) or glycerol ($F_{1,30}$ = 2.39, P = 0.13) comparing Machete Island and Airport Islands in 2013; though samples sizes were small (n = 24 and 7 respectively). Although non-significant, mean glycerol was lower at Airport Islands (0.736 ± 0.060 mmol/l) compared with Machete Island (0.844 ± 0.030). Time of day (P < 0.001) and body mass (P < 0.01) were significant in the model for triglyceride, but no covariates were significant for glycerol.

3.5.3 Plasma metabolite analyses – Multiyear (2011 and 2013)

For a multiyear analysis we utilized data from 167 plasma samples collected in 2011 and 166 samples collected in 2013.

In the drawdown zone, only Common Yellowthroat was captured in sufficient quantities to allow for comparison among stations. In 2011, there was no difference in estimated fattening rate comparing among Airport Islands, Machete Island and Rob's Willow sites ($F_{2,76}$ = 0.02, P = 0.98) or comparing only Airport Islands and Machete Island ($F_{1,59}$ = 0.00, P = 0.96) and in 2013 there was no difference in estimated fattening rate comparing Airport Islands and Machete Island ($F_{1,53}$ = 2.66, P = 0.11). In these models

time of day was the only significant covariate ($P < 0.01$). Pooling data for both years and comparing just Airport Islands and Machete Island there was no effect of site ($F_{1,113} = 1.30$, $P = 0.26$) or year ($F_{1,113} = 0.64$, $P = 0.42$) on estimated fattening rate. Both time of day ($P < 0.01$) and Julian date ($P < 0.05$) were significant in this model.

For Common Yellowthroat at the sites in the drawdown zone, glycerol was independent of site in 2011 ($P > 0.20$) and in 2013. No covariates were significant in these models. Pooling data for both years and comparing only Airport Islands and Machete Island there was an effect of site ($F_{1,113} = 6.70$, $P = 0.011$) but not year ($F_{1,113} = 0.16$, $P = 0.68$) or any other covariate. Glycerol was lower at Airport Islands (0.830 ± 0.018 mmol/l) compared with Machete Island (0.899 ± 0.018 mmol/l).

For Orange-crowned Warbler, comparing between site in and outside of the drawdown zone, there were no differences in either triglyceride ($F_{1,30} = 0.82$, $P = 0.37$) or glycerol ($F_{1,30} = 0.01$, $P = 0.93$) comparing Machete Island and Cartier Point in 2011; though samples sizes were small (n = 19 and 12 respectively). Time of day was significant in the model for triglyceride ($P < 0.001$).

Pooling data from all sites (both in and outside of the drawdown zone), there was a large enough sample size for Common Yellowthroat and Yellow Warbler to compare overall estimated fattening rate and glycerol between 2011 and 2013. There was no significant difference in plasma metabolite levels among years in either species for either triglyceride or glycerol (Table 11). For triglyceride there was a highly significant ($P < 0.001$) time of day effect in both species, and for Common Yellowthroat, but not Yellow Warbler, there was a significant effect of Julian date ($P < 0.05$). For glycerol no covariates were significant for Common Yellowthroat but there was a significant effect of handling time in Yellow Warbler ($P < 0.01$).

Table 11: Annual variation in estimated fattening rate (triglyceride) and glycerol between 2011 and 2013 for Common Yellowthroat (COYE) and Yellow Warbler (YWAR) pooling all sites. Values are least-square means log_{10} metabolite ± S.E., controlling for body mass, handling time, time of day and Julian date, with sample sizes in parentheses

Metabolite	Species	2011	2013	Stats
Triglyceride	COYE	0.837 ± 0.049 (86)	0.904 ± 0.074 (57)	$F_{1,139} = 0.31$, $P = 0.58$
Glycerol	COYE	0.834 ± 0.032 (86)	0.892 ± 0.048 (86)	$F_{1,139} = 0.55$, $P = 0.46$
Triglyceride	YWAR	0.756 ± 0.143 (17)	0.970 ± 0.093 (26)	$F_{1,38} = 0.90$, $P = 0.35$
Glycerol	YWAR	0.928 ± 0.119 (17)	0.702 ± 0.077 (26)	$F_{1,38} = 1.45$, $P = 0.24$

Pooling data from all species in the drawdown zone (only Machete Island and Airport Islands), there was no relationship between residual glycerol and daily water level at the site (Figure 11).

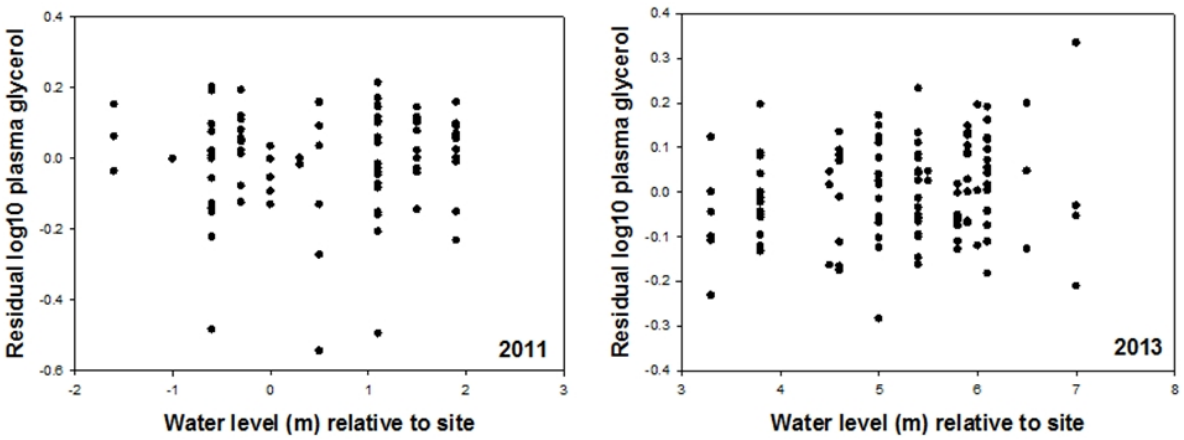

Figure 11: **Variation in residual plasma glycerol in relation to water levels in 2001 and 2013. Data are pooled for Machete/Airport Island and for all species**

3.5.4 Feather isotope analyses – Year 6

In 2013, feather samples were collected at three banding stations. Feather samples were collected from the same individuals as blood samples were. In total, we collected feather samples from 60 Common Yellowthroats, 43 Swainson's Thrushes, 34 Yellow-rumped Warblers and 28 Yellow Warblers.

To be completed after samples collected in Year 6 are analysed.

3.5.5 Feather isotope analyses - Multiyear

To be completed after samples collected in Year 6 are analysed.

3.6 Habitat Sampling

In 2013, habitat sampling was conducted at 204 random plots. In total, 55 plots from forest stratum, 43 plots from shrub stratum, 55 plots from grassland stratum, 16 plots from unvegetated stratum and 35 plots from wetland stratum were sampled (Table 12).

Table 12: Summary of habitat data collected on random plots in spring and fall 2013 (means and ranges)

Strata	Forest	Shrub	Grassland	Unvegetated	Wetland
n of plots	55	43	55	16	35
Tree					
tree cover (%)	34.7 (1-100)	1.7 (0-40)	0	0	1.1 (0-15)
tree height (m)	15.5 (6-40)	2.5 (0-30)	0	0	1.6 (0-15)
tree species (n)	3.7 (1-8)	0.3 (0-2)	0	0	0.3 (0-3)
dead branches (%)	3.1 (0-50)	1.1 (0-40)	0	0	0
Shrub					
shrub cover (%)	26.5 (0-100)	18.5 (0-88)	0.9 (0-30)	0.1 (0-1)	2.4 (0-24)
shrub height (m)	2.7 (0-5)	2.3 (0-4)	0.3 (0-2)	0.1 (0-1)	0.5 (0-2)
shrub species (n)	4.8 (0-12)	1.6 (0-5)	0.2 (0-1)	0.1 (0-1)	0.8 (0-4)
dead branches (%)	2.7 (0-20)	15.2 (0-90)	5 (0-100)	0.1 (0-2)	1.4 (0-30)
Grass					
herbaceous cover (%)	30.1 (0-98)	55.4 (0-100)	70.5 (3-100)	2.4 (0-23)	37.8 (0-96)
herbaceous height (m)	0.3 (0-2)	0.4 (0-2)	0.3 (0-2)	0.1 (0-1)	0.4 (0-2)
herbaceous species (n)	4.1 (0-15)	2.7 (1-6)	2.4 (1-5)	0.3 (0-1)	3.4 (0-12)
Open					
open cover (%)	20.1 (0-88)	26.2 (0-100)	28.9 (0-98)	97.7 (77-100)	58.8 (4-100)

4 DISCUSSION

This section first discusses results from field studies in 2013. The discussion then summarizes the progress made in 2008–2013 toward answering CLBMON 39 management questions. An overview of the management questions and approaches is summarized in Appendix 1.

4.1 Permanent Plot Sampling

In 2013, spring surveys of permanent plots produced 196 observations of neotropical migrants (18 species). The five most frequently detected species in 2013 were the same species as in 2012 (with only the third and fourth species switching ranks from one year to another). Fall migration monitoring was characterized by relatively low water levels within Arrow Lakes Reservoir. The number of surveys when the plots were unavailable to migrants due to flooding was less than in the previous two years. For the majority of the migration season, flooding rendered only the lowest elevation grassland and unvegetated plots unavailable to songbirds. Overall species richness and number of birds detected on plot in 2013 (1270 observations) was very similar to that documented in the previous two years (1119 observations in 2011 and 1188 observations in 2012; CBA 2012, 2013b). In addition, similar to previous years, no neotropical migrant songbirds were detected on unvegetated plots.

One notable difference between year 2013 and the two previous years (high water years) was the high number of birds observed on grassland plots in the drawdown zone. This is consistent with our draft model from Year 5, which predicted that the probability of the presence of a neotropical migrant on a grassland plot decreases with increasing water depth on the plot (CBA 2013c). In 2013, due to lower water levels, more surveys were conducted on grassland plots during dry conditions.

While the average number of neotropical migrants per plot in each elevation band was similar in 2011 and 2012, year 2013 was different. In 2013, the average number of migrants per plot was highest in the 439 elevation band (vs. 440 m elevation band in 2011 and 2012; CBA 2012, 2013b) and more migrants were detected on plots in the drawdown zone and on lower elevation plots in particular. For example, four species of migrants and an average of 2.75 birds per plot were detected in the 434 m elevation band in 2013 while none were detected in either 2011 or 2012 (CBA 2012, 2013b). As well, three species of migrants and an average of 2.25 birds per plot were detected in the 435 m elevation band, while none were detected in 2011 and one species and 1.25 birds per plot were detected in 2012 (CBA 2012, 2013b). And finally, an average of 11.89 birds per plot were detected in the 436 elevation band, while 5.99 birds per plot were detected in 2011 and 3.67 birds were detected per plot in 2012 (CBA 2012, 2013b). Because most of the plots within these elevation bands are covered by grassland, these differences were driven predominantly by grassland/wetland birds (e.g., Savannah Sparrow, Common Yellowthroat , American Pipit).

4.2 Effectiveness monitoring

Year 2013 was the fourth year of spring effectiveness monitoring surveys and the third year of fall effectiveness monitoring surveys. In 2013, surveys of 4 effectiveness monitoring plots (two treatment plots and two control plots) at Rob's Willows area were discontinued. Monitoring was discontinued at these plots because their size was smaller than that of the other effectiveness monitoring plots, their shapes were irregular and they were in close proximity to each other. In spring 2013, we recorded higher cumulative

species richness on treatment plots then on control plots, although more migrants were recorded on control plots. This was due to the fact that on one occasion, a large flock of American Pipits was recorded on a control plot and this observation increased the total number of migrants detected on control plots dramatically. After taking out this one outlier observation, documented neotropical migrant cumulative abundance on control plots was lower than that recorded on treatment plots. In fall, more neotropical migrants were recorded on treatment plots than on control plots but the cumulative species richness was similar between control and treatment plots.

As can be seen in Figure 9, migrant abundance and species richness varied not only between control and treatment plots, but also among different planted areas.

4.3 Random plot sampling:

In spring, because restratification wasn't completed until later in the season, only two vegetation communities were added to the pool of those sampled five or more times. In fall, plots composed of undersampled vegetation communities were prioritized from the beginning of the sampling effort. In addition, low water levels of Arrow Lakes Reservoir in the fall of 2013 allowed us to sample a wide variety of habitats and conduct surveys even at lower elevation grassland habitats. This was a big difference to the situation from previous years (2011-2012) when, due to higher water levels in fall, only forest, shrub and a limited number of higher elevation grassland plots could be surveyed (CBA 2012, 2013b). As a result, after Year 6, 37 % of all vegetation communities have been sampled by 5 or more plots (vs. 17% after Year 5; CBA 2013c) and 77% of all vegetation communities have been sampled at least once (vs. 60 % after Year 5; CBA 2013c).

4.4 Constant effort mist netting

In 2013, only three sites were monitored by constant effort mist netting compared to five sites in 2011-2012. At Jordan River, a control site outside of the drawdown zone, the capture rate in 2013 was very similar to that documented in the previous two years (CBA 2012, 2013b). Swainson's Thrush and Warbling Vireo were the most frequently captured species in all three years and their individual capture rates remained relatively stable from year to year (CBA 2012, 2013b). At Machete Island, the capture rate in 2013 was higher than in the previous two years (CBA 2012, 2013b). Common Yellowthroat was the most frequently captured species in all three years, but its capture rate in 2013 was about twice as high as in 2011 or 2012 (CBA 2012, 2013b). This supports our findings from previous monitoring at this site (2008-2010) which predicted that drier conditions during the fall migration result in higher capture rates of neotropical migrants (CBA 2013c). At Airport Islands, capture rates in 2013 were higher than in 2012 but lower than in 2011 (CBA 2012, 2013b). In 2013, Common Yellowthroat was the most frequently captured species at Airport Islands (similar to 2011) but its capture rate was only about half that from 2011 (and about three times as high as in 2012) (CBA 2012, 2013b). Yellow-rumped Warbler, the most frequently captured species in 2012 and the second most frequently captured species in 2011, was captured at a very low rate in 2013 (CBA 2012, 2013b). Of the three sites monitored, it appears that Airport Islands has the highest annual variation in capture rate and species composition. Because Airport Islands is the lowest monitored site of the three and within the drawdown zone, water levels should affect the utilization of this stopover habitat the most.

4.5 Plasma metabolite and feather isotopes

In 2013, changes in the sampling regime allowed us to collect sufficient number of samples to perform among site comparison for three species. Similar to the results from previous years (CBA 2012, 2013c), we were able to detect the effect of time of day, season (Julian date) and mass on estimated fattening rate. Analyzing data from 2011 and 2013, we did not find any significant annual differences in estimated fattening rate of Common Yellowthroat at any of the two sites in the drawdown zone (or on the data pooled from all stations) despite differences in reservoir levels between years, confirming our results from 2008-2010 (CBA 2013c, Wagner et al. 2014).

We found no significant variation in estimated fattening rate among sites (between sites in and outside of the drawdown zone or between two sites in the drawdown zone with different frequency of flooding). This further supports our findings that reservoir operations do not significantly affect fattening rate of neotropical migrants at these sites.

Only in one comparison was an effect of site on glycerol found (Common Yellowthroat, comparing two sites in the drawdown zone with different frequency of flooding, 2011 and 2013 data pooled) but there was no significant effect of year or site in any other comparison. In 2008-2010, we documented annual variation in glycerol with higher levels of glycerol in drier years and a significant relationship between glycerol and water levels (higher glycerol level with lower water levels) at Machete Island (CBA 2013c, Wagner et al. 2014). Differences in glycerol levels within the drawdown zone tended towards higher glycerol at the drier, less frequently inundated sites, while the results in general failed to show any significant among year differences that had been documented in previous years. The relationship between residual glycerol and daily water levels at sites (Wagner et al. 2014) was not confirmed with 2011 and 2013 data.

4.6 Progress Towards Answering the Management Questions

4.6.1 MQ 1: What is the seasonal and annual variation in the abundance and diversity of neotropical migrants in Revelstoke Reach?

Over the course of six years (2008-2013), data on neotropical migrant abundance and species diversity during fall migration have been collected under CLBMON 39. Spring migration monitoring using random plot surveys was initiated in 2009 (Year 2).

A considerable dataset of neotropical migrant observations during both spring and fall has been collected to date. A brief summary of neotropical migrant seasonal and annual variation documented in the first five years of this study was provided in a 5-year Interim Review report (CBA 2013c). This summary utilized only random plot datasets (spring migration) and Machete Island banding data (fall migration). After Year 6, the seasonal and annual variation in abundance and diversity of neotropical migrants is fairly well documented.

For the final 10-year comprehensive report, combining datasets from multiple components of the CLBMON 39 study will improve the overall understanding of annual and seasonal variation in the abundance and diversity of migrants. Combined with previous but less rigorous studies (Jarvis and Woods 2002, Easton 2007) seasonal and annual variation in abundance and diversity of neotropical migrants will be exceptionally well documented. The current sampling design will allow us to answer this management question in great detail. The next few years of additional sampling will add to the depth and breadth of data on abundance and diversity.

4.6.2 MQ 2: Which habitats within the drawdown zone in Revelstoke Reach are utilized by neotropical migrants and what are their characteristics?

This management question is being addressed primarily by sampling of random plots and documenting neotropical migrant occurrence/use of these plots and their habitat characteristics. As a first stage of an answer to this management question, Revelstoke Reach was divided into 50x50 m plots assigned to one of the *a priori* selected broad habitat strata (forest, shrub, grassland, wetland, unvegetated). In 2009-2012, significant differences in utilization of plots among the broad habitat strata were documented (CBA 2013c). The random plot data collected in 2013 confirmed large differences among these strata in both spring and fall.

The scale of broad habitat strata classification was too coarse for detailed habitat interpretation. In 2013, the study area was divided into random plots based on the vegetation communities (CBA 2013e) to provide more habitat details and more meaningful interpretations. With the current sampling design we will have all the vegetation communities adequately sampled by the end of this study. This will allow us to create stopover habitat use models and determine stopover habitat preferences of different species of neotropical migrants in Revelstoke Reach during both spring and fall migration.

4.6.3 MQ 3: Does the operation of Arrow Lakes Reservoir impact the availability or quality of stopover habitat in Revelstoke Reach for neotropical migrants?

The water levels of Arrow Lakes Reservoir have a direct impact on availability of stopover habitat in Revelstoke Reach. At any given reservoir water level, this effect varies among different habitat types (CBA 2013c). In general, as water levels rise there is less stopover habitat available. The effect of reservoir operation on the availability of stopover habitat has already been largely addressed by the 5 year interim review report (CBA 2013c). The effect of reservoir operation on quality of stopover habitat is still being assessed, though preliminary data suggests that the effect varies among different habitat types, with some stopover habitats being impacted more than others.

4.6.4 MQ 4: Do reservoir operations influence the diversity or abundance of neotropical migrants using stopover habitat within the drawdown area during migration? If so, how do reservoir operations influence the species richness or abundance?

Analyses of data collected at Machete Island in 2008-2010 showed significant variation in capture and recapture rates among years. Daily capture and recapture rate were significantly higher in the 'dry' year (2009) compared to years when the station was flooded (CBA 2013c). Data collected at Machete Island in 2011-2013 shows a similar trend, the year with low water levels (2013) had higher capture rates than the other two years with high water levels.

In addition, our draft model from permanent plot data showed a significant effect of water depth on the presence of neotropical migrants on plot. Migrants were less likely to be present in grassland and shrub plots and more likely to be present in forest plots with increasing water depth. Data from year 6, suggested that in this low water year more migrants were using low elevation, predominantly grassland, plots than in the previous two years with higher water levels.

In the year 5 Interim Review report we demonstrated that the reservoir operations do influence neotropical migrant abundance and diversity in the drawdown zone and that the effect of reservoir operations varies among different broad habitat types. In year 10, with

data collected under different reservoir operation regimes (different years), we will be able to tighten and improve our preliminary models. Therefore, in the year 10 comprehensive report, we will have a detailed understanding of the effect of reservoir operations on migrants' abundance and diversity in all types of stopover habitat in Revelstoke Reach.

4.6.5 MQ 5: Which neotropical migrants (e.g., species or guilds) are most affected by reservoir operations?

Data collected to date shows that some species are more abundant in the drawdown zone in drier years (e.g., MacGillivray's Warbler, Lazuli Bunting, Common Yellowthroat) while others are more abundant in years with higher water levels (e.g., Northern Waterthrush, Swainson's Thrush, Wilson's Warbler). In addition, our preliminary model shows that within the drawdown zone, the grassland habitat is more affected by reservoir operations than shrub or forest habitat (CBA 2013c). Species that prefer grassland habitat during migration (e.g., Savannah Sparrow) are therefore potentially more affected than forest or shrub species. In addition, early season migrants as well as species which prefer stopover habitat that is confined exclusively within the drawdown zone are potentially more affected than late season migrants and habitat generalist species.

Combining data collected under multiple components of this study (timing of migration, distribution and abundance) together with the known life histories (e.g. foraging strategy) of neotropical migrant species using stopover habitat in Revelstoke Reach, we will be able to model neotropical migrants' sensitivity to reservoir operations and identify species most affected. This management question will be addressed in year 10 comprehensive report.

4.6.6 MQ 6: Do reservoir operations affect the physiological health of neotropical migrants using the drawdown zone during fall migration?

This management question has been already partially addressed in the year 5 interim review report (CBA 2013c). With the additional data collected in 2011 and 2013 we are now able to fully address this management question. All data collected to date shows that there is no significant variation in residual plasma triglyceride (estimated fattening rate) of neotropical migrants among years (CBA 2013c, Wagner et al. 2014) or among sites. Moreover, daily water levels at the banding station or migratory origin (δD feather isotope data) did not have a significant effect on the estimated fattening rate (Wagner et al. 2014). Although not a measure of fattening rate, the annual variation in plasma glycerol and β-OH butyrate levels and the inverse relationship between daily water levels at the station and these metabolites documented by Wagner et al. (2014) was not confirmed by the glycerol data from 2011 and 2013.

Previous work conducted in Revelstoke Reach did not find an annual or weekly effect of reservoir water levels on mass gain of neotropical migrants at one of the studied sites (Green et al. 2011). Our data show that the water levels of Arrow Lakes Reservoir do not significantly affect fattening rates of neotropical migrants at the sites monitored in Revelstoke Reach. Because estimated fattening rate is a tool to measure physiological health, our results therefore suggest that reservoir operations do not significantly impact the physiological health of neotropical migrants using the drawdown zone during fall migration.

4.6.7 MQ 7: Can operational adjustments be made to reduce impacts on neotropical migrants during migration or are mitigation measures required to minimize the loss of stopover habitat?

In Year 10, the impact of reservoir operations will be assessed and the most important stopover habitats will be identified (in conjunction with the MQ2 and MQ3). Then, we will be able to model habitat use/availability under different reservoir operational regimes and identify what operational adjustments can be made to mitigate impacts on neotropical migrants. This management question has not been answered yet.

4.6.8 MQ 8: Are the revegetation and the wildlife physical works projects effective at enhancing habitat for neotropical migrants in the drawdown zone?

In the Year 5 Interim Review report (CBA 2013c) we analyzed data collected in the first three years of this component. Although we recorded a significantly higher abundance and diversity of migrants on treatment plots compared to control plots, no significant increase in abundance or species diversity on treatment plots relative to the year of planting was documented.

It must be noted that to date, no revegetation or wildlife physical works projects were undertaken with the primary intent to improve habitat for neotropical migrant songbirds. In order to fully address this management question, the timeframe of the completion of revegetation projects investigated (e.g., creating riparian forest) would ideally be contained within the 10 year timespan of the project. If revegetation projects are to be successful in enhancing habitat for neotropical migrants in the drawdown zone, we would expect to see an increase in species diversity and abundance at these plots in future years. Since data from other components of this study show that high quality shrub/forest habitat have multiple times higher migrant abundance and species diversity than grassland habitat, we expect that the slow increase in species abundance and diversity to date is at least partially caused by the immature growth stage of planted cottonwood stakes.

We will be able to answer this management question in the 10-year comprehensive report.

4.6.9 MQ 9: Are some methods or techniques more effective than others at enhancing habitat for neotropical migrates in the drawdown zone? (e.g., the planting or enhancement of certain riparian vegetation).

Since physical works projects have not yet been implemented, options other than planting shrubs and sedges have not been assessed. Additional habitat enhancement projects will need to be implemented in order to assess the relative benefits of different techniques or methods. Ideally, it would be beneficial to conduct a habitat enhancement project specifically designed to provide habitat for neotropical migrant songbirds.

Alternatively, this question can be answered theoretically based on random plot data. To date, our data suggest that planting of shrubs and trees would likely benefit most neotropical migrants.

4.7 Recommendations

There are two main recommendations for Years 7-10 of CLBMON 39.

Continue all field studies on neotropical migrant songbird use of different habitats as designed in CBA (2013d).

Since the effects on physiology of neotropical migrant birds (MQ6) has been adequately addressed, discontinue the neotropical migrant physiology component of this study (blood and feather sampling).

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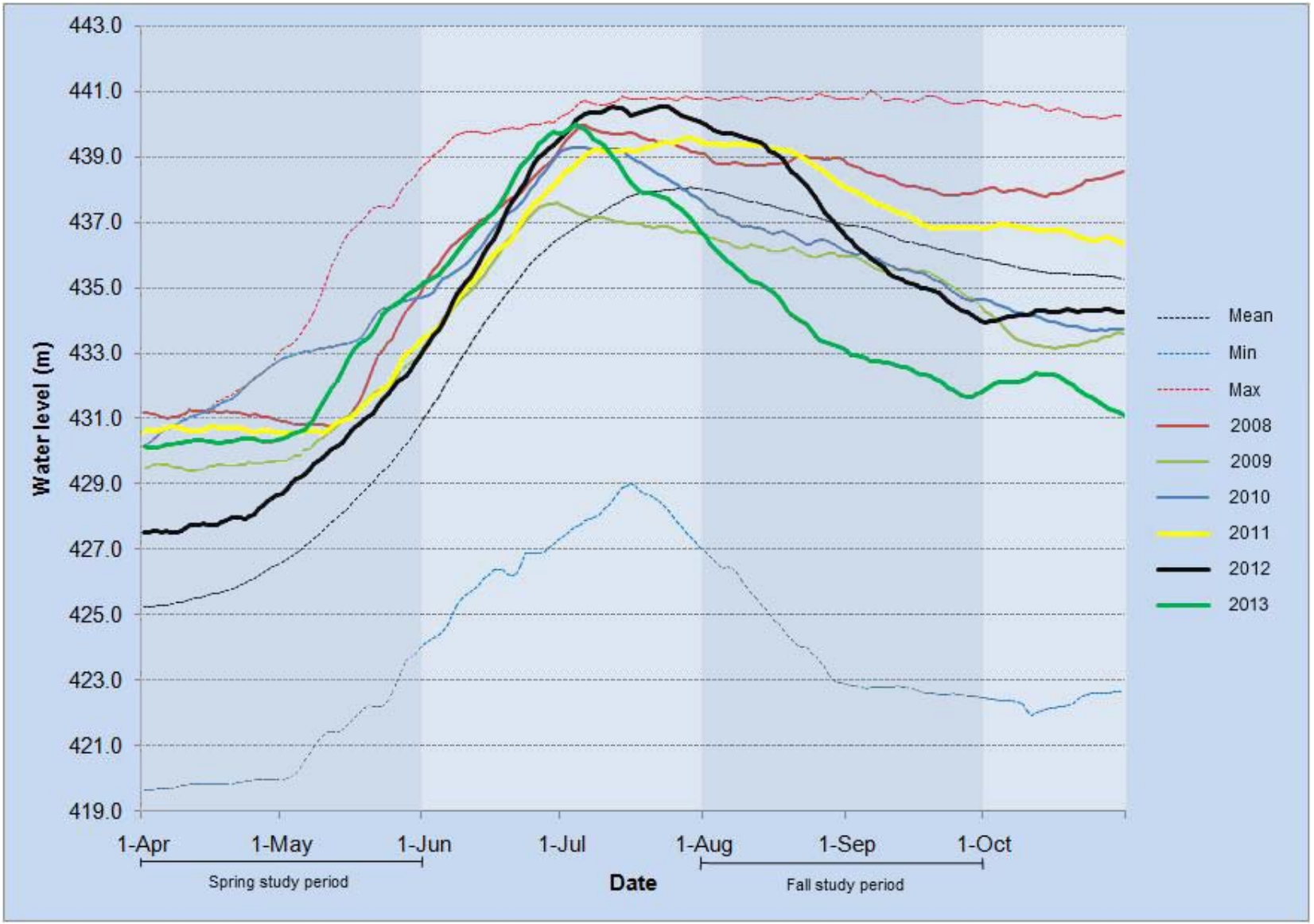
6 APPENDICES

Appendix 1: Management objectives, questions, hypotheses and approaches and status of CLBMON 39 after Year 6 (2013)

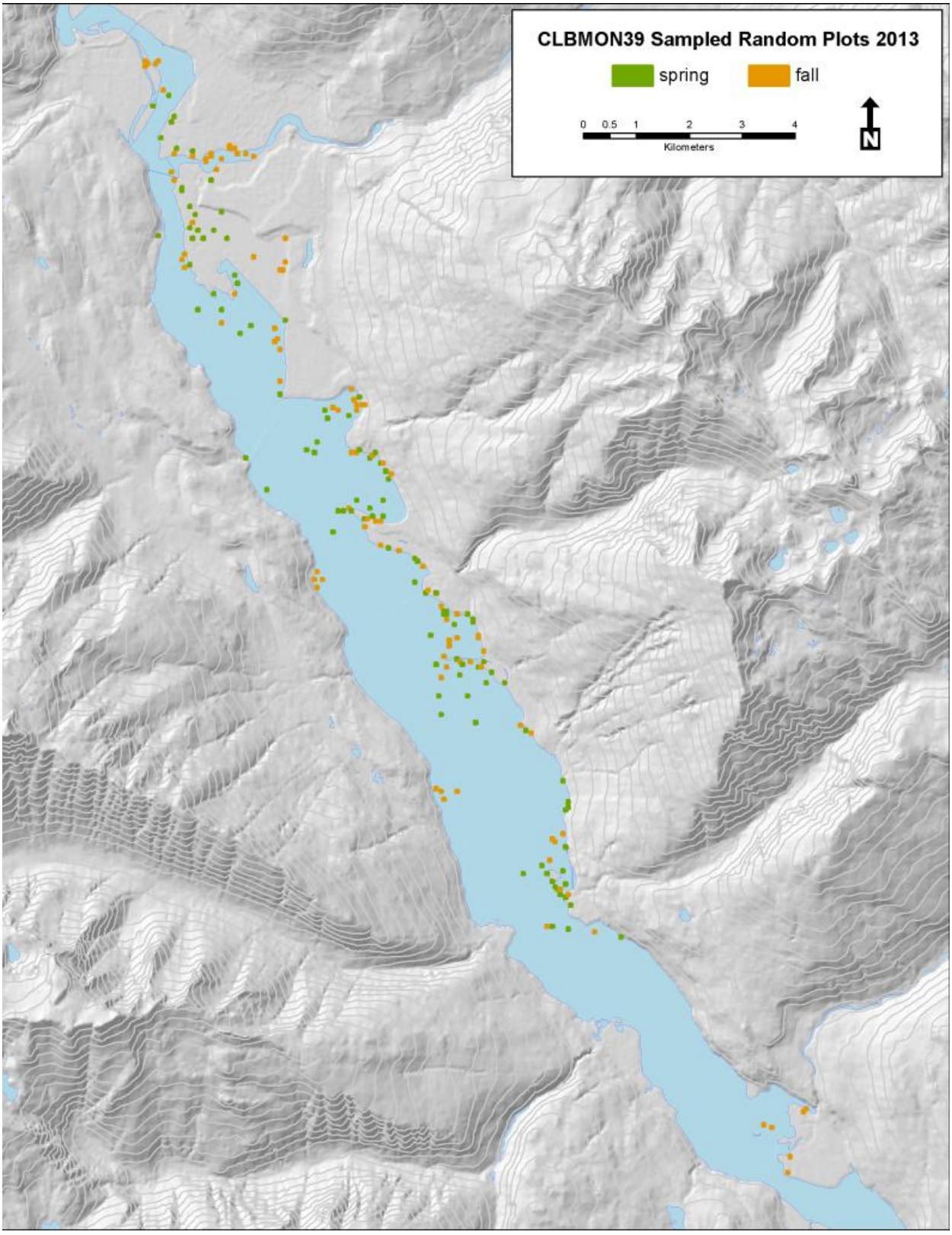
Study Objective	Management Question	Management Hypothesis	Approach	Year 6 (2013) Status	Report Section
1. Determine the migration patterns of migratory songbirds in Revelstoke Reach (within season, across seasons, and across years).	1. What is the seasonal and annual variation in the abundance and diversity of neotropical migrants in Revelstoke Reach?		Constant effort mist netting Area based quadrate surveys	Partly addressed	4.5.1
2. Determine habitat use by neotropical migrants in the drawdown zone of Revelstoke Reach over time (within season, across seasons, and across years) and the impacts of reservoir operations on habitat availability and quality.	2. Which habitats within the drawdown zone in Revelstoke Reach are utilized by neotropical migrants and what are their characteristics?		Area based quadrate surveys Habitat monitoring	In progress	4.5.2
	3. Does the operation of Arrow Lakes Reservoir impact the availability or quality of stopover habitat in Revelstoke Reach for neotropical migrants?	H2: Annual and seasonal variation in reservoir levels and the implementation of soft operational constraints do not influence the availability or quality of stop-over habitat for neotropical migrants.	Area based quadrate surveys Habitat monitoring Habitat availability monitoring	Partly addressed	4.5.3
3. Assess whether reservoir operations affect populations of neotropical migrants that use the area as a stopover site.	4. Do reservoir operations influence the diversity or abundance of neotropical migrants using stopover habitat within the drawdown area during migration? If so, how do reservoir operations influence the species richness or abundance?	H1A: Changes in the diversity of neotropical migrants in Revelstoke Reach are not attributable to reservoir operations. H1B: Changes in the abundance of neotropical migrants in Revelstoke Reach are not attributable to reservoir operations.	Constant effort mist netting Area based quadrate surveys	In progress	4.5.4
	5. Which neotropical migrants (e.g., species or guilds) are most affected by reservoir operations?		Constant effort mist netting Area based quadrate surveys	In progress	4.5.5
	6. Do reservoir operations affect the physiological health of neotropical migrants using the drawdown zone during fall migration?	H3: Annual and seasonal variation in reservoir water levels and the implementation of the soft constraints do not affect the health or population fitness of neotropical migrants as measured by plasma metabolite levels, abundance of riparian species, and age class ratios.	Physiology study (blood metabolites and feather isotopes)	Addressed	4.5.6
4. Determine whether there are specific times during the migratory seasons when minor adjustments to flow rates or water levels will enhance the ability of the drawdown area to support neotropical migrants.	7. Can operational adjustments be made to reduce impacts on neotropical migrants during migration or are mitigation measures required to minimize the loss of stopover habitat?		Constant effort mist netting Area based quadrate surveys	In progress	4.5.7

Study Objective	Management Question	Management Hypothesis	Approach	Year 6 (2013) Status	Report Section
5. Evaluate and inform physical works or revegetation designed to mitigate reservoir operations by enhancing riparian habitat for neotropical migrants.	8. Are the revegetation and the wildlife physical works projects effective at enhancing habitat for neotropical migrants in the drawdown zone?	H4: Revegetation does not change the utilization of the drawdown zone by neotropical migrants as measured by diversity or abundance. H5: Wildlife physical works projects do not change the utilization of the drawdown zone by neotropical migrants as a measure of increased species diversity or abundance.	Area based quadrate surveys Habitat monitoring	In progress	4.5.8
	9. Are some methods or techniques more effective than others at enhancing habitat for neotropical migrates in the drawdown zone? (e.g., the planting or enhancement of certain riparian vegetation).		Area based quadrate surveys Habitat monitoring	In progress	4.5.9

Appendix 2: Water levels (m) in Arrow Lakes Reservoir in 2013 compared with data from 2008 to 2012 and mean, minimum and maximum elevation (1968–2008)



Appendix 3: Random plots surveyed in Revelstoke Reach in 2013



Appendix 4: Birds species detected during CLBMON 39 in 2013 (EM = Effectiveness Monitoring, S = spring, F = fall)

Common Name	Scientific Name	Code	Permanent Plots		Random Plots		EM Plots		Banding	
			S	F	S	F	S	F	Observed	Captured
Alder Flycatcher	*Empidonax alnorum*	ALFL		x					x	x
American Coot	*Fulica americana*	AMCO			x				x	
American Crow	*Corvus brachyrhynchos*	AMCR	x	x	x	x	x	x	x	
American Dipper	*Cinclus mexicanus*	AMDI		x					x	
American Goldfinch	*Spinus tristis*	AMGO	x	x	x	x	x	x	x	
American Kestrel	*Falco sparverius*	AMKE		x				x		
American Pipit	*Anthus rubescens*	AMPI	x	x	x	x	x	x	x	
American Redstart	*Setophaga ruticilla*	AMRE	x	x	x	x	x	x	x	x
American Robin	*Turdus migratorius*	AMRO	x	x	x	x	x	x	x	x
American Wigeon	*Anas americana*	AMWI	x	x	x	x			x	
American Tree Sparrow	*Spizella arborea*	ATSP		x						x
American Three-toed Woodpecker	*Picoides dorsalis*	ATTW							x	
Barred Owl	*Strix varia*	BADO							x	
Bald Eagle	*Haliaeetus leucocephalus*	BAEA	x	x	x	x	x	x	x	
Barrow's Goldeneye	*Bucephala islandica*	BAGO							x	
Bank Swallow	*Riparia riparia*	BANS			x				x	
Barn Swallow	*Hirundo rustica*	BARS		x		x	x	x	x	
Baird's Sandpiper	*Calidris bairdii*	BASA		x						
Black-billed Magpie	*Pica hudsonia*	BBMA			x					
Black-capped Chickadee	*Poecile atricapillus*	BCCH	x	x	x	x	x	x	x	x
Belted Kingfisher	*Megaceryle alcyon*	BEKI	x	x	x	x		x	x	
Brown-headed Cowbird	*Molothrus ater*	BHCO	x	x			x	x		
Blackpoll Warbler	*Setophaga striata*	BLPW								x
Black Swift	*Cypseloides niger*	BLSW		x		x	x	x	x	
Bonaparte's Gull	*Chroicocephalus philadelphia*	BOGU		x						
Brewer's Blackbird	*Euphagus cyanocephalus*	BRBL		x	x	x	x	x	x	
Brown Creeper	*Certhia americana*	BRCR			x				x	x
Bufflehead	*Bucephala albeola*	BUFF	x		x					
Bullock's Oriole	*Icterus bullockii*	BUOR		x	x					
Blue-winged Teal	*Anas discors*	BWTE			x				x	
California Gull	*Larus californicus*	CAGU		x		x		x		
Canada Goose	*Branta canadensis*	CANG	x	x	x	x	x	x	x	
Cassin's Vireo	*Vireo cassinii*	CAVI		x						x
Chestnut-backed Chickadee	*Poecile rufescens*	CBCH		x	x					x
Clay-colored Sparrow	*Spizella pallida*	CCSP		x			x	x		x
Cedar Waxwing	*Bombycilla cedrorum*	CEDW		x		x		x	x	x
Chipping Sparrow	*Spizella passerina*	CHSP	x	x	x		x	x	x	x
Cinnamon Teal	*Anas cyanoptera*	CITE			x					
Common Goldeneye	*Bucephala clangula*	COGO			x					
Cooper's Hawk	*Accipiter cooperii*	COHA						x	x	
Common Loon	*Gavia immer*	COLO		x	x	x			x	
Common Merganser	*Mergus merganser*	COME	x	x	x	x				
Common Nighthawk	*Chordeiles minor*	CONI							x	
Common Raven	*Corvus corax*	CORA	x	x	x	x	x	x	x	
Common Yellowthroat	*Geothlypis trichas*	COYE	x	x	x	x	x	x	x	x
Dark-eyed Junco	*Junco hyemalis*	DEJU		x	x			x	x	x
Downy Woodpecker	*Picoides pubescens*	DOWO	x	x	x	x	x	x	x	
Dusky Flycatcher	*Empidonax oberholseri*	DUFL	x	x	x		x			
Eastern Kingbird	*Tyrannus tyrannus*	EAKI		x				x	x	x
Eurasian Collared-Dove	*Streptopelia decaocto*	EUCD		x						

Common Name	Scientific Name	Code	Permanent Plots		Random Plots		EM Plots		Banding	
			S	F	S	F	S	F	Observed	Captured
European Starling	*Sturnus vulgaris*	EUST							x	
Evening Grosbeak	*Coccothraustes vespertinus*	EVGR		x		x	x	x	x	
Fox Sparrow	*Passerella iliaca*	FOSP								x
Great Blue Heron	*Ardea herodias*	GBHE	x	x	x	x		x	x	
Golden-crowned Kinglet	*Regulus satrapa*	GCKI		x	x	x		x	x	x
Golden-crowned Sparrow	*Zonotrichia atricapilla*	GCSP							x	
Gray Catbird	*Dumetella carolinensis*	GRCA	x	x	x	x		x	x	x
Greater Yellowlegs	*Tringa melanoleuca*	GRYE		x		x			x	
Green-winged Teal	*Anas crecca*	GWTE	x		x	x			x	
Hammond's Flycatcher	*Empidonax hammondii*	HAFL	x		x		x			x
Hairy Woodpecker	*Picoides villosus*	HAWO		x	x				x	x
Herring Gull	*Larus argentatus*	HERG		x	x		x		x	
Hermit Thrush	*Catharus guttatus*	HETH							x	x
Horned Lark	*Eremophila alpestris*	HOLA			x					
Hooded Merganser	*Lophodytes cucullatus*	HOME		x					x	
Killdeer	*Charadrius vociferus*	KILL			x	x	x	x	x	
Lapland Longspur	*Calcarius lapponicus*	LALO		x					x	
Lazuli Bunting	*Passerina amoena*	LAZB	x	x	x	x	x	x	x	x
Long-billed Dowitcher	*Limnodromus scolopaceus*	LBDO		x					x	
Least Flycatcher	*Empidonax minimus*	LEFL	x	x	x	x	x	x	x	x
Least Sandpiper	*Calidris minutilla*	LESA		x		x				
Lesser Yellowlegs	*Tringa flavipes*	LEYE		x		x			x	
Lincoln's Sparrow	*Melospiza lincolnii*	LISP	x	x		x	x	x		x
Mallard	*Anas platyrhynchos*	MALL	x	x	x	x	x	x	x	
Magnolia Warbler	*Setophaga magnolia*	MAWA		x		x			x	x
Marsh Wren	*Cistothorus palustris*	MAWR		x				x	x	x
Merlin	*Falco columbarius*	MERL	x	x	x		x		x	
MacGillivray's Warbler	*Geothlypis tolmiei*	MGWA	x	x	x	x	x	x	x	x
Mountain Bluebird	*Sialia currucoides*	MOBL			x		x			
Mourning Dove	*Zenaida macroura*	MODO			x					
Nashville Warbler	*Oreothlypis ruficapilla*	NAWA		x	x		x		x	x
Northern Flicker	*Colaptes auratus*	NOFL	x	x	x	x	x	x	x	x
Northern Harrier	*Circus cyaneus*	NOHA	x	x	x	x		x	x	
Northern Pintail	*Anas acuta*	NOPI			x				x	
Northern Waterthrush	*Parkesia noveboracensis*	NOWA		x		x				x
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	NRWS	x	x	x	x	x	x	x	
Northern Shoveler	*Anas clypeata*	NSHO		x	x	x			x	
Northern Shrike	*Lanius excubitor*	NSHR	x							
Orange-crowned Warbler	*Oreothlypis celata*	OCWA	x	x	x	x	x	x		x
Osprey	*Pandion haliaetus*	OSPR	x	x	x	x	x	x	x	
Palm Warbler	*Setophaga palmarum*	PAWA		x				x		x
Pacific Wren	*Troglodytes pacificus*	PAWR			x					x
Pied-billed Grebe	*Podilymbus podiceps*	PBGR		x	x	x			x	
Peregrine Falcon	*Falco peregrinus*	PEFA		x						
Pectoral Sandpiper	*Calidris melanotos*	PESA		x		x			x	
Pine Siskin	*Spinus pinus*	PISI		x	x	x	x	x	x	
Pileated Woodpecker	*Dryocopus pileatus*	PIWO		x		x			x	
Prairie Warbler	*Setophaga discolor*	PRAW		x						
Pacific-slope Flycatcher	*Empidonax difficilis*	PSFL								x
Purple Finch	*Haemorhous purpureus*	PUFI							x	
Ring-billed Gull	*Larus delawarensis*	RBGU			x	x			x	
Red-breasted Nuthatch	*Sitta canadensis*	RBNU	x	x	x	x	x		x	x
Ruby-crowned Kinglet	*Regulus calendula*	RCKI	x	x	x	x	x		x	x

Common Name	Scientific Name	Code	Permanent Plots		Random Plots		EM Plots		Banding	
			S	F	S	F	S	F	Observed	Captured
Red Crossbill	*Loxia curvirostra*	RECR		x			x			
Redhead	*Aythya americana*	REDH			x					
Red-eyed Vireo	*Vireo olivaceus*	REVI	x	x	x	x	x	x	x	x
Rough-legged Hawk	*Buteo lagopus*	RLHA			x					
Ring-necked Duck	*Aythya collaris*	RNDU	x	x	x				x	
Red-naped Sapsucker	*Sphyrapicus nuchalis*	RNSA		x						x
Red-tailed Hawk	*Buteo jamaicensis*	RTHA		x	x	x	x		x	
Ruffed Grouse	*Bonasa umbellus*	RUGR	x	x	x	x	x		x	
Rufous Hummingbird	*Selasphorus rufus*	RUHU	x	x	x		x	x	x	x
Red-winged Blackbird	*Agelaius phoeniceus*	RWBL		x	x	x			x	
Savannah Sparrow	*Passerculus sandwichensis*	SAVS	x	x	x	x	x	x	x	x
Semipalmated Plover	*Charadrius semipalmatus*	SEPL							x	
Semipalmated Sandpiper	*Calidris pusilla*	SESA				x				
Snow Goose	*Chen caerulescens*	SNGO					x			
Sora	*Porzana carolina*	SORA		x					x	
Solitary Sandpiper	*Tringa solitaria*	SOSA		x		x		x	x	
Song Sparrow	*Melospiza melodia*	SOSP	x	x	x	x		x	x	x
Spotted Sandpiper	*Actitis macularius*	SPSA		x	x	x		x	x	
Sharp-shinned Hawk	*Accipiter striatus*	SSHA	x	x		x	x		x	x
Steller's Jay	*Cyanocitta stelleri*	STJA		x		x			x	x
Swamp Sparrow	*Melospiza georgiana*	SWSP		x				x	x	x
Swainson's Thrush	*Catharus ustulatus*	SWTH		x		x			x	x
Tennessee Warbler	*Oreothlypis peregrina*	TEWA		x						x
Townsend's Warbler	*Setophaga townsendi*	TOWA	x							x
Tree Swallow	*Tachycineta bicolor*	TRES	x	x	x	x	x			
Traill's Flycatcher	*Empidonax alnorum/traillii*	TRFL		x		x		x	x	x
Trumpeter Swan	*Cygnus buccinator*	TRUS			x					
Turkey Vulture	*Cathartes aura*	TUVU	x	x	x	x	x	x	x	
Unidentified *Accipiter* Hawk	*Accipiter* (sp)	UAHA		x		x			x	
Unidentified *Calidris* sandpiper	*Calidris* (sp)	UCSA		x		x		x	x	
Unidentified *Empidonax* Flycatcher	*Empidonax* (sp)	UEFL		x	x			x	x	
Unidentified Bird	*Aves* (gen, sp)	UNBI	x	x	x	x		x		
Unidentified Blackbird	*Icteridae* (gen, sp)	UNBL		x			x	x		
Unidentified Dowitcher	*Limnodromus* (sp)	UNDO						x		
Unidentified Duck	*Anatinae* (gen, sp)	UNDU		x	x	x			x	
Unidentified Flycatcher	*Tyrannidae* (gen, sp)	UNFL			x					
Unidentified Hawk	*Accipitridae* (gen, sp)	UNHA						x		
Unidentified Hummingbird	*Trochilidae* (gen, sp)	UNHU	x		x					
Unidentified *Larus* Gull	*Larus* (sp)	UNLG		x	x	x		x	x	
Unidentified Shorebird		UNSH		x					x	
Unidentified Songbird		UNSO	x	x	x	x				
Unidentified Sparrow	*Emberizidae* (gen, sp)	UNSP	x	x		x	x	x		
Unidentified Swallow	*Hirundidae* (gen, sp)	UNSW		x	x	x	x		x	
Unidentified Teal		UNTE		x					x	
Unidentified Thrush	*Turdidae* (gen, sp)	UNTH		x						
Unidentified Warbler	*Parulidae* (gen, sp)	UNWA	x	x	x	x		x		
Unidentified Woodpecker	*Picadae* (gen, sp)	UNWO		x	x	x			x	
Unidentified Wren	*Troglodytidae* (gen, sp)	UNWR				x				
Unidentified Yellowlegs	*Tringa melanoleuca/flavipes*	UNYE		x	x					
Unidentified Vireo	*Vireo* (gen, sp)	UVIR		x	x	x		x		
Vaux's Swift	*Chaetura vauxi*	VASW	x	x		x	x	x	x	
Varied Thrush	*Ixoreus naevius*	VATH	x		x				x	x
Veery	*Catharus fuscescens*	VEER	x	x		x	x		x	x

Common Name	Scientific Name	Code	Permanent Plots		Random Plots		EM Plots		Banding	
			S	F	S	F	S	F	Observed	Captured
Violet-green Swallow	*Tachycineta thalassina*	VGSW	x	x	x		x			
Virginia Rail	*Rallus limicola*	VIRA		x					x	
Warbling Vireo	*Vireo gilvus*	WAVI	x	x	x	x	x	x	x	x
White-crowned Sparrow	*Zonotrichia leucophrys*	WCSP	x	x						x
Western Kingbird	*Tyrannus verticalis*	WEKI			x					
Western Meadowlark	*Sturnella neglecta*	WEME	x	x	x		x	x		
Western Tanager	*Piranga ludoviciana*	WETA	x	x		x			x	x
Western Wood-Pewee	*Contopus sordidulus*	WEWP	x	x						x
Willow Flycatcher	*Empidonax traillii*	WIFL		x			x		x	x
Wilson's Phalarope	*Phalaropus tricolor*	WIPH							x	
Wilson's Snipe	*Gallinago delicata*	WISN	x	x	x	x	x		x	
Wilson's Warbler	*Cardellina pusilla*	WIWA	x	x		x	x	x	x	x
Wood Duck	*Aix sponsa*	WODU							x	
White-throated Sparrow	*Zonotrichia albicollis*	WTSP		x					x	x
White-winged Scoter	*Melanitta fusca*	WWSC	x	x						
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	YHBL		x		x			x	
Yellow-rumped Warbler	*Setophaga coronata*	YRWA	x	x	x	x	x	x	x	x
Yellow Warbler	*Setophaga petechia*	YWAR	x	x	x	x	x	x	x	x

Appendix 5: Species and number of birds recorded during permanent plot surveys in Revelstoke Reach in spring 2013

Common Name	On Plot	Off Plot	Overhead	Total
Yellow-rumped Warbler	55	103	2	160
American Pipit	.	73	14	87
Ruby-crowned Kinglet	39	14	.	53
Mallard	10	42	.	52
Savannah Sparrow	36	5	.	41
Vaux's Swift	.	.	27	27
American Wigeon	2	22	.	24
Black-capped Chickadee	6	16	.	22
Tree Swallow	.	5	15	20
American Goldfinch	.	15	5	20
Yellow Warbler	6	14	.	20
White-crowned Sparrow	18	.	.	18
Common Raven	1	4	11	16
Chipping Sparrow	5	8	.	13
Common Yellowthroat	12	.	.	12
Rufous Hummingbird	5	2	4	11
White-winged Scoter	.	9	.	9
Warbling Vireo	3	6	.	9
American Crow	.	4	4	8
Brown-headed Cowbird	.	.	7	7
Violet-green Swallow	.	4	3	7
Canada Goose	.	7	.	7
Northern Flicker	1	6	.	7
Bufflehead	.	6	.	6
Turkey Vulture	.	3	2	5
Ring-necked Duck	.	5	.	5
Lincoln's Sparrow	4	1	.	5
American Robin	.	4	.	4
Green-winged Teal	.	4	.	4
Western Tanager	1	3	.	4
Lazuli Bunting	2	2	.	4
Osprey	.	2	1	3
Bald Eagle	.	3	.	3
Orange-crowned Warbler	.	3	.	3
Dusky Flycatcher	3	.	.	3
Gray Catbird	3	.	.	3
Least Flycatcher	3	.	.	3
Unidentified Bird	1	.	1	2
Common Merganser	.	2	.	2
Hammond's Flycatcher	.	2	.	2
Ruffed Grouse	.	2	.	2
Townsend's Warbler	.	2	.	2
Western Wood-pewee	.	2	.	2
Downy Woodpecker	1	1	.	2
Sharp-shinned Hawk	1	1	.	2
Unidentified Warbler	1	1	.	2

Common Name	On Plot	Off Plot	Overhead	Total
MacGillivray's Warbler	2	.	.	2
Northern Shrike	2	.	.	2
Red-eyed Vireo	2	.	.	2
Wilson's Snipe	2	.	.	2
Merlin	.	.	1	1
Northern Rough-winged Swallow	.	.	1	1
Unidentified Songbird	.	.	1	1
Western Meadowlark	.	.	1	1
American Redstart	.	1	.	1
Belted Kingfisher	.	1	.	1
Great Blue Heron	.	1	.	1
Northern Harrier	.	1	.	1
Red-breasted Nuthatch	.	1	.	1
Varied Thrush	.	1	.	1
Wilson's Warbler	.	1	.	1
Song Sparrow	1	.	.	1
Unidentified Hummingbird	1	.	.	1
Unidentified Sparrow	1	.	.	1
Veery	1	.	.	1
Grand Total	231	415	100	746

Appendix 6: Average densities of on-plot neotropical migrant songbirds detected per permanent plot in each elevation band over the entire spring season in Revelstoke Reach in 2013

Species Code*	Elev. Band (m asl)	431	432	433	434	435	436	437	438	439
	N	1	.	2	2	2	5	5	2	4
YRWA	55	.	.	.	.	.	0.60	4.80	1.00	6.50
RCKI	39	.	.	.	.	.	1.00	5.60	1.00	1.00
SAVS	36	.	.	.	.	0.50	1.80	4.20	0.50	1.00
WCSP	18	.	.	.	.	.	1.60	1.40	.	0.75
COYE	12	.	.	.	.	.	0.20	2.20	.	.
YWAR	6	.	.	.	.	.	.	0.20	1.50	0.50
CHSP	5	.	.	.	.	.	.	1.00	.	.
LISP	4	.	.	.	.	.	0.20	0.40	.	0.25
DUFL	3	.	.	.	.	.	.	0.60	.	.
GRCA	3	.	.	.	.	.	.	0.40	.	0.25
LEFL	3	.	.	.	.	.	.	.	.	0.75
WAVI	3	.	.	.	.	.	.	0.40	.	0.25
LAZB	2	.	.	.	.	.	.	0.20	.	0.25
MGWA	2	.	.	.	.	.	.	0.20	.	0.25
REVI	2	.	.	.	.	.	.	.	.	0.50
SOSP	1	.	.	.	.	.	.	.	.	0.25
UNSP	1	.	.	.	.	.	.	0.20	.	.
UNWA	1	.	.	.	.	.	.	.	.	0.25
VEER	1	.	.	.	.	.	.	.	.	0.25
WETA	1	.	.	.	.	.	.	.	.	0.25
Grand Total	198	.	.	.	.	0.50	5.40	21.80	4.00	13.25

* Species Code: see definition in Appendix 4

Appendix 7: Species and number of birds recorded during permanent plot surveys in Revelstoke Reach in fall 2013

Common Name	On Plot	Off Plot	Overhead	Total
Cedar Waxwing	81	111	226	418
Common Yellowthroat	258	80	.	338
Yellow-rumped Warbler	136	82	88	306
Savannah Sparrow	184	72	28	284
Canada Goose	10	157	44	211
Common Raven	11	79	52	142
Black-capped Chickadee	74	57	.	131
Song Sparrow	100	22	.	122
Vaux's Swift	15	35	44	94
Yellow Warbler	41	25	10	76
American Pipit	2	46	25	73
Lincoln's Sparrow	53	18	.	71
Barn Swallow	3	6	55	64
Mallard	13	42	9	64
Black Swift	.	7	49	56
Violet-green Swallow	.	.	56	56
Long-billed Dowitcher	.	53	.	53
American Redstart	37	14	.	51
Pine Siskin	10	1	40	51
Unidentified Warbler	15	6	29	50
Warbling Vireo	38	10	.	48
Gray Catbird	29	16	.	45
American Crow	1	18	24	43
American Goldfinch	11	4	27	42
Red-eyed Vireo	10	32	.	42
MacGillivray's Warbler	25	16	.	41
Ruby-crowned Kinglet	37	2	.	39
American Robin	19	14	4	37
Northern Flicker	12	20	5	37
Chipping Sparrow	28	7	.	35
Unidentified Bird	14	9	12	35
Great Blue Heron	4	23	7	34
Unidentified Sparrow	12	11	8	31
Pectoral Sandpiper	1	16	11	28
Northern Rough-winged Swallow	.	3	24	27
Willow Flycatcher	19	8	.	27
Osprey	.	17	9	26
Lazuli Bunting	13	11	1	25
American Wigeon	.	23	.	23
Orange-crowned Warbler	16	7	.	23
Wilson's Warbler	14	8	.	22
Red Crossbill	.	10	10	20
Traill's Flycatcher	16	4	.	20
Unidentified *Empidonax* Flycatcher	8	10	.	18
Unidentified *Larus* Gull	.	4	12	16
Western Wood-pewee	1	15	.	16
Wilson's Snipe	11	5	.	16
Belted Kingfisher	4	6	5	15
California Gull	.	3	12	15
Spotted Sandpiper	4	11	.	15
Unidentified *Calidris* Sandpiper	.	13	2	15
Least Flycatcher	10	3	.	13
Unidentified Duck	12	.	.	12

Common Name	On Plot	Off Plot	Overhead	Total
White-crowned Sparrow	5	7	.	12
Golden-crowned Kinglet	3	8	.	11
Unidentified Swallow	.	6	5	11
Hooded Merganser	.	5	5	10
Red-breasted Nuthatch	4	6	.	10
Unidentified Blackbird	.	9	1	10
Common Loon	1	8	.	9
Eastern Kingbird	4	4	1	9
Turkey Vulture	.	7	2	9
Downy Woodpecker	3	4	1	8
Merlin	.	3	5	8
Unidentified Songbird	5	2	1	8
Veery	2	6	.	8
Alder Flycatcher	1	6	.	7
Bald Eagle	.	4	3	7
Brewer's Blackbird	2	5	.	7
Dark-eyed Junco	5	.	2	7
Greater Yellowlegs	1	5	1	7
Northern Harrier	.	5	2	7
Red-tailed Hawk	.	3	4	7
Ruffed Grouse	7	.	.	7
Red-winged Blackbird	1	6	.	7
Red-naped Sapsucker	5	1	.	6
Swainson's Thrush	5	1	.	6
Unidentified Teal	6	.	.	6
Western Tanager	2	3	1	6
Common Merganser	.	5	.	5
Lapland Longspur	1	.	4	5
Lesser Yellowlegs	.	2	3	5
Pileated Woodpecker	2	3	.	5
Brown-headed Cowbird	2	2	.	4
Evening Grosbeak	.	.	4	4
Ring-necked Duck	.	.	4	4
Sharp-shinned Hawk	1	3	.	4
Unidentified Shorebird	.	1	3	4
White-throated Sparrow	4	.	.	4
Pied-billed Grebe	.	3	.	3
Peregrine Falcon	.	3	.	3
Sora	1	2	.	3
Steller's Jay	.	2	1	3
Unidentified Vireo	.	3	.	3
Baird's Sandpiper	.	2	.	2
Chestnut-backed Chickadee	2	.	.	2
Clay-colored Sparrow	2	.	.	2
Dusky Flycatcher	2	.	.	2
Hairy Woodpecker	2	.	.	2
Herring Gull	.	.	2	2
Magnolia Warbler	1	1	.	2
Marsh Wren	.	2	.	2
Northern Shoveler	.	2	.	2
Swamp Sparrow	.	2	.	2
Tennessee Warbler	2	.	.	2
Unidentified Woodpecker	.	2	.	2
Unidentified Yellowlegs	.	2	.	2
Virginia Rail	2	.	.	2
Western Meadowlark	.	2	.	2

Common Name	On Plot	Off Plot	Overhead	Total
Yellow-headed Blackbird	.	.	2	2
American Dipper	.	1	.	1
American Kestrel	.	1	.	1
American Tree Sparrow	1	.	.	1
Bonaparte's Gull	.	1	.	1
Bullock's Oriole	1	.	.	1
Cassin's Vireo	1	.	.	1
Eurasian Collared-dove	1	.	.	1
Least Sandpiper	.	1	.	1
Nashville Warbler	1	.	.	1
Northern Waterthrush	.	1	.	1
Prairie Warbler	1	.	.	1
Rufous Hummingbird	1	.	.	1
Solitary Sandpiper	.	1	.	1
Tree Swallow	.	.	1	1
Unidentified *Accipiter* Hawk	.	1	.	1
Unidentified Thrush	.	1	.	1
Western Palm Warbler	1	.	.	1
White-winged Scoter	.	.	1	1
Grand Total	1506	1438	987	3931

Appendix 8: Number of neotropical migrant songbirds detected on plot during permanent plot surveys in and outside of the drawdown zone in Revelstoke Reach in fall 2013, by broad habitat strata

Species Code*	Forest			Shrub			Grassland			Unvegetated			IN Total	OUT Total	Grand Total
	IN	OUT	Total	IN	OUT	Total	IN	OUT	Total	IN	OUT	Total			
No. of plots	**18**	**16**	**34**	**20**	**9**	**29**	**24**	**4**	**28**	**6**	**1**	**7**	**68**	**30**	**98**
COYE	58	15	73	88	27	115	69	1	70	.	.	.	215	43	258
SAVS	5	2	7	80	2	82	65	30	95	.	.	.	150	34	184
YRWA	91	27	118	10	8	18	.	.	.	.	.	.	101	35	136
SOSP	10	10	20	33	40	73	7	.	7	.	.	.	50	50	100
CEDW	27	18	45	7	29	36	.	.	.	.	.	.	34	47	81
LISP	11	1	12	26	9	35	5	1	6	.	.	.	42	11	53
YWAR	12	9	21	9	11	20	.	.	.	.	.	.	21	20	41
WAVI	8	26	34	1	3	4	.	.	.	.	.	.	9	29	38
AMRE	17	12	29	3	5	8	.	.	.	.	.	.	20	17	37
RCKI	10	7	17	18	2	20	.	.	.	.	.	.	28	9	37
TRFL	.	10	10	11	15	26	.	.	.	.	.	.	11	25	36
GRCA	3	14	17	1	11	12	.	.	.	.	.	.	4	25	29
CHSP	7	6	13	9	1	10	4	1	5	.	.	.	20	8	28
MGWA	5	13	18	.	7	7	.	.	.	.	.	.	5	20	25
AMRO	2	12	14	.	5	5	.	.	.	.	.	.	2	17	19
OCWA	10	.	10	3	3	6	.	.	.	.	.	.	13	3	16
UNWA	10	3	13	1	1	2	.	.	.	.	.	.	11	4	15
WIWA	6	1	7	2	5	7	.	.	.	.	.	.	8	6	14
LAZB	3	2	5	2	2	4	4	.	4	.	.	.	9	4	13
UNSP	4	2	6	1	.	1	4	1	5	.	.	.	9	3	12
AMGO	1	.	1	.	10	10	.	.	.	.	.	.	1	10	11
LEFL	6	3	9	.	1	1	.	.	.	.	.	.	6	4	10
PISI	.	5	5	2	3	5	.	.	.	.	.	.	2	8	10
REVI	8	2	10	.	.	.	.	.	.	.	.	.	8	2	10
UEFL	2	2	4	1	3	4	.	.	.	.	.	.	3	5	8
DEJU	2	2	4	.	.	.	1	.	1	.	.	.	3	2	5
SWTH	1	1	2	.	3	3	.	.	.	.	.	.	1	4	5
WCSP	.	2	2	1	1	2	.	1	1	.	.	.	1	4	5
EAKI	.	1	1	3	.	3	.	.	.	.	.	.	3	1	4
BARS	3	.	3	.	.	.	.	.	.	.	.	.	3	.	3
GCKI	.	3	3	.	.	.	.	.	.	.	.	.	.	3	3
AMPI	.	.	.	.	.	.	2	.	2	.	.	.	2	.	2
BHCO	.	.	.	.	1	1	.	1	1	.	.	.	.	2	2
BRBL	2	.	2	.	.	.	.	.	.	.	.	.	2	.	2
CCSP	1	.	1	1	.	1	.	.	.	.	.	.	2	.	2
DUFL	.	2	2	.	.	.	.	.	.	.	.	.	.	2	2
TEWA	.	2	2	.	.	.	.	.	.	.	.	.	.	2	2
VEER	.	.	.	.	2	2	.	.	.	.	.	.	.	2	2
WETA	.	2	2	.	.	.	.	.	.	.	.	.	.	2	2
BUOR	.	.	.	.	1	1	.	.	.	.	.	.	.	1	1
CAVI	1	.	1	.	.	.	.	.	.	.	.	.	1	.	1
MAWA	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1
NAWA	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1
PRAW	.	.	.	1	.	1	.	.	.	.	.	.	1	.	1
RWBL	.	.	.	.	.	.	1	.	1	.	.	.	1	.	1
WEWP	1	.	1	.	.	.	.	.	.	.	.	.	1	.	1
WPWA	1	.	1	.	.	.	.	.	.	.	.	.	1	.	1
Grand Total	328	219	547	314	211	525	162	36	198	.	.	.	804	466	1270

* Species Code: see definition in Appendix 4

Appendix 9: Number of neotropical migrant songbirds detected on plot during permanent plot surveys in Revelstoke Reach in fall 2013 in different weeks of survey

Species Code*	Week 1 28.7-3.8.	Week 2 4-10.8.	Week 3 11-17.8.	Week 4 18-24.8.	Week 5 25-31.8.	Week 6 1-7.9.	Week 7 8-14.9.	Week 8 15-21.9.	Week 9 22-28.9.	Total
COYE	16	9	18	30	28	40	25	56	36	258
SAVS	12	1	10	11	11	30	65	40	4	184
YRWA	1	.	.	12	.	37	27	28	31	136
SOSP	13	7	11	10	11	13	11	20	4	100
CEDW	32	20	9	6	2	3	.	9	.	81
LISP	.	.	.	.	6	17	10	13	7	53
YWAR	10	12	6	10	3	.	.	.	.	41
WAVI	3	9	15	4	5	1	1	.	.	38
AMRE	4	6	15	4	3	3	2	.	.	37
RCKI	.	.	1	.	.	3	.	5	28	37
TRFL	14	9	9	1	2	1	.	.	.	36
GRCA	7	7	7	2	2	3	1	.	.	29
CHSP	10	6	7	5	.	.	.	.	.	28
MGWA	2	5	12	2	2	1	.	1	.	25
AMRO	3	4	5	2	.	1	1	3	.	19
OCWA	.	.	.	4	.	3	.	9	.	16
UNWA	.	4	3	3	5	.	.	.	.	15
WIWA	.	1	4	.	.	1	1	4	3	14
LAZB	7	3	2	1	.	.	.	.	.	13
UNSP	.	.	1	.	1	2	1	3	4	12
AMGO	1	10	.	.	.	.	.	.	.	11
LEFL	8	.	1	.	1	.	.	.	.	10
PISI	.	2	.	.	.	8	.	.	.	10
REVI	4	2	4	.	.	.	.	.	.	10
UEFL	1	2	1	.	1	2	1	.	.	8
DEJU	.	.	1	.	.	.	2	2	.	5
SWTH	1	.	.	.	2	1	1	.	.	5
WCSP	.	.	.	.	.	2	1	2	.	5
EAKI	1	.	1	2	.	.	.	.	.	4
BARS	.	3	.	.	.	.	.	.	.	3
GCKI	.	.	.	.	.	.	1	2	.	3
AMPI	.	.	.	.	.	.	.	.	2	2
BHCO	.	1	.	1	.	.	.	.	.	2
BRBL	.	.	.	.	.	.	.	.	2	2
CCSP	.	.	.	.	1	.	.	1	.	2
DUFL	2	.	.	.	.	.	.	.	.	2
TEWA	.	.	.	.	.	.	1	.	1	2
VEER	1	.	1	.	.	.	.	.	.	2
WETA	1	.	.	.	1	.	.	.	.	2
BUOR	1	.	.	.	.	.	.	.	.	1
CAVI	.	.	.	.	1	.	.	.	.	1
MAWA	1	.	.	.	.	.	.	.	.	1
NAWA	1	.	.	.	.	.	.	.	.	1
PRAW	.	.	.	1	.	.	.	.	.	1
RWBL	.	.	.	1	.	.	.	.	.	1
WEWP	.	.	1	.	.	.	.	.	.	1
WPWA	.	.	.	.	.	.	.	1	.	1
Grand Total	157	123	145	112	88	172	152	199	122	1270

* Species Code: see definition in Appendix 4

* Species Code: see definition in Appendix 6

Appendix 10: Average densities of on-plot neotropical migrant songbirds detected per permanent plot in each elevation band over the entire season in Revelstoke Reach in fall 2013

Species Code*	Elev. Band (m asl)	431	432	433	434	435	436	437	438	439	440	441	≥442
	N	2	1	4	4	4	9	14	18	12	8	7	15
COYE	258	.	.	.	0.25	1.00	1.67	3.64	6.50	2.25	3.63	0.43	0.73
SAVS	184	.	.	.	1.50	1.00	7.67	0.64	1.56	2.83	0.25	0.43	1.93
YRWA	136	.	.	.	.	.	0.11	0.79	1.78	4.75	1.25	1.00	1.20
SOSP	100	.	.	.	.	.	1.00	0.50	1.39	0.75	3.13	.	1.67
CEDW	81	.	.	.	.	.	.	.	1.28	0.92	1.38	0.57	2.13
LISP	53	.	.	.	0.25	.	1.00	0.57	0.89	0.67	0.13	0.14	0.60
YWAR	41	.	.	.	.	.	.	0.50	0.56	0.33	0.88	.	0.87
WAVI	38	.	.	.	.	.	.	0.29	0.22	0.08	0.63	0.86	1.20
AMRE	37	.	.	.	.	.	.	0.36	0.39	0.67	0.88	0.43	0.47
RCKI	37	.	.	.	.	.	.	0.07	1.28	0.33	0.13	0.71	0.20
TRFL	36	.	.	.	.	.	.	0.21	0.44	.	1.75	0.29	0.60
GRCA	29	.	.	.	.	.	.	.	0.06	0.25	1.13	0.71	0.73
CHSP	28	.	.	.	.	.	.	0.14	0.78	0.33	0.25	0.14	0.33
MGWA	25	.	.	.	.	.	.	.	0.11	0.25	0.88	.	0.87
AMRO	19	.	.	.	.	.	.	.	.	0.17	.	1.00	0.67
OCWA	16	.	.	.	.	.	.	0.21	.	0.83	.	.	0.20
UNWA	15	.	.	.	.	.	.	.	0.11	0.75	0.25	.	0.13
WIWA	14	.	.	.	.	.	.	0.14	0.17	0.25	.	.	0.40
LAZB	13	.	.	.	.	.	.	0.07	0.11	0.50	0.13	0.14	0.13
UNSP	12	.	.	.	0.25	0.25	0.11	0.07	0.11	0.25	.	.	0.20
AMGO	11	.	.	.	.	.	.	.	0.06	.	.	.	0.67
LEFL	10	.	.	.	.	.	.	.	0.06	0.42	0.13	0.43	.
PISI	10	.	.	.	.	.	0.22	.	.	.	0.38	0.71	.
REVI	10	.	.	.	.	.	.	0.07	.	0.58	0.25	.	.
UEFL	8	.	.	.	.	.	.	.	0.11	0.08	0.38	.	0.13
DEJU	5	.	.	.	.	.	.	0.07	0.06	0.08	.	.	0.13
SWTH	5	.	.	.	.	.	.	.	.	0.08	.	.	0.27
WCSP	5	.	.	.	.	.	0.11	.	.	.	.	.	0.27
EAKI	4	.	.	.	.	.	.	.	0.17	.	.	0.14	.
BARS	3	.	.	.	.	.	.	.	.	0.25	.	.	.
GCKI	3	.	.	.	.	.	.	.	.	.	.	0.14	0.13
AMPI	2	.	.	.	0.50	.	.	.	.	.	.	.	.
BHCO	2	.	.	.	.	.	.	.	.	.	0.13	.	0.07
BRBL	2	.	.	.	.	.	.	0.14	.	.	.	.	.
CCSP	2	.	.	.	.	.	.	.	0.11	.	.	.	.
DUFL	2	.	.	.	.	.	.	.	.	.	0.25	.	.
TEWA	2	.	.	.	.	.	.	.	.	.	0.13	0.14	.
VEER	2	.	.	.	.	.	.	.	.	.	.	.	0.13
WETA	2	.	.	.	.	.	.	.	.	.	.	0.29	.
BUOR	1	.	.	.	.	.	.	.	.	.	.	.	0.07
CAVI	1	.	.	.	.	.	.	.	.	0.08	.	.	.
MAWA	1	.	.	.	.	.	.	.	.	.	0.13	.	.
NAWA	1	.	.	.	.	.	.	.	.	.	.	.	0.07
PRAW	1	.	.	.	.	.	.	0.07	.	.	.	.	.
RWBL	1	.	.	.	.	.	.	.	0.06	.	.	.	.
WEWP	1	.	.	.	.	.	.	.	.	0.08	.	.	.
WPWA	1	.	.	.	.	.	.	.	0.06	.	.	.	.
Total	1270	.	.	.	2.75	2.25	11.89	8.57	18.39	18.83	18.38	8.71	17.20

* Species Code: see definition in Appendix 4

Appendix 11: Species and number of birds detected on effectiveness monitoring plots during surveys in spring 2013

Common Name	On plot	Off plot	Overhead	Total
American Pipit	65	153	125	343
Canada Goose	.	96	7	103
Yellow-rumped Warbler	9	23	14	46
Vaux's Swift	.	5	38	43
American Goldfinch	3	7	17	27
American Robin	7	18	1	26
Red Crossbill	.	.	25	25
Violet-green Swallow	.	.	25	25
Yellow Warbler	.	24	.	24
Pine Siskin	.	3	20	23
Tree Swallow	.	2	15	17
Chipping Sparrow	6	11	.	17
Northern Rough-winged Swallow	.	10	6	16
Common Yellowthroat	.	12	.	12
Mallard	.	5	5	10
Warbling Vireo	.	10	.	10
Brewer's Blackbird	.	2	7	9
American Crow	.	8	.	8
Dusky Flycatcher	.	8	.	8
Savannah Sparrow	1	4	2	7
Rufous Hummingbird	4	1	2	7
Red-tailed Hawk	.	6	1	7
Killdeer	.	7	.	7
Western Meadowlark	.	7	.	7
American Redstart	.	6	.	6
Mountain Bluebird	3	3	.	6
Unidentified Swallow	.	3	2	5
Common Raven	.	4	1	5
Wilson's Warbler	.	5	.	5
Ruby-crowned Kinglet	1	4	.	5
Black Swift	.	.	4	4
Turkey Vulture	.	3	1	4
Hammond's Flycatcher	.	4	.	4
MacGillivray's Warbler	.	4	.	4
Ruffed Grouse	.	4	.	4
Black-capped Chickadee	.	3	.	3
Lazuli Bunting	.	3	.	3
Least Flycatcher	.	3	.	3
Orange-crowned Warbler	2	1	.	3
Unidentified Blackbird	.	.	2	2
Osprey	.	1	1	2
Sharp-shinned Hawk	.	1	1	2
Bald Eagle	.	2	.	2
Brown-headed Cowbird	.	2	.	2
Herring Gull	.	2	.	2
Merlin	.	2	.	2

Common Name	On plot	Off plot	Overhead	Total
Nashville Warbler	.	2	.	2
Northern Flicker	.	2	.	2
Red-breasted Nuthatch	.	2	.	2
Downy Woodpecker	1	1	.	2
Unidentified Sparrow	1	1	.	2
Barn Swallow	.	.	1	1
Clay-colored Sparrow	.	1	.	1
Evening Grosbeak	.	1	.	1
Lincoln's Sparrow	.	1	.	1
Red-eyed Vireo	.	1	.	1
Snow Goose	.	1	.	1
Veery	.	1	.	1
Willow Flycatcher	.	1	.	1
Wilson's Snipe	.	1	.	1
Grand Total	103	498	323	924

Appendix 12: Species and number of birds detected on effectiveness monitoring plots during surveys in fall 2013

Common Name	On Plot	Off Plot	Overhead	Total
Pine Siskin	10	19	115	144
Canada Goose	3	113	14	130
Yellow-rumped Warbler	16	22	57	95
Cedar Waxwing	7	40	31	78
Common Yellowthroat	43	29	.	72
American Pipit	.	20	44	64
Lincoln's Sparrow	50	7	.	57
Black Swift	.	.	52	52
Vaux's Swift	.	.	37	37
Mallard	16	4	4	24
Savannah Sparrow	13	7	4	24
Unidentified Duck	.	9	12	21
American Goldfinch	.	6	13	19
Black-capped Chickadee	2	7	6	15
Brewer's Blackbird	.	15	.	15
Unidentified Songbird	.	2	13	15
Great Blue Heron	6	8	.	14
Yellow Warbler	1	4	6	11
Dark-eyed Junco	10	.	.	10
Song Sparrow	6	3	.	9
American Redstart	.	8	.	8
Barn Swallow	.	4	4	8
Red-breasted Merganser	.	8	.	8
Unidentified Sparrow	1	4	3	8
American Wigeon	2	.	5	7
Northern Rough-winged Swallow	.	1	6	7
Tree Swallow	.	.	7	7
Common Raven	.	6	.	6
Gray Catbird	.	6	.	6
Red-eyed Vireo	.	5	.	5
White-crowned Sparrow	5	.	.	5
American Robin	.	4	.	4
Belted Kingfisher	.	2	2	4
Sora	4	.	.	4
Unidentified Warbler	.	2	2	4
Wilson's Snipe	1	1	2	4
Green-winged Teal	.	.	3	3
Lazuli Bunting	.	3	.	3
Merlin	.	2	1	3
Spotted Sandpiper	1	1	1	3
Swamp Sparrow	2	1	.	3
Unidentified *Larus* Gull	.	2	1	3
American Crow	.	1	1	2
Herring Gull	.	1	1	2
Lesser Yellowlegs	2	.	.	2
MacGillivray's Warbler	.	2	.	2

Common Name	On Plot	Off Plot	Overhead	Total
Osprey	.	1	1	2
Red-breasted Nuthatch	.	2	.	2
Rufous Hummingbird	1	.	1	2
Traill's Flycatcher	1	1	.	2
Bald Eagle	.	1	.	1
Brown-headed Cowbird	.	1	.	1
Cassin's Vireo	.	1	.	1
Common Loon	.	1	.	1
Eastern Kingbird	.	1	.	1
Hammond's Flycatcher	.	1	.	1
House Wren	1	.	.	1
Marsh Wren	.	1	.	1
Northern Flicker	.	1	.	1
Northern Pintail	1	.	.	1
Red-necked Grebe	.	1	.	1
Red-tailed Hawk	.	1	.	1
Sanderling	1	.	.	1
Sharp-shinned Hawk	.	1	.	1
Unidentified *Empidonax* Flycatcher	1	.	.	1
Unidentified Bird	1	.	.	1
Unidentified Teal	1	.	.	1
Western Wood-pewee	.	1	.	1
Willow Flycatcher	.	1	.	1
Grand Total	**209**	**396**	**449**	**1,054**

Appendix 13: Species and number of birds detected during random plot surveys in Revelstoke Reach in spring 2013

Common Name	On Plot	Off Plot	Overhead	Total
Canada Goose	28	149	19	196
American Pipit	1	37	105	143
Mallard	21	102	5	128
American Robin	88	33	1	122
American Wigeon	14	95	2	111
Tree Swallow	26	19	17	62
Yellow-rumped Warbler	29	18	2	49
Unidentified *Larus* Gull	.	.	40	40
Unidentified Swallow	.	8	31	39
Common Raven	1	31	5	37
American Crow	2	17	9	28
Green-winged Teal	7	17	.	24
Bufflehead	.	20	.	20
Ruby-crowned Kinglet	15	5	.	20
Yellow Warbler	6	11	2	19
Black-capped Chickadee	7	9	.	16
Killdeer	.	15	1	16
Northern Flicker	1	15	.	16
Western Meadowlark	.	16	.	16
Chipping Sparrow	.	13	.	13
Common Merganser	.	13	.	13
Unidentified Duck	.	13	.	13
Violet-green Swallow	.	2	11	13
Least Flycatcher	1	10	.	11
Northern Pintail	.	10	.	10
Rufous Hummingbird	8	1	1	10
Horned Lark	.	1	8	9
Northern Rough-winged Swallow	.	1	8	9
Pine Siskin	.	8	1	9
Unidentified Bird	3	1	5	9
Dark-eyed Junco	8	.	.	8
Northern Shoveler	.	8	.	8
Ring-billed Gull	.	.	8	8
Red-breasted Nuthatch	1	7	.	8
Ring-necked Duck	.	8	.	8
Common Yellowthroat	1	5	1	7
Osprey	1	5	1	7
Savannah Sparrow	3	3	1	7
Turkey Vulture	.	6	1	7
American Goldfinch	.	.	6	6
Cinnamon Teal	2	4	.	6
Unidentified Songbird	5	.	1	6
Bald Eagle	.	3	2	5
Song Sparrow	.	5	.	5
Blue-winged Teal	.	4	.	4
Common Goldeneye	.	4	.	4
Great Blue Heron	.	3	1	4
Golden-crowned Kinglet	2	2	.	4
Gray Catbird	3	1	.	4
Mountain Bluebird	1	3	.	4
Varied Thrush	.	4	.	4
Warbling Vireo	1	3	.	4

Common Name	On Plot	Off Plot	Overhead	Total
American Coot	2	1	.	3
Belted Kingfisher	.	1	2	3
Hammond's Flycatcher	1	2	.	3
Nashville Warbler	1	2	.	3
Red-eyed Vireo	.	3	.	3
Red-tailed Hawk	.	.	3	3
Spotted Sandpiper	2	1	.	3
Bank Swallow	.	.	2	2
Brewer's Blackbird	.	2	.	2
Bullock's Oriole	.	2	.	2
Common Loon	.	2	.	2
Merlin	.	2	.	2
Orange-crowned Warbler	2	.	.	2
Pied-billed Grebe	1	1	.	2
Unidentified *Empidonax* Flycatcher	1	1	.	2
Unidentified Hummingbird	1	.	1	2
Unidentified Yellowlegs	.	2	.	2
Unidentified Vireo	.	2	.	2
Wilson's Snipe	.	2	.	2
American Redstart	.	1	.	1
Black-billed Magpie	.	.	1	1
Brown Creeper	.	1	.	1
Chestnut-backed Chickadee	1	.	.	1
Downy Woodpecker	.	1	.	1
Dusky Flycatcher	.	1	.	1
Hairy Woodpecker	1	.	.	1
Herring Gull	.	.	1	1
Lazuli Bunting	1	.	.	1
MacGillivray's Warbler	.	1	.	1
Mourning Dove	.	1	.	1
Northern Harrier	.	1	.	1
Pacific Wren	.	1	.	1
Redhead	.	1	.	1
Rough-legged Hawk	.	1	.	1
Ruffed Grouse	.	1	.	1
Red-winged Blackbird	.	1	.	1
Trumpeter Swan	.	1	.	1
Unidentified Flycatcher	.	1	.	1
Unidentified Warbler	1	.	.	1
Unidentified Woodpecker	.	1	.	1
Western Kingbird	.	1	.	1
Grand Total	**301**	**810**	**305**	**1416**

Appendix 14: Average densities of on-plot neotropical migrant songbirds detected per random plot in each stratum over the entire season in spring 2013

Common Name	Forest	Shrub	Grassland	Unvegetated	Wetland	Total
American Robin	2.93	0.10	.	.	.	0.81
Yellow-rumped Warbler	1.00	.	.	.	.	0.27
Tree Swallow	.	0.38	.	.	0.75	0.24
Ruby-crowned Kinglet	0.45	0.07	.	.	.	0.14
Dark-eyed Junco	0.21	0.07	.	.	.	0.07
Yellow Warbler	0.03	0.14	.	.	0.05	0.06
Gray Catbird	.	.	.	.	0.15	0.03
Savannah Sparrow	0.03	0.07	.	.	.	0.03
Golden-crowned Kinglet	0.07	.	.	.	.	0.02
Orange-crowned Warbler	0.07	.	.	.	.	0.02
American Pipit	.	.	.	.	0.05	0.01
Common Yellowthroat	.	0.03	.	.	.	0.01
Hammond's Flycatcher	0.03	.	.	.	.	0.01
Lazuli Bunting	.	0.03	.	.	.	0.01
Least Flycatcher	0.03	.	.	.	.	0.01
Mountain Bluebird	.	0.03	.	.	.	0.01
Nashville Warbler	0.03	.	.	.	.	0.01
Unidentified *Empidonax* Flycatcher	0.03	.	.	.	.	0.01
Unidentified Warbler	0.03	.	.	.	.	0.01
Warbling Vireo	0.03	.	.	.	.	0.01
Grand Total	5.00	0.93	.	.	1.00	1.76

Appendix 15: Species and number of birds detected during random plot surveys in Revelstoke Reach in fall 2013

Common Name	On Plot	Off Plot	Overhead	Total
Canada Goose	48	179	24	251
Cedar Waxwing	8	8	104	120
Mallard	.	64	4	68
Savannah Sparrow	26	13	3	42
American Crow	9	21	5	35
Common Raven	.	26	7	33
Black-capped Chickadee	18	8	.	26
Common Yellowthroat	10	12	.	22
Unidentified Duck	.	18	.	18
Unidentified *Larus* Gull	.	15	2	17
Northern Rough-winged Swallow	.	9	7	16
Pine Siskin	.	2	14	16
American Wigeon	.	6	9	15
Green-winged Teal	1	13	.	14
Red-eyed Vireo	2	11	.	13
Spotted Sandpiper	6	7	.	13
Yellow-rumped Warbler	2	1	10	13
Greater Yellowlegs	7	5	.	12
American Goldfinch	.	1	10	11
Unidentified Sparrow	8	2	1	11
Yellow Warbler	3	4	4	11
Tree Swallow	.	.	10	10
California Gull	.	.	9	9
Osprey	.	6	3	9
Unidentified Swallow	.	.	9	9
American Redstart	.	8	.	8
American Robin	5	3	.	8
Gray Catbird	1	7	.	8
Killdeer	3	5	.	8
Lesser Yellowlegs	1	7	.	8
Bald Eagle	1	4	2	7
Turkey Vulture	.	5	2	7
Northern Flicker	.	5	1	6
Northern Shoveler	.	4	2	6
Red-breasted Nuthatch	3	3	.	6
Song Sparrow	3	3	.	6
Swainson's Thrush	4	2	.	6
Unidentified Warbler	1	.	5	6
Wilson's Snipe	3	1	1	5
Barn Swallow	.	1	3	4
Belted Kingfisher	.	3	1	4
Black Swift	.	2	2	4
Common Merganser	.	4	.	4
Great Blue Heron	.	2	2	4
Lazuli Bunting	1	3	.	4
Pectoral Sandpiper	.	.	4	4

Common Name	On Plot	Off Plot	Overhead	Total
Semipalmated Sandpiper	.	4	.	4
Solitary Sandpiper	1	3	.	4
Unidentified Vireo	.	4	.	4
Evening Grosbeak	.	.	3	3
Red-tailed Hawk	.	.	3	3
Sharp-shinned Hawk	1	1	1	3
Veery	1	2	.	3
Brewer's Blackbird	.	2	.	2
Downy Woodpecker	.	2	.	2
Golden-crowned Kinglet	.	2	.	2
Least Sandpiper	.	2	.	2
MacGillivray's Warbler	1	1	.	2
Magnolia Warbler	2	.	.	2
Northern Harrier	.	1	1	2
Pileated Woodpecker	1	1	.	2
Ring-billed Gull	.	.	2	2
Ruffed Grouse	.	2	.	2
Steller's Jay	1	1	.	2
Traill's Flycatcher	1	1	.	2
Unidentified Bird	2	.	.	2
Vaux's Swift	.	.	2	2
Warbling Vireo	1	1	.	2
Western Tanager	.	2	.	2
American Pipit	1	.	.	1
Common Loon	.	1	.	1
Least Flycatcher	.	1	.	1
Lincoln's Sparrow	1	.	.	1
Northern Waterthrush	1	.	.	1
Orange-crowned Warbler	1	.	.	1
Pied-billed Grebe	.	1	.	1
Red-winged Blackbird	.	.	1	1
Ruby-crowned Kinglet	.	1	.	1
Unidentified *Accipiter* Hawk	.	1	.	1
Unidentified *Calidris* Sandpiper	.	1	.	1
Unidentified Songbird	.	.	1	1
Unidentified Woodpecker	.	1	.	1
Unidentified Wren	.	1	.	1
Willow Flycatcher	.	1	.	1
Wilson's Warbler	1	.	.	1
Yellow-headed Blackbird	1	.	.	1
Grand Total	192	544	274	1010

Appendix 16: Average densities of on-plot neotropical migrant songbirds detected per random plot in each stratum over the entire season in fall 2013

Common Name	Forest	Shrub	Grassland	Unvegetated	Wetland	Total
Savannah Sparrow	0.17	0.03	0.44	.	0.87	0.26
Common Yellowthroat	0.10	.	0.19	.	0.27	0.10
Cedar Waxwing	0.24	0.03	.	.	.	0.08
Unidentified Sparrow	.	0.06	0.13	.	0.27	0.08
American Robin	0.17	.	.	.	.	0.05
Swainson's Thrush	0.14	.	.	.	.	0.04
Song Sparrow	.	.	0.06	.	0.13	0.03
Yellow Warbler	0.07	0.03	.	.	.	0.03
Magnolia Warbler	0.07	.	.	.	.	0.02
Red-eyed Vireo	0.07	.	.	.	.	0.02
Yellow-rumped Warbler	0.07	.	.	.	.	0.02
American Pipit	.	.	.	0.13	.	0.01
Gray Catbird	0.03	.	.	.	.	0.01
Lazuli Bunting	0.03	.	.	.	.	0.01
Lincoln's Sparrow	0.03	.	.	.	.	0.01
MacGillivray's Warbler	0.03	.	.	.	.	0.01
Northern Waterthrush	0.03	.	.	.	.	0.01
Orange-crowned Warbler	0.03	.	.	.	.	0.01
Traill's Flycatcher	.	.	.	.	0.07	0.01
Unidentified Warbler	0.03	.	.	.	.	0.01
Veery	0.03	.	.	.	.	0.01
Warbling Vireo	0.03	.	.	.	.	0.01
Wilson's Warbler	0.03	.	.	.	.	0.01
Yellow-headed Blackbird	.	.	.	.	0.07	0.01
Grand Total	1.45	0.16	0.81	0.13	1.67	0.86

Appendix 17: Banding data summary from Airport Islands Banding Station, Revelstoke Reach, 2013

Species Code*	No. of Newly Captured**	%	Capture Rate***	No. of Same-Day Recap	%	No. of Recap	Recap Rate (%)	Total No. Recaptures	No. of Unbanded	Total No.	Total Capture Rate***
COYE	98	50.8	0.1557	12	12.2	23	23.5	35	1	134	0.2129
SAVS	53	27.5	0.0842	2	3.8	.	.	2	.	55	0.0874
WIFL	8	4.1	0.0127	8	100.0	9	112.5	17	.	25	0.0397
YRWA	12	6.2	0.0191	1	8.3	.	.	1	.	13	0.0207
LISP	5	2.6	0.0079	2	40.0	.	.	2	.	7	0.0111
SOSP	5	2.6	0.0079	1	20.0	1	20.0	2	.	7	0.0111
YWAR	3	1.6	0.0048	.	.	1	33.3	1	.	4	0.0064
OCWA	3	1.6	0.0048	.	.	.	.	.	.	3	0.0048
SWSP	2	1.0	0.0032	.	.	.	.	.	.	2	0.0032
GRCA	1	0.5	0.0016	.	.	.	.	.	.	1	0.0016
HAFL	1	0.5	0.0016	.	.	.	.	.	.	1	0.0016
MAWR	1	0.5	0.0016	.	.	.	.	.	.	1	0.0016
PAWA	1	0.5	0.0016	.	.	.	.	.	.	1	0.0016
RUHU	.	.	.	.	.	.	.	.	1	1	0.0016
Total	193	100.0	0.3066	26	13.5	34	17.6	60	2	255	0.4051

* Species Code: see definition in Appendix 4
** No. of Newly Captured: for CLBMON 39 in 2013 (included recaptures of birds banded in previous year)
*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 18: Banding data summary from Machete Island Banding Station, Revelstoke Reach, 2013

Species Code*	No. of Newly Captured**	%	Capture Rate***	No. of Same-Day Recap	%	No. of Recap	Recap Rate (%)	Total No. Recaptures	No. of Unbanded	Total No.	Total Capture Rate***
COYE	262	25.9	0.3169	41	15.6	60	22.9	102	28	391	0.4729
OCWA	88	8.7	0.1064	6	6.8	3	3.4	9	10	107	0.1294
YWAR	83	8.2	0.1004	4	4.8	4	4.8	8	.	91	0.1101
YRWA	87	8.6	0.1052	1	1.6	1	1.6	2	1	90	0.1089
GRCA	32	3.2	0.0387	6	18.8	28	87.5	34	2	68	0.0822
WAVI	58	5.7	0.0702	1	1.7	6	10.3	7	2	67	0.0810
REVI	47	4.6	0.0568	.	.	14	29.8	14	.	61	0.0738
WIFL	45	4.5	0.0544	4	8.9	6	13.3	10	.	55	0.0665
AMRE	37	3.7	0.0448	.	.	5	13.5	5	1	43	0.0520
SOSP	27	2.7	0.0327	3	11.1	10	37.0	13	3	43	0.0520
LISP	24	2.4	0.0290	5	20.8	2	8.3	7	2	33	0.0399
TRFL	24	2.4	0.0290	3	12.5	4	16.7	7	1	32	0.0387
BCCH	12	1.2	0.0145	.	.	19	158.3	19	.	31	0.0375
SWTH	27	2.7	0.0327	2	7.4	2	7.4	4	.	31	0.0375
MGWA	27	2.7	0.0327	1	3.7	.	.	1	.	28	0.0339
VEER	21	2.1	0.0254	1	4.8	2	9.5	3	.	24	0.0290
WIWA	18	1.8	0.0218	3	16.7	.	.	3	2	23	0.0278
ALFL	19	1.9	0.0230	.	.	2	10.5	2	.	21	0.0254
LEFL	14	1.4	0.0169	2	14.3	3	21.4	5	.	19	0.0230
SAVS	11	1.1	0.0133	.	.	.	.	.	1	12	0.0145
LAZB	8	0.8	0.0097	.	.	.	.	.	.	8	0.0097
RCKI	5	0.5	0.0060	1	20.0	.	.	1	.	6	0.0073
SWSP	5	0.5	0.0060	1	20.0	.	.	1	.	6	0.0073
CHSP	5	0.5	0.0060	.	.	.	.	.	.	5	0.0060
CCSP	3	0.3	0.0036	.	.	.	.	.	1	4	0.0048
ATSP	2	0.2	0.0024	1	50.0	.	.	1	.	3	0.0036
CEDW	3	0.3	0.0036	.	.	.	.	.	.	3	0.0036
MAWA	2	0.2	0.0024	1	50.0	.	.	1	.	3	0.0036
TEWA	3	0.3	0.0036	.	.	.	.	.	.	3	0.0036
NOWA	2	0.2	0.0024	.	.	.	.	.	.	2	0.0024
WCSP	1	0.1	0.0012	1	100.0	.	.	1	.	2	0.0024
WEWP	2	0.2	0.0024	.	.	.	.	.	.	2	0.0024
BLPW	1	0.1	0.0012	.	.	.	.	.	.	1	0.0012
DEJU	1	0.1	0.0012	.	.	.	.	.	.	1	0.0012
EAKI	1	0.1	0.0012	.	.	.	.	.	.	1	0.0012
MAWR	1	0.1	0.0012	.	.	.	.	.	.	1	0.0012
NAWA	1	0.1	0.0012	.	.	.	.	.	.	1	0.0012
PAWR	1	0.1	0.0012	.	.	.	.	.	.	1	0.0012
PSFL	1	0.1	0.0012	.	.	.	.	.	.	1	0.0012
Total	1011	100.0	1.2229	88	8.7	171	16.9	259	54	1324	1.6015

* Species Code: see definition in Appendix 4
** No. of Newly Captured: for CLBMON 39 in 2013 (included recaptures of birds banded in previous year)
*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 19: Banding data summary from Jordan River Banding Station, Revelstoke Reach, 2013

Species Code*	No. of Newly Captured**	%	Capture Rate***	No. of Same-Day Recap	%	No. of Recap	Recap Rate (%)	Total No. Recaptures	No. of Unbanded	Total No.	Total Capture Rate***
WAVI	119	22.5	0.1261	6	5.0	17	14.3	23	.	142	0.1505
SWTH	101	19.1	0.1070	6	5.9	7	6.9	13	.	114	0.1208
RCKI	40	7.6	0.0424	12	30.0	.	.	12	.	52	0.0551
AMRE	36	6.8	0.0381	.	.	7	19.4	7	1	44	0.0466
DEJU	33	6.2	0.0350	1	3.0	5	15.2	6	1	40	0.0424
MGWA	24	4.5	0.0254	1	4.2	8	33.3	9	1	34	0.0360
REVI	22	4.2	0.0233	3	13.6	5	22.7	8	.	30	0.0318
BCCH	11	2.1	0.0117	.	.	17	154.5	17	1	29	0.0307
SOSP	14	2.6	0.0148	1	7.1	9	64.3	10	1	25	0.0265
GCKI	13	2.5	0.0138	.	.	4	30.8	4	.	17	0.0180
YWAR	15	2.8	0.0159	.	.	1	6.7	1	.	16	0.0170
WIWA	13	2.5	0.0138	2	15.4	.	.	2	.	15	0.0159
ALFL	10	1.9	0.0106	1	10.0	1	10.0	2	.	12	0.0127
OCWA	6	1.1	0.0064	1	16.7	2	33.3	3	.	9	0.0095
LISP	8	1.5	0.0085	.	.	.	.	.	.	8	0.0085
AMRO	7	1.3	0.0074	.	.	.	.	.	.	7	0.0074
CEDW	5	0.9	0.0053	.	.	1	20.0	1	.	6	0.0064
HETH	6	1.1	0.0064	.	.	.	.	.	.	6	0.0064
TRFL	4	0.8	0.0042	1	25.0	1	25.0	2	.	6	0.0064
WIFL	4	0.8	0.0042	1	25.0	.	.	1	.	5	0.0053
COYE	2	0.4	0.0021	.	.	.	.	.	1	3	0.0032
LEFL	3	0.6	0.0032	.	.	.	.	.	.	3	0.0032
MAWA	3	0.6	0.0032	.	.	.	.	.	.	3	0.0032
CAVI	2	0.4	0.0021	.	.	.	.	.	.	2	0.0021
GRCA	2	0.4	0.0021	.	.	.	.	.	.	2	0.0021
RBNU	2	0.4	0.0021	.	.	.	.	.	.	2	0.0021
RNSA	2	0.4	0.0021	.	.	.	.	.	.	2	0.0021
RUHU	.	.	.	.	.	.	.	.	2	2	0.0021
SSHA	2	0.4	0.0021	.	.	.	.	.	.	2	0.0021
VEER	2	0.4	0.0021	.	.	.	.	.	.	2	0.0021
WCSP	1	0.2	0.0011	1	100.0	.	.	1	.	2	0.0021
WTSP	2	0.4	0.0021	.	.	.	.	.	.	2	0.0021
YRWA	2	0.4	0.0021	.	.	.	.	.	.	2	0.0021
BRCR	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
CBCH	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
CHSP	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
FOSP	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
HAFL	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
HAWO	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
LAZB	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
NAWA	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
NOWA	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
RSFL	.	.	.	.	.	.	.	.	1	1	0.0011
STJA	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
TOWA	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
VATH	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
WETA	1	0.2	0.0011	.	.	.	.	.	.	1	0.0011
Total	529	100.0	0.5605	37	7.0	85	16.1	122	9	660	0.6993

* Species Code: see definition in Appendix 4
** No. of Newly Captured: for CLBMON 39 in 2013 (included recaptures of birds banded in previous year)
*** Capture Rate/Total Capture Rate: in birds/net-hour