

Columbia River Project Water Use Plan

KINBASKET AND ARROW LAKES RESERVOIRS

Reference: CLBMON 39

Arrow Lakes Reservoir: Neotropical Migrant Use of the Drawdown Zone

Study Period: 2012

**Cooper Beauchesne and Associates Ltd.
Head Office
Box 646, 1799 Swayne Road
Errington, BC**

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***CLBMON 39: Arrow Lakes Reservoir: Neotropical
Migrant Use of the Drawdown Zone
Year 5 (2012)***



Michal Pavlik and John M. Cooper

Cooper Beauchesne and Associates Ltd.

Head Office

Box 646, 1799 Swayne Road

Errington, BC V0R 1V0

Tel: 250 954-1822

Contact: John Cooper

jcooper@cooperbeauchesne.com

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EXECUTIVE 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 5 (2012).

In 2012, the CLBMON 39 study consisted of four major components: permanent plot surveys, effectiveness monitoring plot surveys, randomly selected plot surveys and constant effort mist netting.

In fall 2012, 98 permanent plots both in and outside of the drawdown zone were monitored. In total 881 surveys were conducted and 2,375 neotropical migrant songbirds of 51 species were recorded. The most frequently recorded migrant species on plot were Pine Siskin (*Spinus pinus*: 209 records) and Common Yellowthroat (*Geothlypis trichas*: 203 records). When controlling for the number of plots in each elevation band, the highest density of migrants was documented on plots from the 440 m elevation band (440–441 m). No migrants were recorded on plots in the four lowest elevation bands (431–434 m). A subsample of permanent plots was surveyed in spring (23 plots). In total, 125 surveys were conducted and 592 migrants of 37 species were recorded. The most often recorded species on plot was Yellow-rumped Warbler (*Setophaga coronata*: both Audubon's and Myrtle subspecies combined), with 47 records.

To monitor the response of migrants to the revegetation projects, surveys of 27 effectiveness monitoring plots were conducted—16 treatment plots (planted with cottonwood stakes) and 11 control plots (untreated area located in similar habitat). In spring, 160 effectiveness monitoring surveys were conducted and 86 migrants of 18 species were recorded on plot. Of these, 74% of individuals and 14 species were recorded on cottonwood treatment plots and 26% of individuals and 12 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, 123 random plots were surveyed and 285 migrants (30 species) were recorded on plot, with an average density of 2.32 migrants per plot. The highest relative density (7.12 migrants/plot) was recorded in forest plots, followed by shrub plots (2.64), wetland plots (0.87) and grassland plots (0.21). In fall, 67 random plots were surveyed and 153 migrants (21 species) were recorded on plot, with an average density of 2.28 migrants per plot. The highest relative density (4.69 migrants/plot) was recorded in forest plots, followed by shrub plots (3.05), wetland plots (0.56) and grassland plots (0.10).

In 2012 habitat data were collected from 304 plots—188 random plots, 94 permanent plots and 22 effectiveness monitoring plots.

In 2012, three sites in the drawdown zone (Airport Islands, Rob's Willows and Machete Island) and two sites outside of the drawdown zone (Cartier Point and Jordan River) were monitored by constant effort mist netting for a total of 43 surveys and 2,143.5 net-hours. Airport Islands had an overall capture rate of 0.2950 birds/net-hour and a recapture rate of 4.1%. In total, 120 individuals from 11 species were captured, with Yellow-rumped Warbler being the most frequently captured species (0.1328). At Rob's Willows, 129 individuals from 19 species were captured, with an overall capture rate of 0.4649 birds/net-hour and a recapture rate of 1.6%. Yellow-rumped Warbler was the most commonly captured species (0.1225). During Cooper Beaudesne and Associates Ltd.'s operations at the Machete Island Banding Station, 356 individuals from 31 species were captured, with an overall capture rate of 0.6933 birds/net-hour and a recapture rate of 35.3%. The most frequently captured species was Common Yellowthroat (0.2240). At Cartier Point, 84 individuals from 23 species were captured, with an overall capture rate of 0.3246 birds/net-hour and a recapture rate of 11.4%. Pine Siskin was the most frequently captured species (0.0966). At Jordan River, 608 individuals of 45 species were captured, with an overall capture rate of 0.8850 birds/net-hour and a recapture rate of 20.2%. The most commonly captured species was Warbling Vireo (*Vireo gilvus*: 0.1543).

Due to delays in renewing appropriate permits, blood and feather samples were not collected in 2012. Progress on answering the management questions for CLBMON 39 is discussed and recommendations for changes to methods for Years 6-10 are suggested.

KEYWORDS

reservoir operations, neotropical migrants, songbirds, spring migration, fall migration, stopover habitat, Revelstoke Reach, Arrow Lakes Reservoir, British Columbia, BC Hydro, Wilson's Warbler, Orange-crowned Warbler, Common Yellowthroat, Yellow Warbler

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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 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 (Silllett 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).

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, 2012a). 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 5 of the 10-year study.

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 migrants 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 **Error! Reference source not found.**

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).

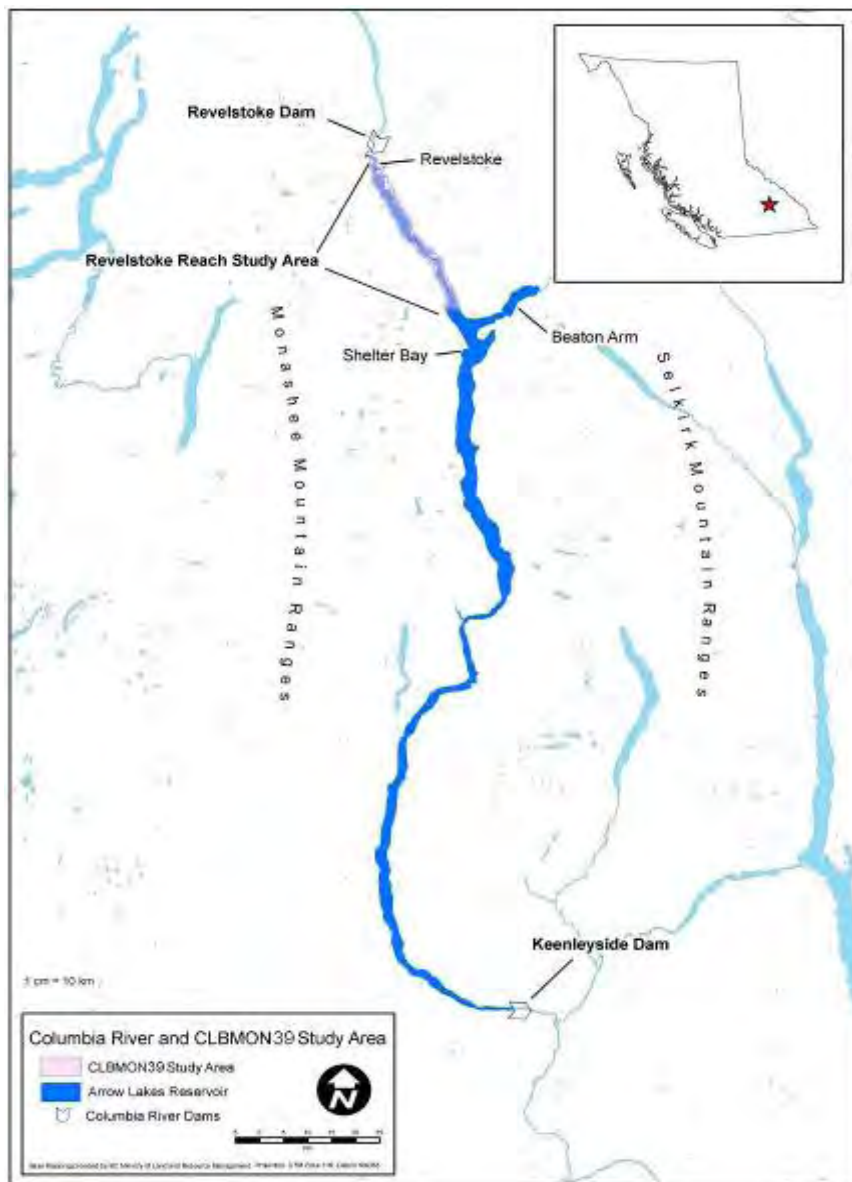


Figure 1: CLBMON 39 study area in Revelstoke Reach, Arrow Lakes Reservoir

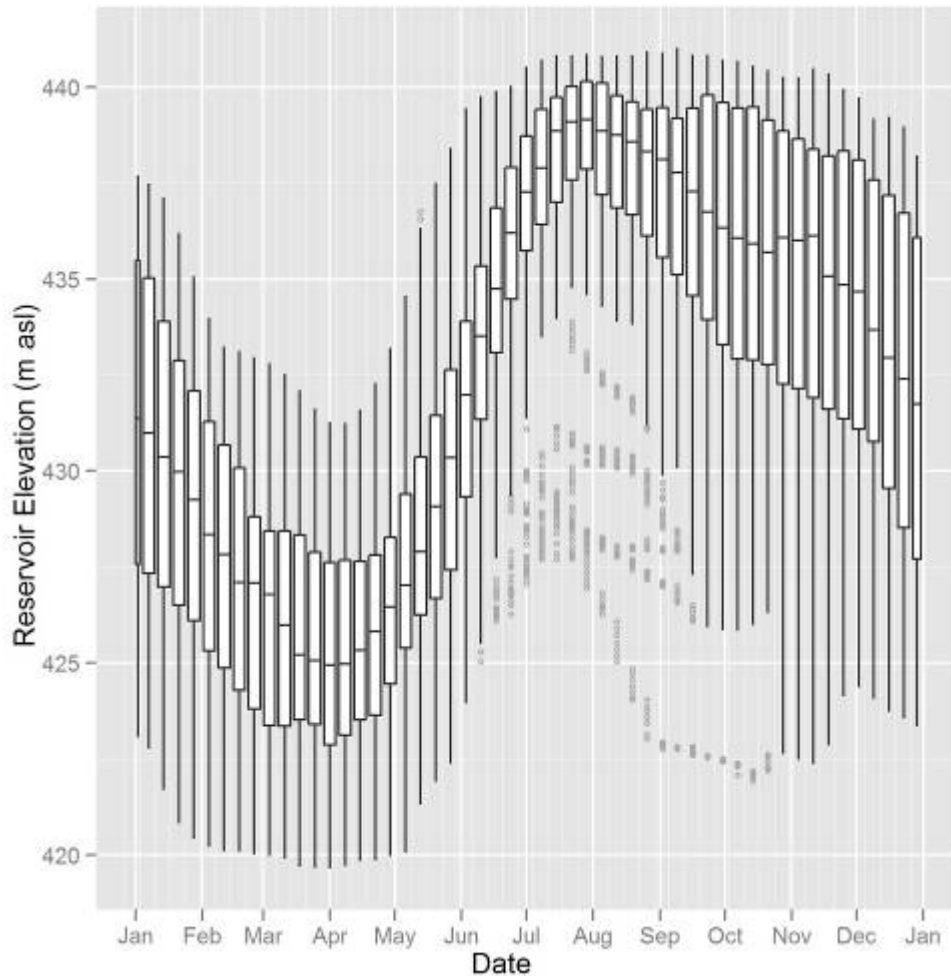


Figure 2: Historical hydrological data from Arrow Lakes Reservoir (1968–2008) plotted in weekly intervals

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 and hypotheses is provided in Appendix 1. A brief overview of methods used in 2012 is provided below. For a detailed account of these methods, refer to the CLBMON 39 protocol report (CBA 2012b).

2.1 Permanent Plot Sampling

A permanent fixed quadrat (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 populations of 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. Plots were selected based on habitat and elevation. The location of permanent plots was determined through a GIS analysis (based on digital elevation models, CLBMON 33 data and orthophotos), and 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 $\geq 5\%$ tree cover (> 5 m high)

- Shrub: plots with $\geq 5\%$ shrub cover and $< 5\%$ tree cover
 - Grassland: plots with $\geq 10\%$ 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 2012 is shown in Table 1 and Appendix 3.

Table 1: Stratification of permanent plots and number of plots within each habitat stratum and elevation band (DDZ = drawdown zone) surveyed in fall 2012

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 2012, a subset of 23 permanent plots was surveyed in spring for the first time (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 2012

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

Permanent plots were selected for sampling prior to the field season. 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 quadrat 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 (Appendix 3). Sixteen

treatment plots (planted with cottonwood stakes) and 11 control plots (untreated area located in similar habitat) were monitored. Effectiveness monitoring plots were located at 12 Mile, 9 Mile, McKay Creek and Cartier Bay, and all of them were studied 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 2012a).

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 quadrat (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.

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 4), 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.

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 populations of 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 2012 the migration monitoring station at Machete Island was operated by the Canadian Wildlife Service (CWS). CBA conducted one sampling session per week at this site.

In addition to Machete Island, four sites from 2011 were sampled at least once per week by constant effort mist netting (Table 3, Appendix 5). Two sites were in the drawdown zone and two sites were outside of the drawdown zone. In 2011, these sites were selected because they were expected to have high capture rates.

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	Large riparian site	Machete Island Banding Station net lines
Rob's Willows	Yes	438	Large riparian site	Large complex of shrubby vegetation (willow dominated); most similar to the habitat at Machete Island Banding Station but lower site elevation (flooded for longer time), more open habitat (more grass and forbs), and shrub and trees, on average, are lower in height and more sparsely distributed than at Machete
Airport Islands	Yes	437	Small 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
Cartier Point	No	441	Control outside of the drawdown zone	Mostly cottonwood- and birch-dominated forest site with bracken fern and thimbleberry understory; drier than any other site; some nets on the edge of the drawdown zone (shrubby cottonwood outlining the high water mark)

In 2012, each of the five 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. While conducting sampling at Machete Island, CBA used CWS's banding station nets (when available), which were installed in permanent net lanes. Two low-elevation sites (Rob's Willows and Airport Islands) were not accessible early in the season due to high water levels. Usually, 6–10 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.

Nets were opened 30 minutes before sunrise by putting them on the pre-installed poles (at sites monitored by CBA) or by unrolling them (at Machete Island). 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 (Figure 9).



Figure 9: CBA technician releasing a banded bird, Airport Island Banding Station (left). CBA technician banding birds at Cartier Point Banding Station (right)

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, furred 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 (and at Machete Island before the migration monitoring station was fully operational) 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*), Wilson's Warbler (*Cardellina pusilla*) and Orange-crowned Warbler (*Oreothlypis celata*).

2.4.1.1 Blood metabolite sampling

In 2012, due to delays in renewing appropriate permits, blood metabolite work was not conducted. For detailed sampling protocols, see the CBA monitoring protocol (CBA 2012b).

2.4.1.2 Feather isotope sampling and preparation

In 2012, due to delays in renewing appropriate permits, feather isotope work was not conducted. For detailed sampling protocols, see the CBA monitoring protocol (CBA 2012b).

2.5 Habitat Monitoring

Vegetation and habitat data were collected in conjunction with the approaches described in Sections 2.1, 2.2 and 2.3. For permanent plots and effectiveness monitoring plots, habitat data were collected following the CBA habitat monitoring protocol (CBA 2012b). Habitat data were collected at permanent plots in both the spring and fall season, and at effectiveness monitoring plots in fall only. For the habitat use-availability study, habitat and vegetation data were collected from all random plots. Habitat characteristics were

recorded at each plot after the bird survey was completed, following the methods described in the CBA random plot monitoring protocol (CBA 2012b).

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 2012 were submitted to the Migratory Bird Populations Division–Bird Banding Office in Ottawa by December 15, 2012.

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 5 (2012). 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.

No statistical analyses are reported in this report. Detailed analyses that address the management questions and hypotheses will be provided in the 5-year (2008–2012) comprehensive report in 2013. All 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 2012

During the entire spring survey season (April–May), the reservoir levels were higher than the long-term average but lower than in the previous four years (Appendix 2).

In July 2012, above full pool water levels were recorded in the Arrow Lakes Reservoir, and the levels approached the historical maximum. At the beginning of the fall survey period, the reservoir levels were still at full pool (440.1 m ASL on July 31, 2012), which was the highest level during the last 5 years. In mid-August, the reservoir levels started to decline rapidly. The water levels remained above the mean level for the rest of August but were below the mean in September. At the end of the fall season, reservoir levels were the lowest of the last 5-year fall survey period (434.4 m ASL on September 25, 2012) (Appendix 2).

3.2 Permanent Plot Sampling

Spring surveys

Between April 26 and May 30, 2012, 23 permanent plots were surveyed once per week for a total of 125 surveys.

In total, 724 individual birds of 60 species were recorded (Appendix 6, Appendix 7). Neotropical migrant songbirds accounted for 592 individuals (81.8%) and 37 species (61.7%). Of these, 219 individuals were recorded on plot, 158 individuals were recorded off plot and 215 individuals were recorded flying over the plot (Appendix 7).

The most common species of neotropical migrant songbird recorded on plot was Yellow-rumped Warbler (*Setophaga coronata* [Audubon's and Myrtle subspecies combined]: 47 individuals). Other species with more than 10 records included Ruby-crowned Kinglet (*Regulus calendula*: 37 individuals), White-crowned Sparrow (*Zonotrichia leucophrys*: 31), Savannah Sparrow (*Passerculus sandwichensis*: 20), Common Yellowthroat (14) and Wilson's Warbler (13). In addition, 19 other species (57 individuals) were recorded; they had less than 10 records each (Appendix 7).

Twelve species of neotropical migrant songbirds were recorded off plot and/or flying overhead but not on plot (Appendix 7). They included American Pipit (*Anthus rubescens*: 91), unidentified swallow (37), Tree Swallow (*Tachycineta bicolor*: 35), Cliff Swallow (*Petrochelidon pyrrhonota*: 27), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*: 21), Pine Siskin (*Spinus pinus*: 17) and another seven species which had less than 10 records each: American Goldfinch (*Spinus tristis*), Brown-headed Cowbird (*Molothrus ater*), Western Wood-Pewee (*Contopus sordidulus*), Brewer's Blackbird (*Euphagus cyanocephalus*), Cedar Waxwing (*Bombycilla cedrorum*), Chipping Sparrow (*Spizella passerina*) and Tennessee Warbler (*Oreothlypis peregrina*).

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 439 m elevation band (23.25 birds per plot over the season), followed by the 437 m elevation band (20.20 birds per plot over the season), 438 m elevation band (4.50) and 436 m elevation band (3.20). No neotropical migrant songbirds were detected on plot in the 431 m–435 m elevation bands (Appendix 8).

Fall surveys

Between July 31 and September 25, 2012, 98 permanent plots were surveyed once per week for a total of 881 surveys.

In total, 3,575 individual birds of 110 species were recorded (Appendix 6, Appendix 9). Neotropical migrant songbirds accounted for 2,375 individuals (66.4%) and 51 species (46.4%). Of these, 1,188 individuals were recorded on plot, 329 individuals were recorded off plot, and 858 individuals were recorded flying over the plot (Appendix 9).

The most frequently recorded species of neotropical migrant songbird on plot was Pine Siskin (209 individuals). Other species with more than 50 records each included Common Yellowthroat (203 individuals), Yellow-rumped Warbler (101), Cedar Waxwing (93), Savannah Sparrow (72) and Yellow Warbler (69). In addition, 39 other species (732 individuals) had less than 50 records each (Appendix 9).

Six species of neotropical migrant songbirds were recorded off plot and/or flying overhead but not on plot (Appendix 9). They included Tree Swallow (34 individuals), Northern Rough-winged Swallow (22), Barn Swallow (*Hirundo rustica*: 12), Brewer's Blackbird (2) and two other species which had only one record each: Cassin's Vireo (*Vireo cassinii*) and Townsend's Solitaire (*Myadestes townsendi*).

Of the 1,188 neotropical migrant songbirds recorded on plot, 54.1% (643 individuals) were recorded in the drawdown zone and 45.9% (545 individuals) were recorded outside of the drawdown zone (Appendix 10). Of the species with 10 or more individuals recorded, two species had more than 75% of observations on plots in the drawdown zone: American Redstart (*Setophaga ruticilla*) and Western Wood-Pewee. Conversely, four species had more than 75% observations on plots outside of the drawdown zone: Gray Catbird (*Dumetella carolinensis*), Warbling Vireo (*Vireo gilvus*), MacGillivray's Warbler (*Geothlypis tolmiei*) and White-crowned Sparrow (Appendix 10).

Plots from the forest stratum accounted for most detections of neotropical migrant songbirds (593 individuals), followed by the shrub stratum (485) and the grassland stratum (110) (Appendix 10). 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 63 individuals in week 9 to 233 individuals in week 6 (Appendix 11).

Three of the five most frequently detected species (Pine Siskin, Common Yellowthroat and Savannah Sparrow), together with Song Sparrow (*Melospiza melodia*), were present in Revelstoke Reach over the entire study period (Appendix 11). The abundance of Cedar Waxwing (fourth most frequently detected species), Yellow Warbler, American Redstart, Red-eyed Vireo (*Vireo olivaceus*), Gray Catbird, Warbling Vireo, Willow Flycatcher (*Empidonax traillii*), MacGillivray's Warbler, Traill's Flycatcher (*Empidonax alnorum/traillii*), Western Wood-Pewee and Lazuli Bunting (*Passerina amoena*) was highest at the beginning of the season, and all these species disappeared from Revelstoke Reach before the end of study period (Appendix 11). Conversely, the abundance of Yellow-rumped Warbler (third most frequently detected species), White-crowned Sparrow, Lincoln's Sparrow (*Melospiza lincolni*) and Ruby-crowned Kinglet, was highest in the second half of the season (Appendix 11).

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 440 m elevation band (31.75), followed by the 438 m elevation band (16.56), 439 m elevation band (16.25), \geq 442 m elevation band (13.33), 441 m elevation band (13.00), 437 m elevation band (8.00), 436 m elevation band (3.67) and 435 m elevation band (1.25) (Appendix 12). No birds were recorded on plot in the four lowest elevation bands (431–434 m).

3.3 Effectiveness Monitoring Plot Sampling

In 2012, 27 effectiveness monitoring plots (16 treatment and 11 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.

Spring surveys

In spring, 160 surveys were conducted. The first survey was conducted on April 24, 2012; the last was conducted on May 29, 2012.

In total, 956 individuals of 44 species were recorded (Appendix 6, Appendix 13). Overall, 88 birds (20 species) were recorded on plot, 396 birds (36 species) were recorded off plot and 472 birds (21 species) were recorded overhead (Appendix 13). Of the 86 neotropical migrant songbirds (18 species identified) recorded on plot, 74% and 14 species were recorded on cottonwood treatment plots, and 26% and 12 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 2012

Common Name	CT	CC	Total
Yellow-rumped Warbler	27	1	28
White-crowned Sparrow	9	3	12
Savannah Sparrow	6	2	8
Mountain Bluebird	6	1	7
Wilson's Warbler	1	4	5
American Robin	2	1	3
Common Yellowthroat	1	2	3
Unidentified Sparrow	2	1	3
Chipping Sparrow	2	.	2
Lazuli Bunting	.	2	2
Lincoln's Sparrow	.	2	2
Orange-crowned Warbler	2	.	2
Ruby-crowned Kinglet	2	.	2
Yellow Warbler	1	1	2
American Pipit	.	1	1
Dark-eyed Junco	1	.	1
Eastern Kingbird	1	.	1
Nashville Warbler	.	1	1
Western Meadowlark	1	.	1
Grand Total	64	22	86

Yellow-rumped Warbler was the most frequently detected species, followed by White-crowned Sparrow, Savannah Sparrow and Mountain Bluebird (*Sialia currucoides*) (Table 4). Six species were recorded on cottonwood treatment plots only, four species were recorded on control plots only, and the remaining eight species were detected on both cottonwood treatment and control plots (Table 4).

Fall surveys

In fall, 238 surveys were conducted. The first survey was conducted on August 2, 2012; the last was conducted on September 27, 2012.

In fall, 1,054 individuals of 60 species were recorded (Appendix 6, Appendix 14). 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 14).

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 2012

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
Trill's Flycatcher	1	.	1
Unidentified <i>Empidonax</i> Flycatcher	1	.	1
Unidentified Sparrow	1	.	1
Yellow Warbler	.	1	1
Grand Total	126	41	167

When controlling for the number of plots in each stratum, the average species richness of neotropical migrant songbirds recorded on plot varied between control and treatment plots and among weeks. In the first three weeks of spring surveys, higher average species richness and bird density were recorded on treatment plots than on control plots;

however, during the last three weeks of spring surveys, higher average species richness and bird density were recorded on control plots (Figure 10). In fall, average species richness was higher on treatment plots than on control plots in four weeks, and average bird density was higher on treatment plots than on control plots in five weeks (Figure 10).

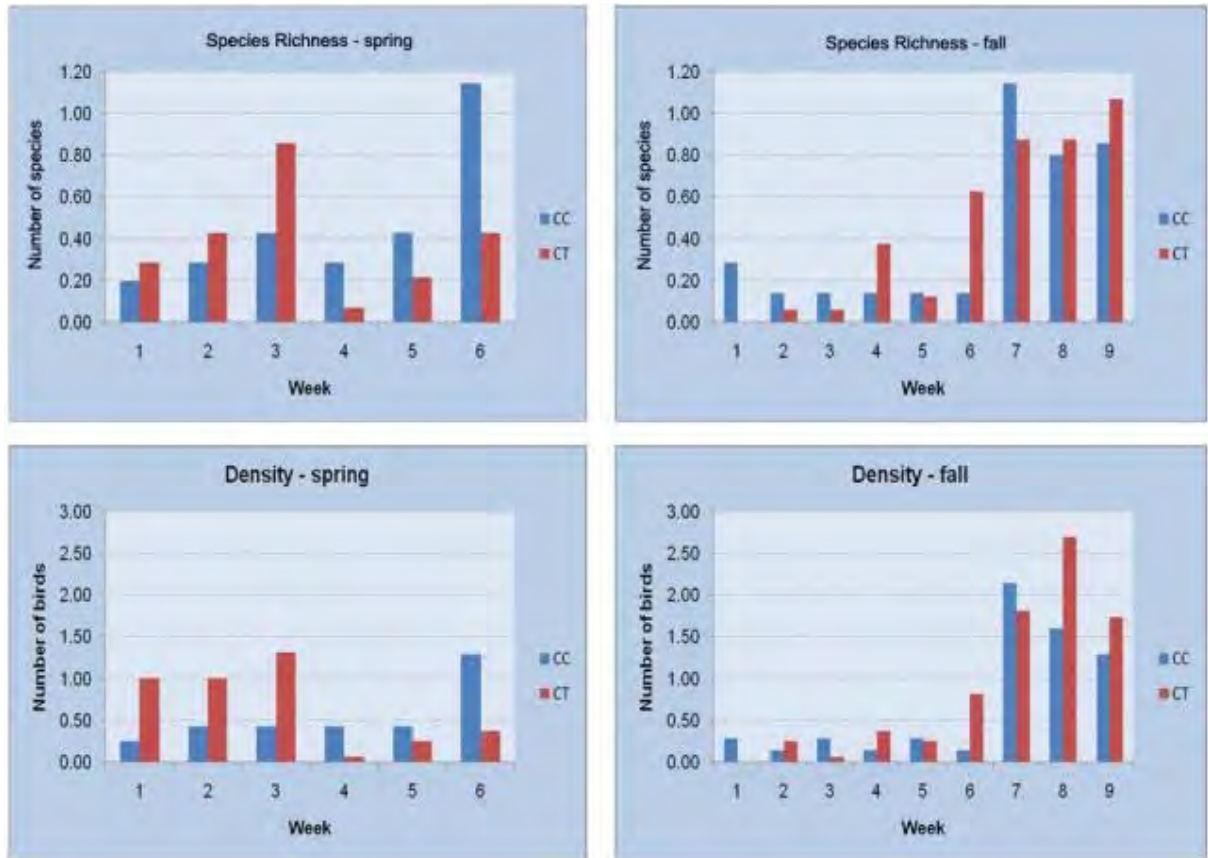


Figure 10: Species richness and density of neotropical migrant songbirds on effectiveness monitoring plots in spring and fall 2012, plotted in weekly averages per plot in each strata (CC = cottonwood control, CT = cottonwood treatment)

3.4 Random Plot Sampling

Spring surveys

In spring 2012, the first random plot was surveyed on April 4; the last was surveyed on May 31. In total, 123 random plots were surveyed: 26 plots were forested, 28 were from each of the shrub and grassland strata, 18 were unvegetated and 23 were from the wetland stratum (Table 6).

In total, 3,156 birds were recorded in spring: 365 (11.6%) were observed on plot, 1,428 (45.2%) were off plot and 1,363 (43.2%) were overhead (Appendix 15). Of the birds recorded on plot, neotropical migrant songbirds accounted for 285 birds (30 species), with an average density of 2.32 birds per plot (Appendix 16). Forested plots had the highest relative density (7.12 birds/plot), followed by shrub plots (2.64 birds/plot), wetland

plots (0.87 birds/plot) and grassland plots (0.21 birds/plot) (Appendix 16). No neotropical migrant songbirds were detected on unvegetated plots.

Table 6: Number of random plots surveyed each week in Revelstoke Reach in spring 2012

Stratum	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	4	3	3	2	2	3	5	1	3	26
Grassland	1	1	4	5	1	4	4	4	4	28
Shrub	3	3	2	4	2	3	4	3	4	28
Unvegetated	1	2	4	4	3	1	2	.	1	18
Wetland	1	2	4	3	3	2	4	1	3	23
Total	10	11	17	18	11	13	19	9	15	123

The most frequently detected neotropical migrant species was Yellow-rumped Warbler, with an overall average density of 0.67 birds per plot (2.65 birds/plot for the forest stratum, 0.36 birds/plot for the shrub stratum and 0.17 birds/plot for the wetland stratum) (Appendix 16). Other abundant species were American Robin (*Turdus migratorius*: overall average density of 0.49 birds/plot; 1.96 birds/plot for the forest stratum and 0.32 birds/plot for the shrub stratum), Wilson's Warbler (overall average density of 0.13 birds/plot; 0.43 birds/plot for the shrub stratum and 0.15 birds/plot for the forest stratum) and Ruby-crowned Kinglet (overall average density of 0.12 birds/plot; 0.46 birds/plot for the forest stratum and 0.11 birds/plot for the shrub stratum).

In 2012, surveys were initiated three weeks earlier than in previous years (starting the first week of April). Of all the neotropical migrant songbirds detected during random plot surveys, 62.5% were recorded in April (1,075 individuals of 20 species) and 37.5% were recorded in May (645 individuals of 46 species) (Figure 11). The species richness was the lowest in the first week of surveys (seven species) and was the highest in the last week of surveys (30 species) (Figure 11). The proportion of breeding birds (assumed by observed breeding behaviour) to all birds recorded was relatively low until mid-May (< 10%), then increased rapidly to 49% by the last week of surveys (Figure 12).

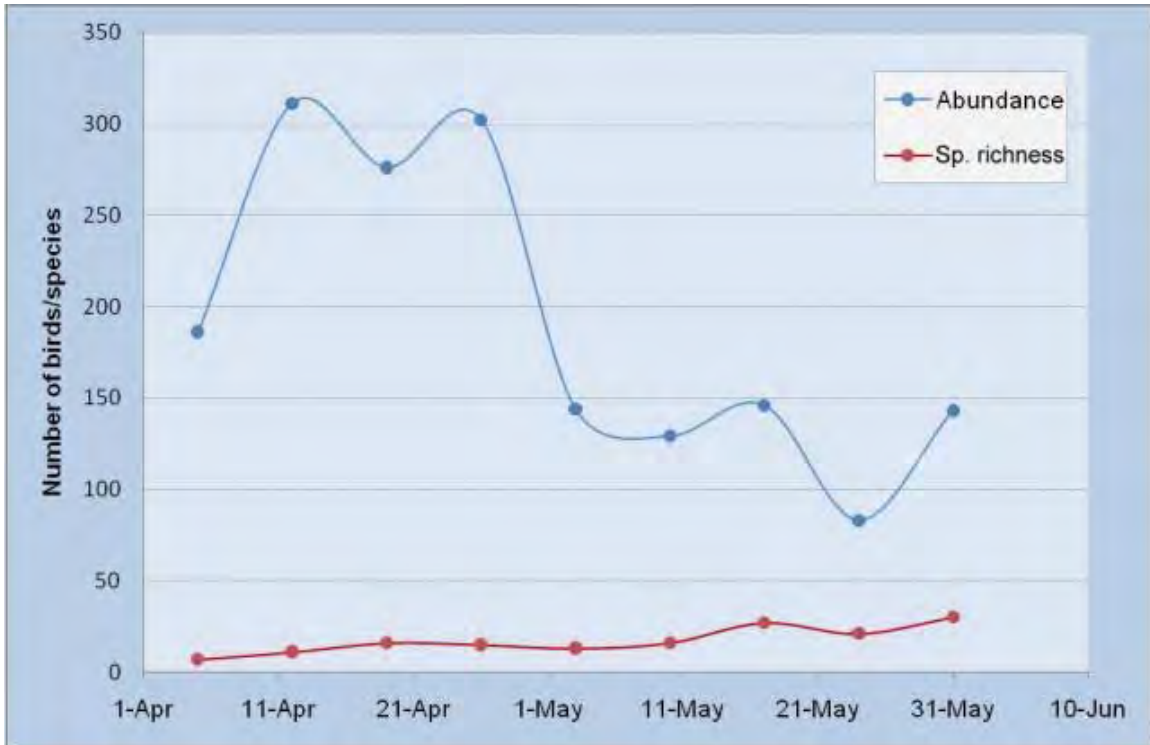


Figure 11: Species richness and abundance of neotropical migrant songbirds recorded during random plot surveys (on plot, off plot and overhead combined) in each week of the 2012 spring surveys

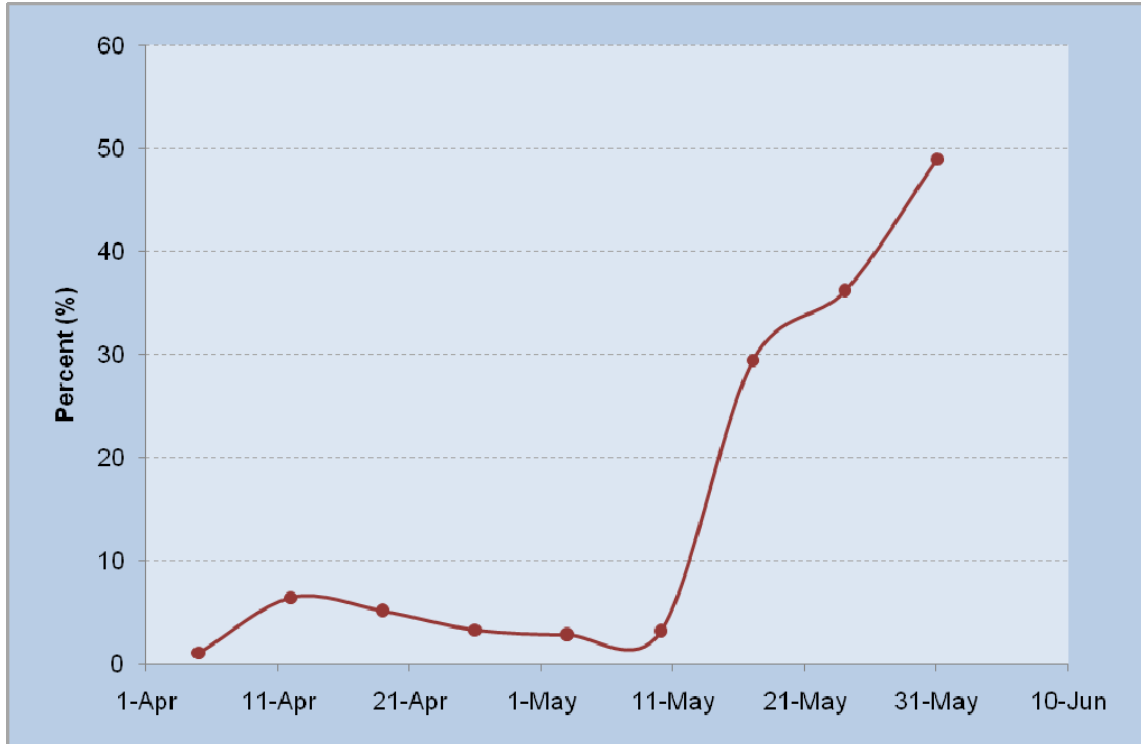


Figure 12: Proportion of neotropical migrant songbirds (on plot, off plot and overhead combined) that were detected breeding (assumed by observed breeding behaviour) during random plot surveys in spring 2012

Fall surveys

In fall 2012, 67 random plots were surveyed. The first plot was surveyed on August 7; the last was surveyed on September 26. Sixteen of these plots were forested, 22 were from the shrub stratum, 10 were from the grassland stratum, one was unvegetated and 18 were from the wetland stratum (Table 7). High water levels early in the season severely restricted the availability of plots in some strata (unvegetated strata, in particular). As a result, only one unvegetated plot was surveyed.

Table 7: Number of random plots surveyed each week in Revelstoke Reach in fall 2012

Stratum	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Total
	4-10.8.	11-17.8.	18-24.8.	25-31.8.	1-7.9.	8-14.9.	15-21.9.	22-28.9.	
Forest	1	5	3	3	1	2	1	.	16
Grassland	1	1	.	2	1	2	1	2	10
Shrub	1	4	3	5	2	3	2	2	22
Unvegetated	.	.	.	1	.	.	.	.	1
Wetland	1	3	4	3	1	4	1	1	18
Total	4	13	10	14	5	11	5	5	67

In total, 1,057 birds were recorded in the fall: 252 (23.8%) were observed on plot, 493 (46.6%) were off plot and 312 (29.5%) were overhead (Appendix 17). Neotropical migrant songbirds accounted for 153 birds (21 species), with an average density of 2.28 birds per plot (Appendix 18). Forested plots had the highest relative density (4.69 birds/plot), followed by shrub plots (3.05 birds/plot), wetland plots (0.56 birds/plot) and grassland plots (0.10 birds/plot) (Appendix 18). No neotropical migrant songbirds were detected on unvegetated plots.

The two most frequently detected neotropical migrant species were Pine Siskin and Yellow-rumped Warbler. Pine Siskin had an overall average density of 0.39 birds per plot (0.82 birds/plot for the shrub stratum and 0.50 birds/plot for the forest stratum). Yellow-rumped Warbler had the same overall average density but average density by strata differed (0.94 birds/plot for the forest stratum, 0.41 birds/plot for the shrub stratum and 0.11 birds/plot for the wetland stratum (Appendix 18). Other abundant species were Cedar Waxwing (overall average density of 0.34 birds/plot; 1.25 birds/plot for the forest stratum and 0.14 birds/plot for the shrub stratum), Common Yellowthroat (overall average density of 0.25 birds/plot; 0.38 birds/plot for the forest stratum, 0.36 birds/plot for the shrub stratum and 0.17 birds/plot for the wetland stratum), American Robin (overall average density of 0.13 birds/plot; 0.50 birds/plot for the forest stratum and 0.05 birds/plot for the shrub stratum) and Song Sparrow (overall average density of 0.10 birds/plot; 0.32 birds/plot for the shrub stratum).

Substrate use in spring and fall

In spring, the substrate (plant) types most frequently used by neotropical migrant songbirds were willow (68 observations), graminoids (46), redcedar (20) and cottonwood (18) (Figure 13). In fall, cottonwood was used most frequently (51), followed by willow (41) and aspen (14) (Figure 13).

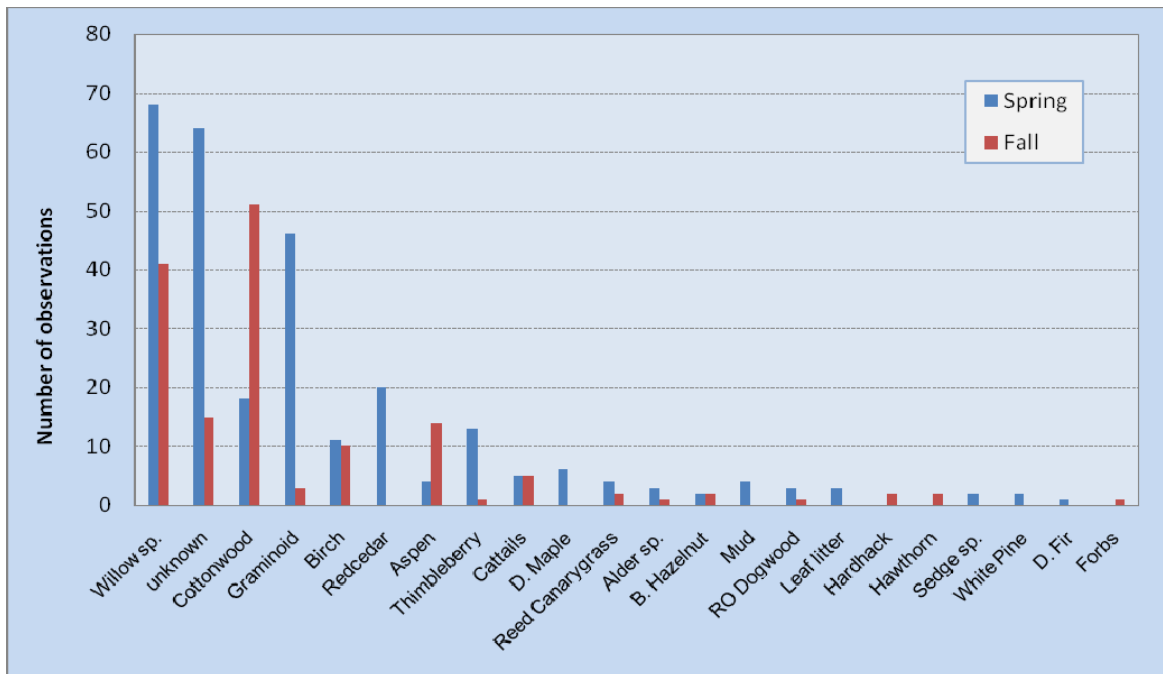


Figure 13: Substrate used by neotropical migrant songbirds during random plot surveys in spring and fall 2012

3.5 Constant Effort Mist Netting and Neotropical Migrant Physiology

3.5.1 Constant effort mist netting

In 2012, five sites were monitored for a total of 43 surveys and 2,143.50 net-hours (Table 8). The first survey was conducted on August 4, 2012 (Cartier Point); the last was conducted on September 27, 2012 (Airport Islands, Rob’s Willows).

Based on the location/strata of the sites and the capture rates in the Year 4, we focused our survey effort in 2012 primarily 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 number of surveys conducted at each of the five sites varied from six to 13. At the beginning of the season, fewer surveys were conducted at sites in the drawdown zone than at sites outside of the drawdown zone because the lower elevation sites were flooded; therefore, mist netting at those sites was not possible. During this period, effort was focused on the sites outside of the drawdown zone (especially Jordan River). As soon as the lower elevation sites became available, the effort was redistributed evenly between all five sites, with Airport Islands and Jordan River being the first surveyed.

The maximum number of mist nets used at a site varied from nine at Airport Islands to 14 at Machete Island. At the beginning of the season, fewer nets (as few as five) were used per site due to the logistics of setting up the banding station (mostly cleaning and setting

up the net lanes) and to high water levels (some net lanes were flooded). In addition, 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 capture rate—the number of nets was always adjusted to allow for the safe processing of captured birds. In September, a large number of our mist net poles were stolen from the Cartier Point Banding Station. Although not all of the net poles were stolen, and spare poles were brought to the site as soon as possible, the loss affected the number of operational nets for the rest of the month. Weather (rain, strong wind) also contributed to the variation in the number of net-hours per week.

Table 8: Mist netting survey effort (number of net-hours) per banding site in 2012

Banding site	N of surveys	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Grand Total
		4–10.8.	11–17.8.	18–24.8.	25–31.8.	1–7.9.	8–14.9.	15–21.9.	22–29.9.	
Airport Islands	9	.	.	71.75*	92.00*	53.50	49.50	99.50*	40.50	406.75
Rob's Willows	6	.	.	35.50	48.00	50.00	48.00	48.00	48.00	277.50
Machete Island	8	25.50	42.00	54.00	56.00	84.00	84.00	84.00	84.00	513.50
Cartier Point	7	36.00	36.00	45.25	48.00	38.50	.	25.00	30.00	258.75
Jordan River	13	96.00*	165.00**	108.50*	120.00*	60.00	50.00	60.00	27.50	687.00
Total	43	157.50	243.00	315.00	364.00	286.00	231.50	316.50	230.00	2,143.50

* two surveys during the week

** three surveys during the week

Species richness and capture rates differed among the five banding sites. At Airport Islands, the overall capture rate was 0.2950 birds/net-hour (Appendix 19). In total, 120 individuals from 11 species were captured. Yellow-rumped Warbler was the most frequently captured species (0.1328 birds/net-hour), followed by Common Yellowthroat (0.0738 birds/net-hour), Savannah Sparrow (0.0369 birds/net-hour) and Lincoln's Sparrow (0.0123 birds/net-hour). The capture rate for newly captured birds was 0.2409 birds/net-hour, and the recapture rate was 4.1%. The recapture rate for the same-day recaptures was 14.3%. Wilson's Snipe (*Gallinago delicata*) and Brown-headed Cowbird were the only species captured exclusively at this site.

At Rob's Willows, 129 individuals from 19 species were captured. The overall capture rate was 0.4649 birds/net-hour, the capture rate for newly captured birds was 0.4505 birds/net-hour and the recapture rate was 1.6% (Appendix 20). Yellow-rumped Warbler was the most frequently captured species (0.1225 birds/net-hour), followed by Common Yellowthroat (0.0649 birds/net-hour), Lincoln's Sparrow (0.0432 birds/net-hour) and Black-capped Chickadee (*Poecile atricapilla*: 0.0360 birds/net-hour). The recapture rate for the same-day recaptures was 1.6%. There was no species captured exclusively at this site.

During CBA operations at Machete Island, 356 individuals from 31 species were captured (Appendix 21). The overall capture rate was 0.6933 birds/net-hour, the capture rate for newly captured birds was 0.4693 birds/net-hour and the recapture rate was 35.3%. This recapture rate is inflated and will be readjusted once we receive a complete copy of the 2012 CWS banding data from Machete Island. The four most frequently

captured species at Machete Island were Common Yellowthroat (0.2240 birds/net-hour), Yellow-rumped Warbler (0.0798 birds/net-hour), American Redstart (0.0409 birds/net-hour), Red-eyed Vireo (0.0351 birds/net-hour) and Swainson's Thrush (*Catharus ustulatus*: 0.0351 birds/net-hour). The recapture rate for the same-day recaptures was 10.0%. Two species were captured only at Machete Island: Eastern Kingbird (*Tyrannus tyrannus*) and Western Wood-Pewee.

At Cartier Point, 84 individuals from 23 species were captured (Appendix 22). The overall capture rate was 0.3246 birds/net-hour, the capture rate for newly captured birds was 0.2705 birds/net-hour and the recapture rate was 11.4%. Pine Siskin was the most frequently captured species (0.0966 birds/net-hour), followed by Black-capped Chickadee (0.0580 birds/net-hour), Swainson's Thrush (0.0232 birds/net-hour) and Common Yellowthroat and Gray Catbird (both 0.0193 birds/net-hour). The recapture rate for the same-day recaptures was 5.7%. Spotted Sandpiper (*Actitis macularia*) was captured only at this site.

At Jordan River, 608 individuals of 45 species were captured (Appendix 23). The overall capture rate was 0.8850 birds/net-hour, the capture rate for newly captured birds was 0.6987 birds/net-hour and the recapture rate was 20.2%. The most commonly captured species was Warbling Vireo (0.1543 birds/net-hour), followed by Swainson's Thrush (0.1426 birds/net-hour), MacGillivray's Warbler (0.0771 birds/net-hour), American Redstart (0.0670 birds/net-hour), Yellow-rumped Warbler (0.0466 birds/net-hour) and Song Sparrow (0.0451 birds/net-hour). The recapture rate for the same-day recaptures was 5.2%. Ten species were captured exclusively at this site: Townsend's Warbler (*Setophaga townsendi*), Hammond's Flycatcher (*Empidonax hammondi*), Nashville Warbler (*Oreothlypis ruficapilla*), Lazuli Bunting, Pacific-slope Flycatcher (*Empidonax difficilis*), Varied Thrush (*Ixoreus naevius*), Hermit Thrush (*Catharus guttatus*), Mountain Chickadee (*Poecile gambeli*), Pacific Wren (*Troglodytes pacificus*) and Steller's Jay (*Cyanocitta stelleri*).

The species composition and capture rates of the four focal neotropical migrant songbirds (Common Yellowthroat, Yellow Warbler, Orange-crowned Warbler and Wilson's Warbler) varied among banding sites.

In the drawdown zone, 107 Common Yellowthroats were banded. This was the most frequently captured species at Machete Island (0.2240 birds/net-hour), and the second most commonly captured species at Airport Islands (0.0738 birds/net-hour) and Rob's Willows (0.0649 birds/net-hour). Outside of the drawdown zone, only eight individuals were captured. Common Yellowthroat was the fourth most commonly captured species at Cartier Point (0.0193 birds/net-hour) and twentieth most commonly captured species at Jordan River (0.0058 birds/net-hour). The seasonal variation in capture rates of Common Yellowthroat at Airport Islands and Machete Island in 2012 is compared with that from 2011 in Figure 14.

In 2012, 11 Yellow Warblers were captured and newly banded in the drawdown zone, and 20 were captured and newly banded outside of the drawdown zone. At the sites in the drawdown zone, Yellow Warbler was most frequently captured at Machete Island (eighth most commonly captured species, with a capture rate of 0.0234 birds/net-hour). At Airport Islands, Yellow Warbler was the seventh most frequently captured species (0.0025 birds/net-hour). At Rob's Willows, no Yellow Warblers were captured. Outside of the drawdown zone, Yellow Warbler was the seventh most commonly captured species at Jordan River (0.0393 birds/net-hour) and Cartier Point (0.0039 birds/net-hour).

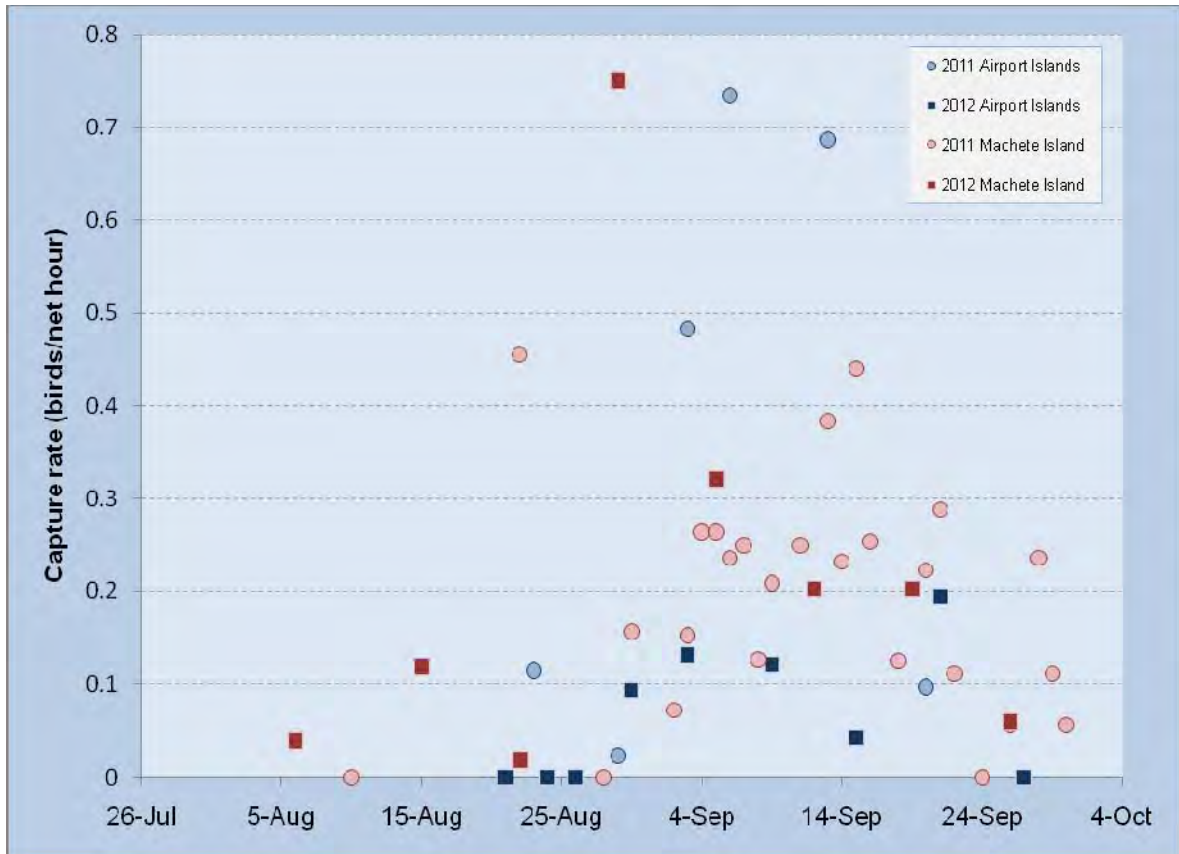


Figure 14: Seasonal variation in capture rates of Common Yellowthroat at five banding sites in 2011 and 2012

In total, 21 Orange-crowned Warblers were captured and newly banded in the drawdown zone, and four were captured and newly banded outside of the drawdown zone. In the drawdown zone, Orange-crowned Warbler was the most frequently captured at Rob's Willows (fifth most commonly captured species, with a capture rate of 0.0324 birds/net-hour). It was the seventh most frequently captured species at Machete Island (0.0253 birds/net-hour) and Airport Islands (0.0025 birds/net-hour). Outside of the drawdown zone, Orange-crowned Warbler was the twentieth most commonly captured species at Jordan River (0.0058 birds/net-hour). This species was not captured at the Cartier Point Banding Station.

In 2012, eight Wilson's Warblers were captured and newly banded in the drawdown zone, and 11 were captured and newly banded outside of the drawdown zone. Wilson's Warbler was the ninth most frequently captured species at Rob's Willows (0.0144 birds/net-hour) and twelfth at Machete Island (0.0078 birds/net-hour). No Wilson's Warblers were captured at Airport Islands. Outside of the drawdown zone, it was the thirteenth most commonly captured species at Jordan River (0.0160 birds/net-hour) and the seventh at Cartier Point (0.0039 birds/net-hour).

3.5.1.1 Injuries and mortalities

In 2012, two birds (Common Yellowthroat and Yellow-rumped Warbler) died in the bird bag due to unknown causes. Another bird (Warbling Vireo) suffered an eye injury while in the net due to an attack by a Black-capped Chickadee. Two captured birds had leg injuries, one (Townsend's Warbler) had a growth on the back toe, and another (Chestnut-backed Chickadee) had a healed old injury (broken leg) with the back toe growing backwards. One bird (Alder Flycatcher) suffered a minor wing strain. Two foreign recaptures (Common Yellowthroats) had a broken leg and were released unmeasured.

3.5.1.2 Species at Risk

No species at risk were captured or banded in 2012.

3.5.2 Plasma metabolite analysis

In 2012, no blood samples were collected due to delays in renewing appropriate permits.

3.5.3 Feather isotope analyses

In 2012, no feather samples were collected due to delays in renewing appropriate permits.

3.6 Habitat Sampling

Habitat sampling was conducted throughout the spring and fall season on permanent plots, effectiveness monitoring plots and random plots. In total, 304 habitat plot surveys were conducted.

On permanent plots, 94 habitat surveys were conducted in spring and fall 2012. A summary of habitat data collected is provided in Table 9.

On effectiveness monitoring plots, 22 habitat surveys were conducted in fall 2012. A summary of habitat data collected is provided in Table 10.

In 2012, habitat data were collected on sampled random plots after the bird survey was conducted. A summary of habitat data collected on 188 random plots is provided in Table 11. High water levels in early fall prevented the collection of accurate habitat data at some plots; therefore, data from those plots are not summarized.

Table 9: Summary of habitat data collected on permanent plots in spring and fall 2012 (means and ranges)

Stratum IN/OUT of the drawdown zone	Forest		Shrub		Grassland		Unvegetated	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
No. of plots	19	16	16	6	27	4	5	1
Tree								
tree cover (%)	32.4 (5–75)	39.2 (5–70)	0.6 (0–3)	0.5 (0–2)	0	0	0	0
tree height (m)	11.8 (7–21)	14.6 (5–25)	1.8 (0–10)	2 (0–6)	0	0	0	0
tree species (n)	1.9 (1–7)	3.9 (1–7)	0.3 (0–1)	0.5 (0–2)	0	0	0	0
dead branches (%)	1.5 (0–10)	0	5 (0–10)	0	0	0	0	0
Shrub								
shrub cover (%)	35.9 (8–70)	55 (15–85)	33.3 (1–77)	35.8 (15–70)	0.1 (0–1)	0.8 (0–3)	0	0
shrub height (m)	3 (2–5)	2.2 (1–5)	2.7 (2–4)	2.2 (1–4)	0.3 (0–3)	0.3 (0–1)	0	0
shrub species (n)	5.2 (2–13)	7.3 (2–12)	1.6 (1–3)	5 (2–9)	0.1 (0–1)	0.8 (0–3)	0	0
dead branches (%)	5.6 (0–20)	1.7 (0–5)	19.1 (0–70)	10 (0–30)	72.5 (0–100)	0	0	0
Grass								
herbaceous cover (%)	57 (15–98)	57.8 (15–85)	61.3 (10–90)	68.3 (40–90)	81.3 (20–100)	90 (70–100)	2.8 (0–12)	10
herbaceous height (m)	0.2 (0–1)	0.3 (0–1)	0.3 (0–2)	0.2 (0–1)	0.9 (0–3)	0.4 (0–1)	2 (0–10)	0.2
herbaceous species (n)	5.6 (3–10)	7.8 (5–10)	3.7 (2–5)	6.8 (5–10)	2.9 (1–7)	7.3 (2–10)	0.6 (0–2)	5
Open								
open cover (%)	7.4 (0–33)	2 (0–10)	15.6 (0–40)	6.8 (0–20)	15.7 (0–80)	10 (0–30)	97.2 (88–100)	90

Table 10: Summary of habitat data collected on effectiveness monitoring plots in fall 2012 (means and ranges)

Stratum	Control	Treatment
No. of plots	9	13
Tree		
tree cover (%)	2.5 (0–2)	0.9 (0–5)
tree height (m)	3.6 (0–10)	0.7 (0–7)
tree species (n)	0.4 (0–2)	0.1 (0–1)
dead branches (%)	1.5 (0–10)	0
Shrub		
shrub cover (%)	12.7 (0–35)	46.5 (5–60)
shrub height (m)	2.4 (0–5)	2.6 (1–3)
shrub species (n)	1 (0–4)	2.3 (1–5)
dead branches (%)	10 (0–20)	29 (10–60)
Grass		
herbaceous cover (%)	92 (80–100)	89 (35–100)
herbaceous height (m)	1 (0–2)	0.9 (0–2)
herbaceous species (n)	2.4 (1–5)	3.5 (2–10)
Open		
open cover (%)	0.1 (0–20)	10 (0–100)

Table 11: Summary of habitat data collected on random plots in spring and fall 2012 (means and ranges)

Stratum	Forest	Shrub	Grassland	Unvegetated	Wetland
No. of plots	42	48	38	19	41
Tree					
tree cover (%)	39.5 (1–95)	1.2 (0–12)	0.1 (0–2)	0	0
tree height (m)	18.3 (7–30)	2.6 (0–18)	1.1 (0–25)	0	0
tree species (n)	3.7 (1–9)	0.3 (0–3)	0.1 (0–1)	0	0
dead branches (%)	4.7 (0–15)	1.7 (0–10)	3 (1–5)	0	0
Shrub					
shrub cover (%)	34.6 (0–100)	23.5 (1–90)	0.75 (0–10)	0	2.9 (0–28)
shrub height (m)	2.4 (0–5)	2.2 (1–4)	0.5 (0–5)	0	0.7 (0–4)
shrub species (n)	6.0 (0–14)	2.1 (0–8)	0.4 (0–3)	0	0.5 (0–2)
dead branches (%)	4.0 (0–20)	16.9 (0–90)	24.6 (0–70)	0	27.5 (0–100)
Grass					
herbaceous cover (%)	33.6 (0–85)	54.7 (0–100)	82.2 (25–100)	0.7 (0–12)	52.4 (0–100)
herbaceous height (m)	0.3 (0–2)	0.4 (0–2)	0.3 (0–2)	0 (0–0.1)	0.3 (0–2)
herbaceous species (n)	4 (0–12)	3.5 (0–10)	2.1 (1–4)	0.2 (0–2)	2.3 (0–7)
Open					
open cover (%)	13.7 (0–90)	21.4 (0–98)	16.9 (0–75)	99.3 (88–100)	44.5 (0–100)

4 DISCUSSION

4.1 Progress Towards Answering the Management Questions

Although this report does not attempt to answer any of the CLBMON 39 management questions related to reservoir operations and neotropical migrant songbird use of the drawdown zone, significant progress was made in 2008–2012 towards answering these management questions, as discussed below. An overview of the management questions and approaches is summarized in Appendix 1.

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

Over the course of five years, data on spring and fall migration abundance and species diversity have been collected under CLBMON 39. Spring migration monitoring using random plot surveys was initiated in 2009 (Year 2) under CLBMON 11B-2, and in 2012 this study became part of CLBMON 39 (a permanent plot survey component was also added).

Under CLBMON 39, day-to-day migration monitoring was conducted at the Machete Island Banding Station in 2008–2010 using constant effort mist netting and census routes. Although limited to Machete Island, this approach proved very useful in documenting seasonal and annual variation in abundance and diversity of neotropical migrant songbirds (MCA 2009, CBA 2010c, 2011b). In 2011, the Terms of Reference were changed, and the Canadian Wildlife Service assumed responsibility for operating the Machete Island Banding Station. CBA focused on sampling other habitats in Revelstoke Reach by establishing banding stations in four different habitats and initiating fall surveys of permanent and random plots.

In 2012, spring surveys were initiated three weeks earlier than in previous years (i.e., the first week of April in 2012 vs. the last week of April in previous years). This change proved to be valuable. Although species richness per week was generally lower in April, the abundance of neotropical migrants detected during random plot surveys in April was greater than in May. More than half of all bird detections were recorded in April. All four of the most commonly detected species (Yellow-rumped Warbler, American Robin, Wilson's Warbler and Ruby-crowned Kinglet) are relatively early season migrants in Revelstoke Reach, and their migration is usually slowing down by mid-May. Conversely, a lot of other migrants do not arrive in Revelstoke Reach in good numbers until mid-May (e.g., flycatchers, Parulidae warblers). Even though these species boost the overall diversity of migrants in the second half of May, their numbers are generally low. Habitat is usually unavailable before the first week of April due to snow; therefore, we suspect that species diversity and abundance would be low if surveys were conducted before the beginning of April. In addition, a relatively low abundance of migrants and a high proportion of breeding birds late in the spring would limit the efficiency of these surveys if they were conducted into June. For these reasons, it appears that the earlier time frame for conducting spring surveys is ideal.

Data from 2012, combined with the data from previous years (data collected during banding sessions and permanent and random surveys), have provided an extensive database. Because recent years were characterized by relatively high water levels during fall migration, species diversity and abundance during "low water years" was not well documented. During fall surveys in 2009 (the only "low water year" during 2008-2012), we recorded higher than usual species abundance and diversity of neotropical migrants

at Machete Island (CBA 2010c). Since surveys in 2009 were restricted to Machete Island, abundance and diversity in other habitats (surveyed in 2011-2012) were not documented.

The 5-year comprehensive report will likely provide an adequate description of seasonal and annual variation in neotropical migrants. Additional years of study, in Years 6 through 10, will allow more sampling of habitats previously only sampled for 2 years (2011-2012) and, hopefully, under more variable reservoir operations (e.g., lower water levels). These additional data should provide an excellent dataset to more accurately answer MQ 1.

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

In 2008–2010, CLBMON 39 survey effort was concentrated on Machete Island at the migration monitoring station. In addition, a census route was established at Machete Island (and at two other sites in 2010) in order to document the presence of species that were not recorded at the banding station and/or were not easily captured in mist nets. During these three years, use of other habitats by migrating songbirds in Revelstoke Reach was not studied due to the nature of the surveys conducted. Nevertheless, use of the available habitat at Machete Island was documented by daily mist netting surveys and censuses. Permanent habitat plots were also established at Machete Island, and measurements were taken each year to document any changes over time (regrowth at and around the banding station area due to periodic tree and brush cutting). This approach was ideal for detailed monitoring of one site but would not allow us to describe all important habitats and use of those habitats by birds in Revelstoke Reach.

The Terms of Reference were altered for Year 4 so that other habitats would be sampled because MQ 2 could not be adequately addressed by sampling only one site. In addition, spring monitoring previously conducted under CLBMON 11B-2 was added to CLBMON 39. Under CLBMON 11B-2, surveys of randomly selected plots were conducted in spring, starting in Year 2 (2009). Random plot surveys were designed specifically to document habitat availability and habitat use by bird species in the drawdown zone. Pilot analyses conducted on CLBMON 11B-2 data in Year 2 showed strong habitat/use associations (CBA 2009, 2011a); therefore, this approach was adopted by CLBMON 39. In 2011, fall surveys of random plots were initiated to cover all habitats associated with Revelstoke Reach.

The hierarchy of preferred substrates was slightly different between spring and fall in 2012, but there was still a strong preference for willow and cottonwood substrates, which was consistent with results from 2011.

Water levels during the spring surveys were normally low and rarely influenced our ability to survey pre-selected random plots. Conversely, extremely high water levels in early August severely restricted the availability of plots in certain strata (especially unvegetated and grassland plots), and interfered with accurate habitat sampling. In September, after a rapid drop in the water level, more grassland plots became available but unvegetated plots were still mostly inaccessible. Unavailability of random plots from these strata in fall due to flooding resulted in a very small sample size of these strata.

We will provide a preliminary answer to this management question in the 5-year comprehensive report, although the fall component would benefit from further study since we have conducted only two seasons of data collection.

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

Data collected from the Machete Island migration monitoring station in 2008-2010 documented variation in diversity and abundance of neotropical migrant songbirds between years (MCA 2009, CBA 2010c, 2011b). The higher use of Machete Island by migrants in the year with lower water levels (2009) suggests that there was more terrestrial habitat available, and that attracted more land birds, than in higher water years when the site was more like an island of terrestrial habitat surrounded by water (e.g., 2008).

A pilot analysis in 2011 indicated that neotropical migrant songbirds used extensively flooded habitat less often than partly flooded or dry habitat (CBA 2012a). Flooding of certain stopover habitats may make them unavailable to neotropical migrants, and therefore may affect availability and quality of such habitats. As documented in 2011 and 2012 by both permanent plot and random plot surveys, a large proportion of habitats were completely underwater at the beginning of the season and were therefore unavailable to migrating birds. Some lower elevation habitats (e.g., unvegetated, grassland) remained flooded for most of the season.

We plan to address this management question in the 5-year comprehensive report by using habitat availability modelling under different reservoir operations in combination with bird occurrence data from permanent and random plots and capture-recapture data.

4.1.4 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?

Data collected at the Machete Island migration monitoring station in the first three years of this study documented differences in use of Machete Island by neotropical migrant songbirds in different years (MCA 2009, CBA 2010c, 2011b). Preliminary data suggest that overall abundance and diversity of migrants was higher in the year when the reservoir was not filled to capacity (e.g., 2009) than in years when the water level reached full pool (e.g., 2008, 2010).

During summer 2012, above normal full pool water levels caused extensive flooding of low-elevation shrub habitats in Revelstoke Reach. Water levels remained extremely high for a long period, and despite a rapid decline after mid-August which exposed a large portion of the area (water levels in September were lower than those in 2011), we recorded unusually low capture rates of neotropical migrants at the Airport Islands site. For example, in 2012 the capture rate for Common Yellowthroat (the most frequently captured species at this site in 2011) was 5.4 times lower than in 2011. Not all data from Machete Island are available to date, but it appears that the capture rates of Common Yellowthroat in 2012 at the other stations (at higher elevations both in and outside of drawdown zone) were similar to those in 2011. Although not yet supported by statistical analysis, this suggests that Machete Island was not as high a quality stopover site for this species (and other neotropical migrants) in 2012 than during 2008-2011.

Pilot analyses of data from permanent plots conducted in Year 4 suggested that neotropical migrant songbirds used extensively flooded plots less than partially flooded and/or dry habitat (CBA 2012a). In 2012, we surveyed a subsample of permanent plots in spring, and focused on low-elevation plots that usually remain underwater for most of the fall season. Very few birds were observed during either spring or fall migration at plots below 436 m ASL. Although results from the spring migration cannot be directly

compared to those from the fall migration (due to different compositions of migrants and stages of vegetation development), they do suggest that these low-elevation plots/habitats do not support vegetation communities that are of high importance as stopover habitat for neotropical migrants.

A more in-depth analysis of the effect of reservoir operations (water depth, timing of flooding, and length of period of flooding) on neotropical migrant songbird use of stopover habitats within the drawdown zone will be provided in the 5-year comprehensive report.

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

Constant effort mist netting and bird banding operations at the Machete Island Banding Station in 2008–2010, together with the capture data from other stations in 2011–2012, have generated an extensive database of capture-recapture records. We can assess which species are most likely to be affected by reservoir operations by investigating annual and seasonal changes and patterns of neotropical migrant abundance, recapture rates and stopover length in relation to water levels. To date, no statistical analyses have been performed on this data set; therefore, no species has been identified as being more affected than another.

In 2008–2011, physiological effects were assessed by measuring blood metabolite levels of four focal species (Common Yellowthroat, Yellow Warbler, Orange-crowned Warbler and Wilson's Warbler). Preliminary results showed that Wilson's Warblers fatten at a significantly higher rate than the other three species, which suggests that they have a higher dependence on the habitats in Revelstoke Reach (CBA 2010c, 2011b, 2012a). It follows that this species may be more affected than the other focal species if habitat is unavailable due to flooding.

Monitoring of other habitats within and outside of the drawdown zone by permanent and random plots was initiated in 2011. Although a pilot analysis conducted in 2011 suggested that grassland plots are more affected by flooding than are the other habitats (e.g., shrub, forest) (CBA 2012a), a comprehensive statistical analysis of this data set has not yet been conducted.

To address this management question, the capture-recapture data, permanent plot data and blood metabolite data will be analyzed for the 5-year comprehensive report, and species most affected by reservoir operations will be identified.

In Year 6–10 of this study, it may be beneficial to alter the study design to allow for more in-depth monitoring of the species identified to be most affected.

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

Indicators of physiological health are measured through analysis of blood metabolites. Plasma metabolite assays provide one means of assessing fattening rates of neotropical migrants. In 2008–2010 all blood samples were taken from birds captured at Machete Island. Results from these three years showed no evidence of strong age or sex differences in plasma metabolites. Estimated fattening rate was significantly higher for Wilson's Warbler than for the other three focal species, in all three years (MCA 2009, CBA 2010c, 2011b).

In 2011, plasma samples were collected at Machete Island and four other sites. The 2011 results confirmed those of previous years: the estimated fattening rate was significantly higher for Wilson's Warbler than for the other three focal species. However, no significant difference in estimated fattening rates among sites or between sites in and outside of the drawdown zone was found for any species (CBA 2012a). These results suggest that reservoir operations do not affect physiological health for the species sampled under the operational regimes experienced in 2008-2011.

In 2011 the sample size for some species (e.g., Wilson's Warbler) was small, and the distribution of samples among sites was not ideal (e.g., few Common Yellowthroat samples from outside of the drawdown zone). Despite greater survey effort in 2012 (2,143.5 net-hours vs. 1,564.3 net-hours in 2011), the desired sample size could have been met only for Common Yellowthroat within the drawdown zone. In 2012 we captured 127 individuals in the drawdown zone and 8 individuals outside of the drawdown zone. For the other three focal species, the desired sample size of 30 per site (small sites within the drawdown zone, large sites within the drawdown zone and control sites outside the drawdown zone) was not obtained.

In 2008–2010, CBA operated was usually able to capture sufficient numbers of the four focal species for blood/feather isotope analyses while operating the Machete Island migration monitoring station. In 2011, the Terms of Reference changed and CWS assumed responsibility for operating the Machete Island Banding Station, while CBA focused on sampling other habitats in Revelstoke Reach in order to address MQ 2. The sampling regime in 2011 and 2012 resulted in much lower capture rates of the four focal species because they do not occur in sufficiently high densities in other habitats in Revelstoke Reach.

An in-depth analysis of data collected at Machete Island in 2008–2010 and in other habitats in 2011 will be provided in the 5-year comprehensive report. Based on the low densities and low capture rates of the focal species in other habitats of Revelstoke Reach in 2011–2012, we suggest that the objectives and/or sampling design be changed to meet the goals of this study component.

4.1.7 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?

Data being collected at all permanent plots and random plots, together with constant effort mist netting data, will be used to address this management question.

In the 5-year comprehensive report, data will be analyzed and the impact of reservoir operations on neotropical migrants and their stopover habitat will be evaluated. If certain reservoir operation regimes are found to impact neotropical migrants, we will assess the magnitude of that impact. By using the habitat map of Revelstoke Reach compiled by CBA for CLBMON 36 (CBA 2013), we will be able to model habitat availability under different water regimes and identify what operational adjustments can be made to mitigate impacts on neotropical migrants. However, it is unlikely that we will be able to draw many significant conclusions in the 5-year comprehensive report because we have conducted only two seasons of fall monitoring in habitats outside of Machete Island. This management question will most likely be fully addressed in the 10-year comprehensive report.

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

During the first three years of CLBMON 39, the revegetation and WPW projects in Revelstoke Reach were not monitored. Effectiveness monitoring of these projects was initiated during the spring surveys under CLBMON 11B-2 in Year 3 (2010). In spring 2010 and 2011, multiple WPW projects were monitored (cottonwood stakes revegetation, water sedge and mixed sedges revegetation monitoring, WPW6A, WPW14/15A–Cartier Bay transect). In Year 4 (2011), after the new Terms of Reference were adopted, fall monitoring of the effectiveness of the revegetation projects was also conducted. Based on preliminary results from CLBMON 11B-2 (CBA 2010a, 2011a), we concluded that only cottonwood stake revegetation plots should be monitored under CLBMON 39, both in spring and fall. Other aspects of CLBMON 11B-2 were discontinued because the WPW projects are not specifically designed for neotropical migrant songbirds.

Previous results from CLBMON 11B-2 and CLBMON 39 together showed the local importance of riparian shrub and forest habitat for neotropical migrant songbirds in Revelstoke Reach (CBA 2010a, 2011a, 2011b, 2012a). Those results suggest that if the reintroduction of cottonwoods in grassland habitats is successful, it could enhance species diversity within those areas. Preliminary data from CLBMON 11B-2 and CLBMON 39 showed higher overall species richness and abundance of neotropical migrant songbirds on treatment plots than on control plots (CBA 2010a, 2011a, CBA 2012a). Although no formal statistical analyses were performed in 2012, results from both spring and fall did not show this trend. This could be caused by multiple factors. A detailed, multi-year analysis will be provided in the 5-year comprehensive report. Due to the relatively early stage of the revegetation project (cottonwood plantings need several years before they can provide more complex habitat), further monitoring of these plots is needed to determine if revegetation projects are successful in enhancing habitat for neotropical migrants. We estimate we will be able to answer this management question in the 10-year comprehensive report.

4.1.9 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).

Although we began collecting data to address this management question in fall 2011 under CLBMON 39, spring monitoring was initiated in 2009 (previously under CLBMON 11B-2). Preliminary data from CLBMON 11B-2 and CLBMON 39 together showed that neotropical migrants are more frequently detected in willow or cottonwood habitat than in other habitat types (CBA 2010a, 2011a, 2011b, 2012a).

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.

4.2 Recommendations

4.2.1 Banding data from the Machete Island Banding Station

In the first three years of the CLBMON 39 study (2008–2010), effort was focused on Machete Island, where a migration monitoring station was operated on a daily basis. Under the new Terms of Reference adopted in 2011, CBA agreed to sample other habitats, while CWS assumed responsibility for the Machete Island Banding Station. It was also agreed that data collected there by a third party must be made readily available to CBA. To date, we have not received a copy of the 2012 banding data due to difficulties internal to the third party.

CBA would like to stress that these data are very important for analyses that need to be incorporated into the Year-5 comprehensive report. In particular, the data are needed to assess recapture rate, stopover length and movement of neotropical migrants within the drawdown zone, and to calibrate the capture rates recorded at stations in other habitats.

4.2.2 Plasma metabolite and feather isotope sampling

In 2011, the number of blood samples collected from the four focal species (Common Yellowthroat, Yellow Warbler, Orange-crowned Warbler and Wilson's Warbler) was lower than expected. The desired sample distribution of 30 samples per stratum (small riparian site in the drawdown zone, large riparian site in the drawdown zone and control site outside of the drawdown zone) for each species was obtained only for Common Yellowthroat at sites in the drawdown zone (CBA 2012a). No blood samples were collected in 2012, but the capture rates were similar to or lower than those in 2011, which suggests that the desired size and distribution of samples would not have been met.

The focal species were selected based on their historical abundance at the Machete Island Banding Station, but their capture rates at other stations have been relatively low because these species do not occur in sufficiently high densities elsewhere in the drawdown zone. This could be resolved by selecting new focal species that have higher capture rates in a variety of habitats (preferably, if the Year-5 comprehensive report identifies these species as being negatively affected by reservoir operations) or by increasing sampling effort (either in terms of conducting more net-hours at existing banding sites or by surveying more sites).

Despite a greater survey effort in 2012, we were unable to capture enough individuals of the focal species to allow for a robust analysis; therefore, we suggest that the objective of this component of the study and/or the sampling design should be changed for the Year 6–10 study period. We will analyze and interpret Year 1–5 data for the comprehensive report in 2013, and new recommendations will be highlighted there.

4.2.3 Recommendations identified in the Year-5 comprehensive report

In 2013, Year 1–5 data will be analyzed for the multi-year comprehensive report, and some of the management questions are expected to be adequately addressed. It is likely that some questions will be addressed better than others and new recommendations will be identified. These recommendations should be incorporated into the Year 6 studies, if possible.

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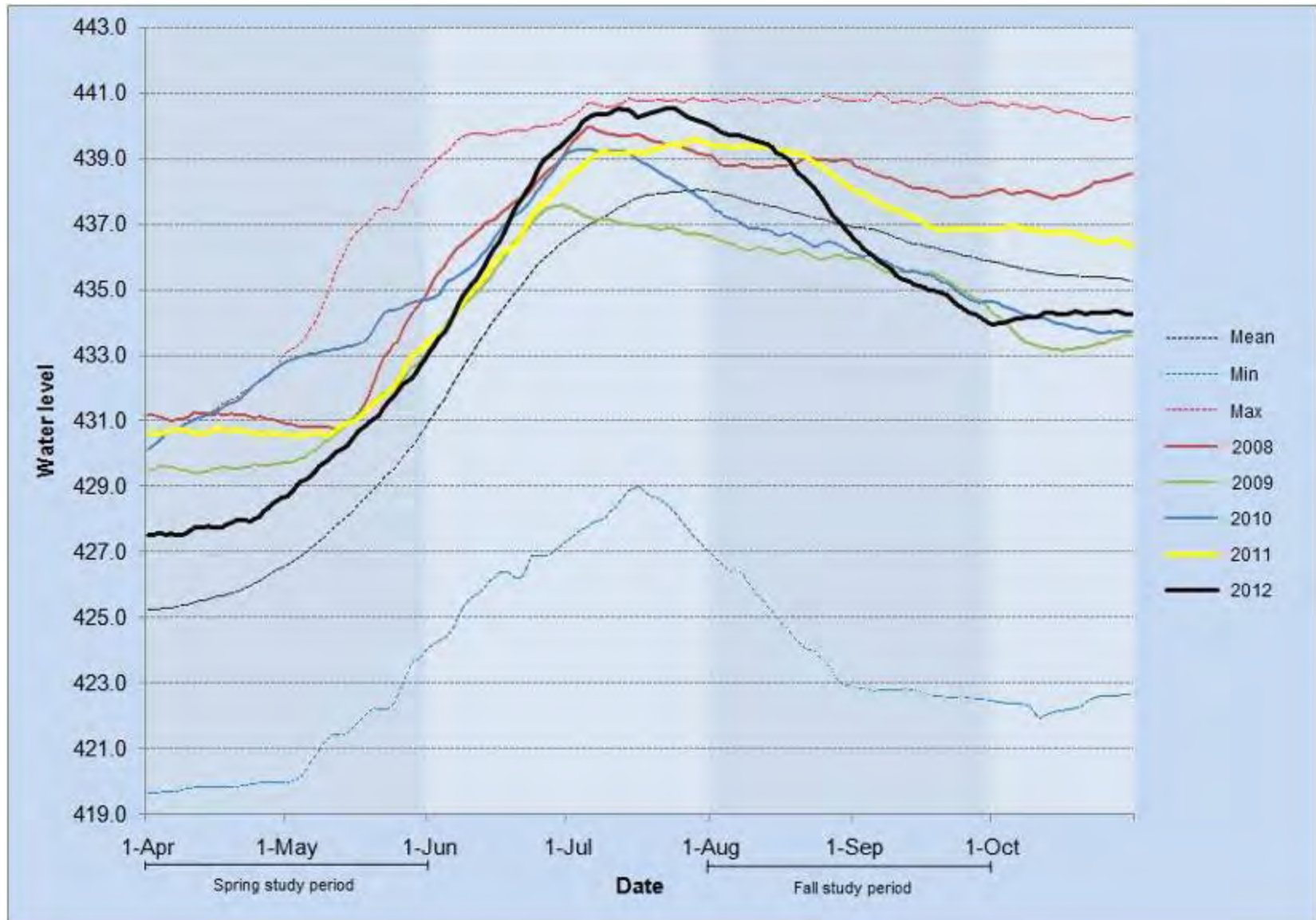
6 APPENDICES

Appendix 1: Management objectives, questions, hypotheses and approaches and status of CLBMON 39 after Year 5 (2012)

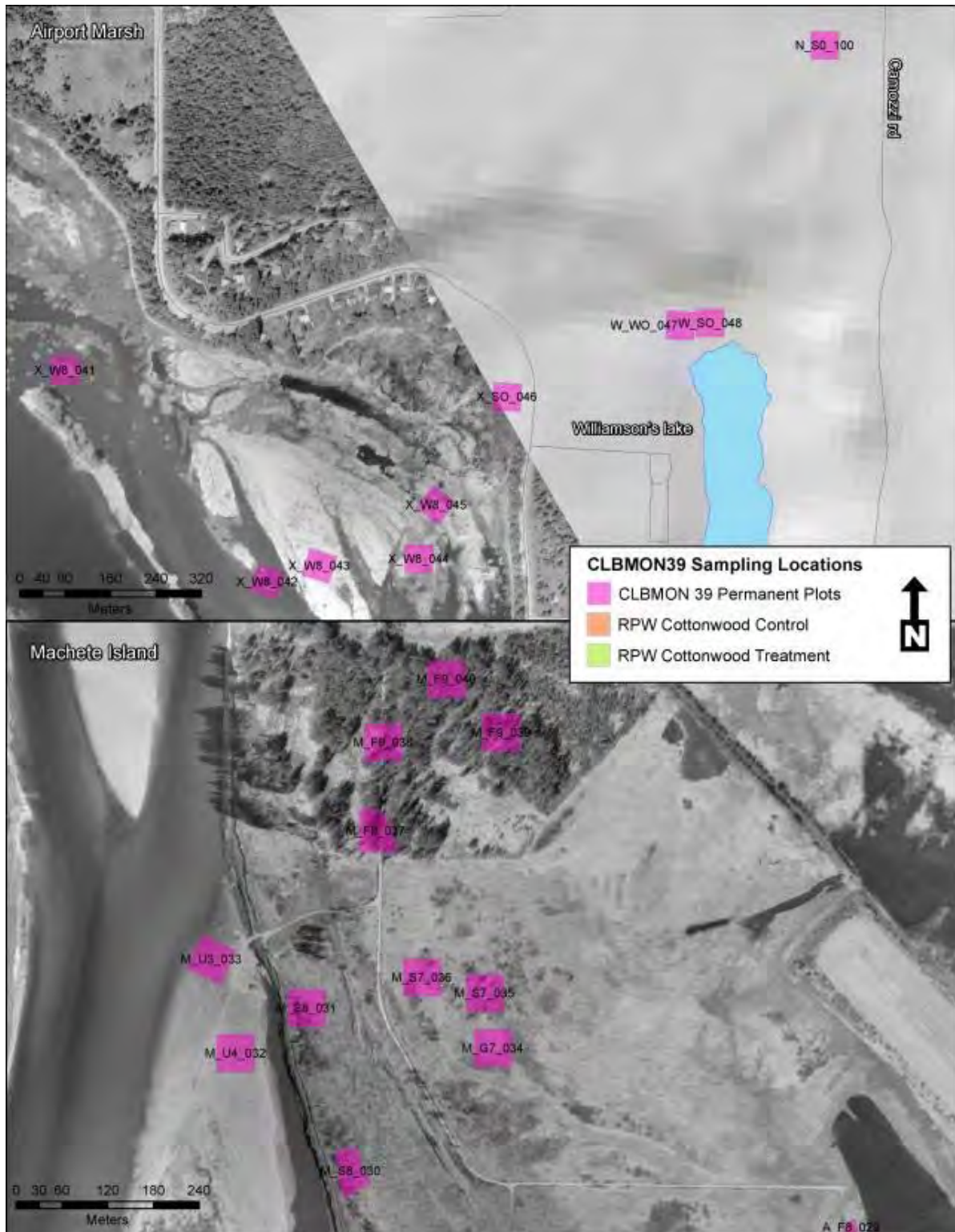
Study Objective	Management Question	Management Hypothesis	Approach	Year 5 (2012) Status	Report Section
1. Determine the migration patterns of migratory songbirds in Revelstoke Reach (within season, across seasons, and across years).	1. What is the seasonal and annual variation in the abundance and diversity of neotropical migrants in Revelstoke Reach?		Constant effort mist netting Area based quadrature surveys	In progress	4.1.1
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 quadrature surveys Habitat monitoring	In progress	4.1.2
	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 quadrature surveys Habitat monitoring Habitat availability monitoring	In progress	4.1.3
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 quadrature surveys	In progress	4.1.4
	5. Which neotropical migrants (e.g., species or guilds) are most affected by reservoir operations?		Constant effort mist netting Area based quadrature surveys	In progress	4.1.5
	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)	In progress	4.1.6
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 quadrature surveys	In progress	4.1.7

Study Objective	Management Question	Management Hypothesis	Approach	Year 5 (2012) 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 quadrat surveys Habitat monitoring	In progress	4.1.8
	9. Are some methods or techniques more effective than others at enhancing habitat for neotropical migrants in the drawdown zone? (e.g., the planting or enhancement of certain riparian vegetation).		Area based quadrat surveys Habitat monitoring	In progress	4.1.9

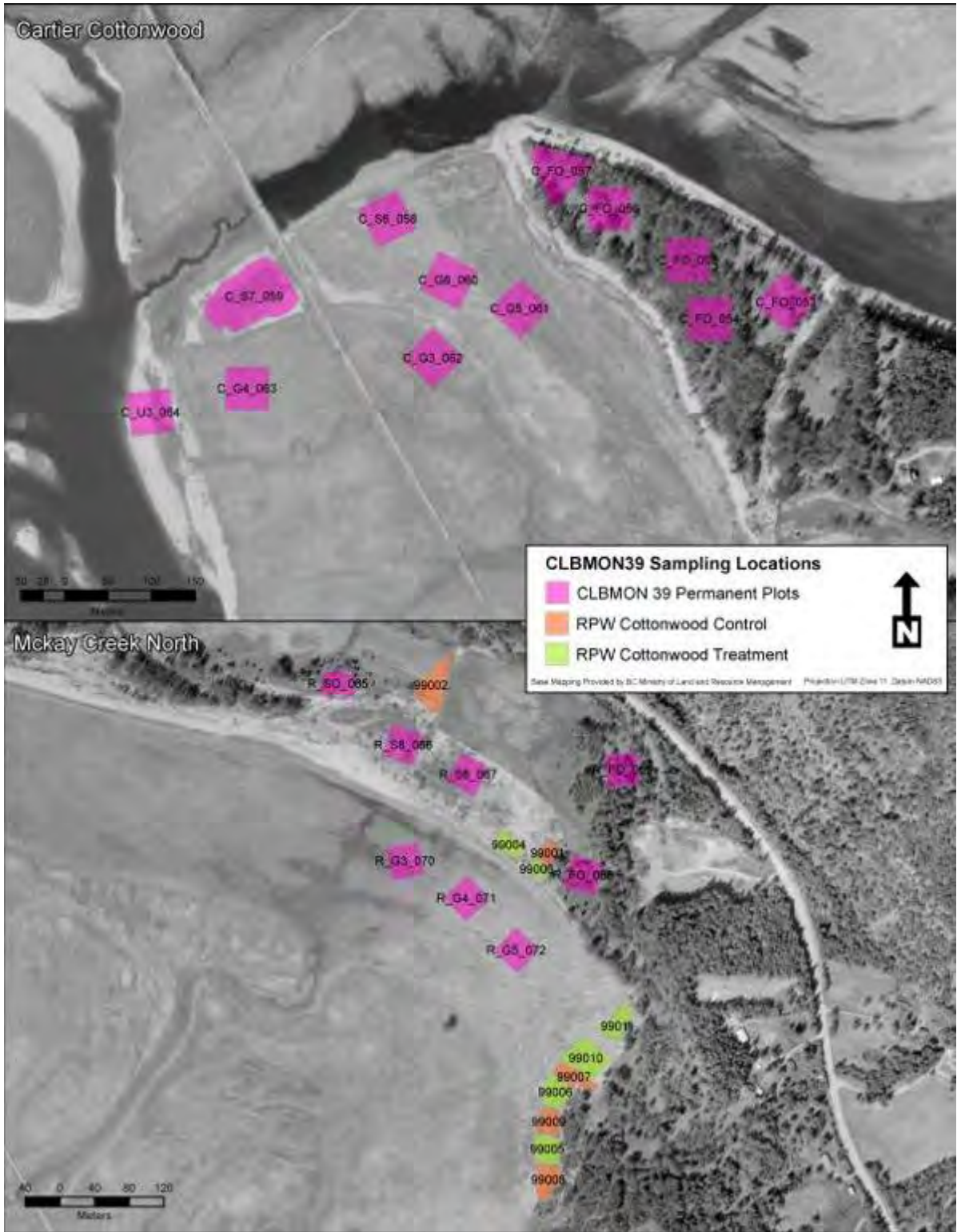
Appendix 2: Water levels (m) in Arrow Lakes Reservoir in 2012 compared with data from 2008 to 2011 and mean, minimum and maximum elevation (1968–2008)

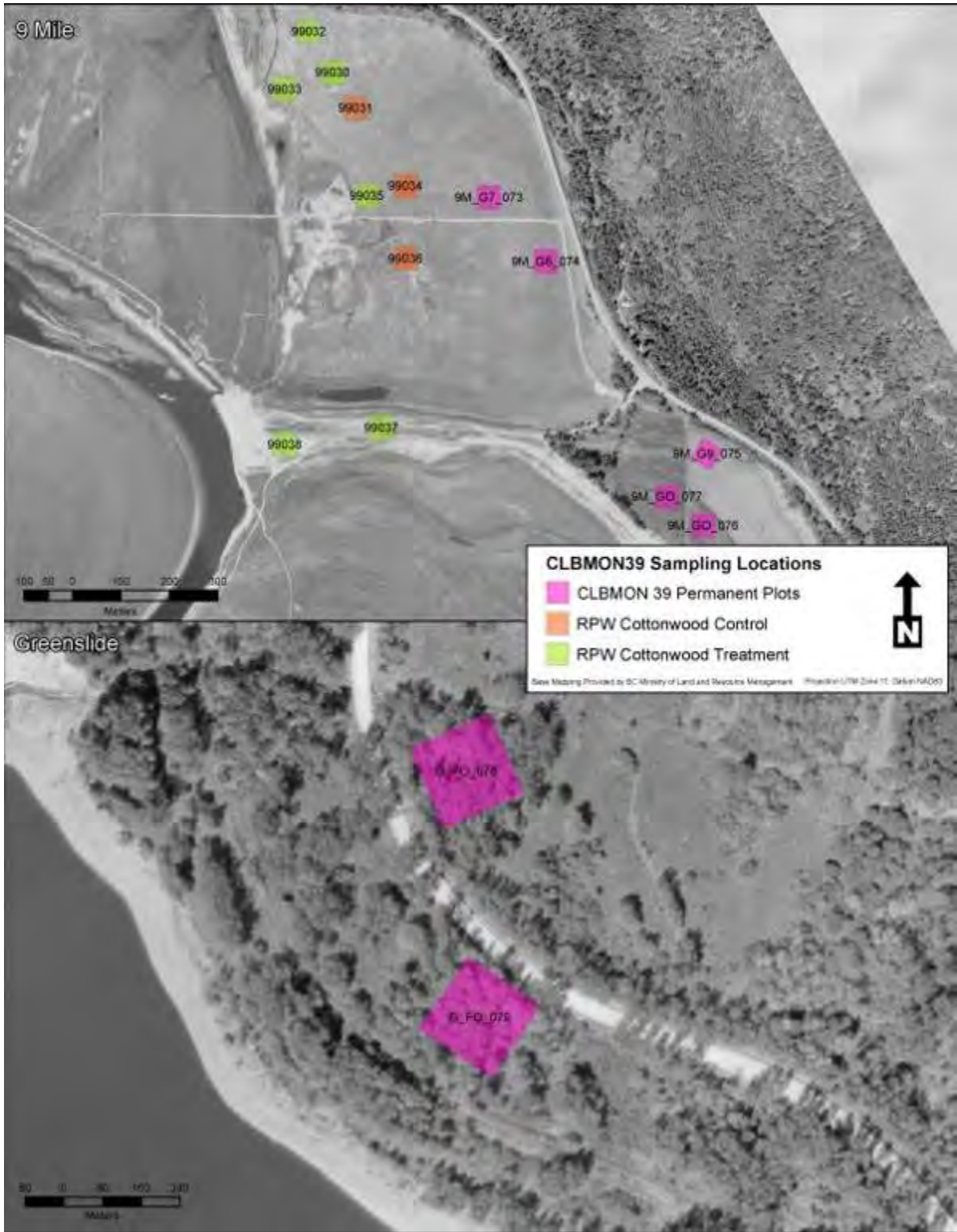






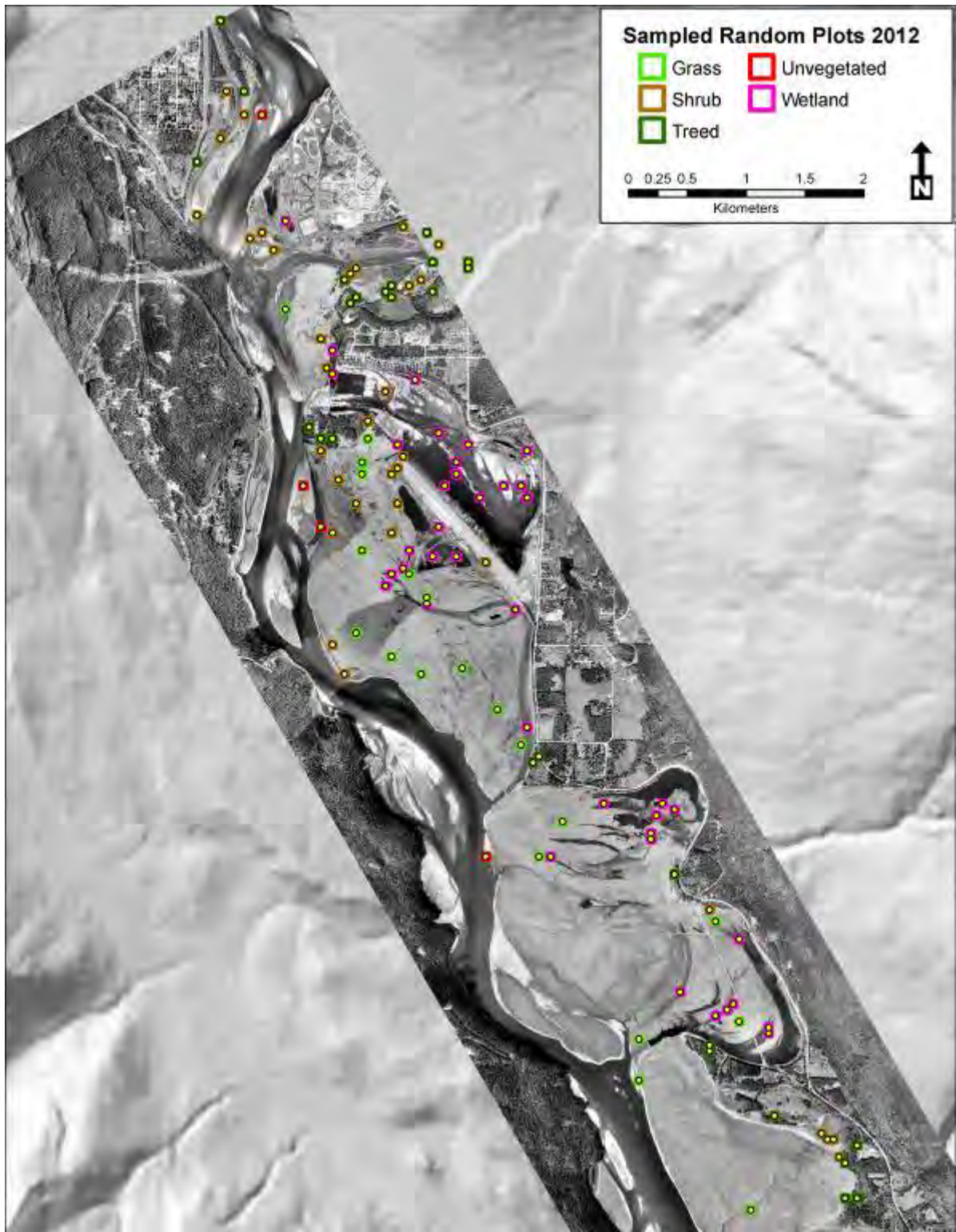


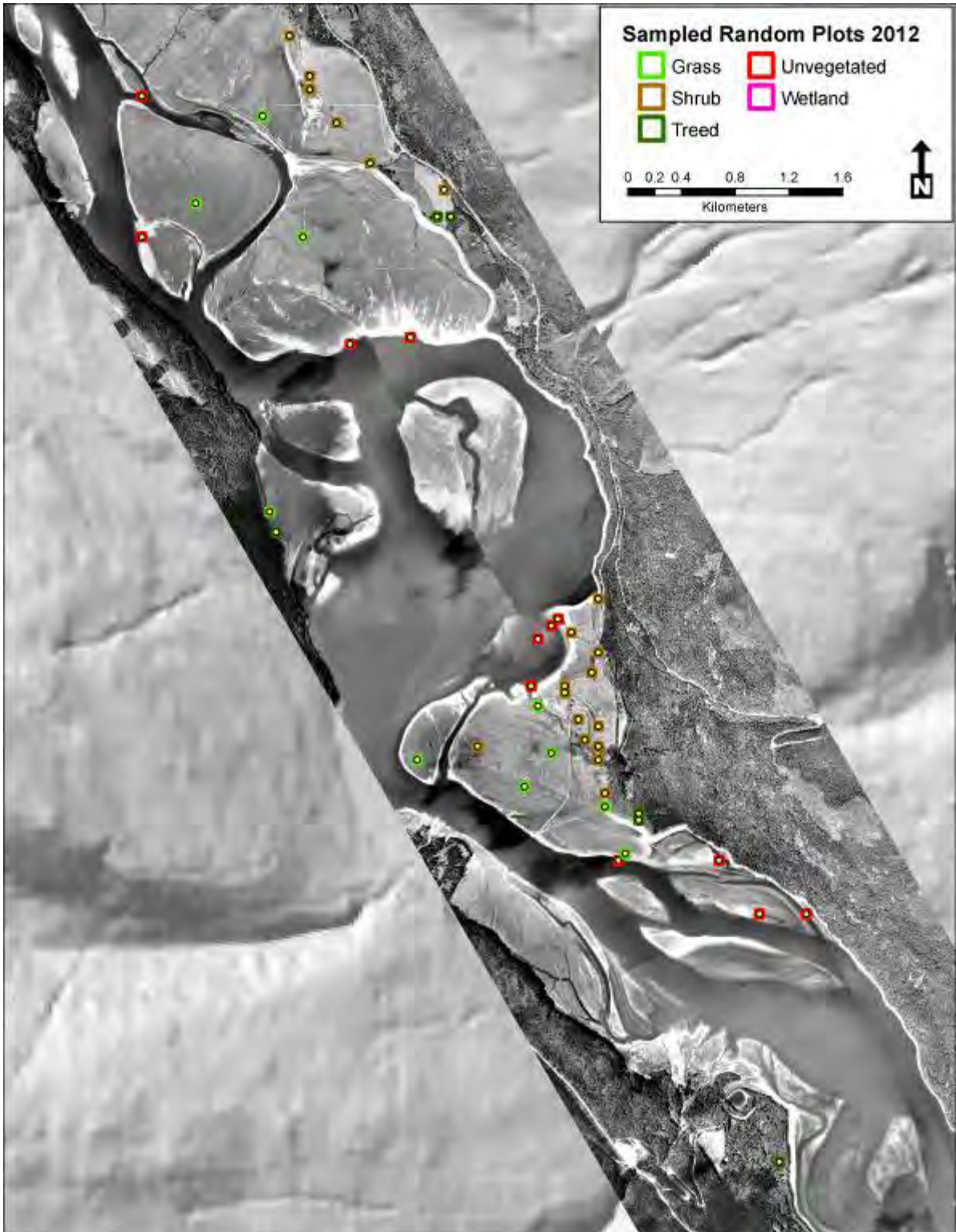




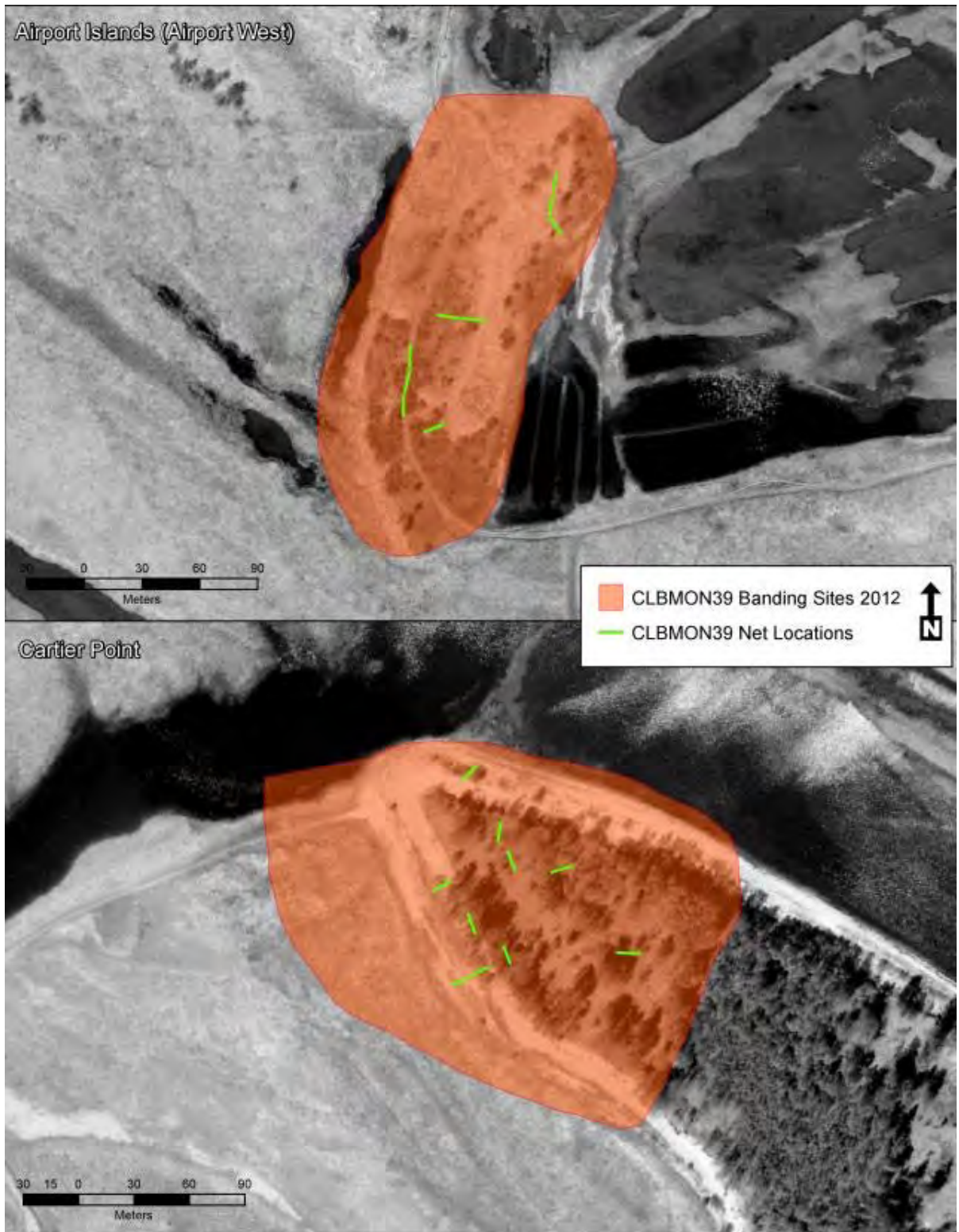


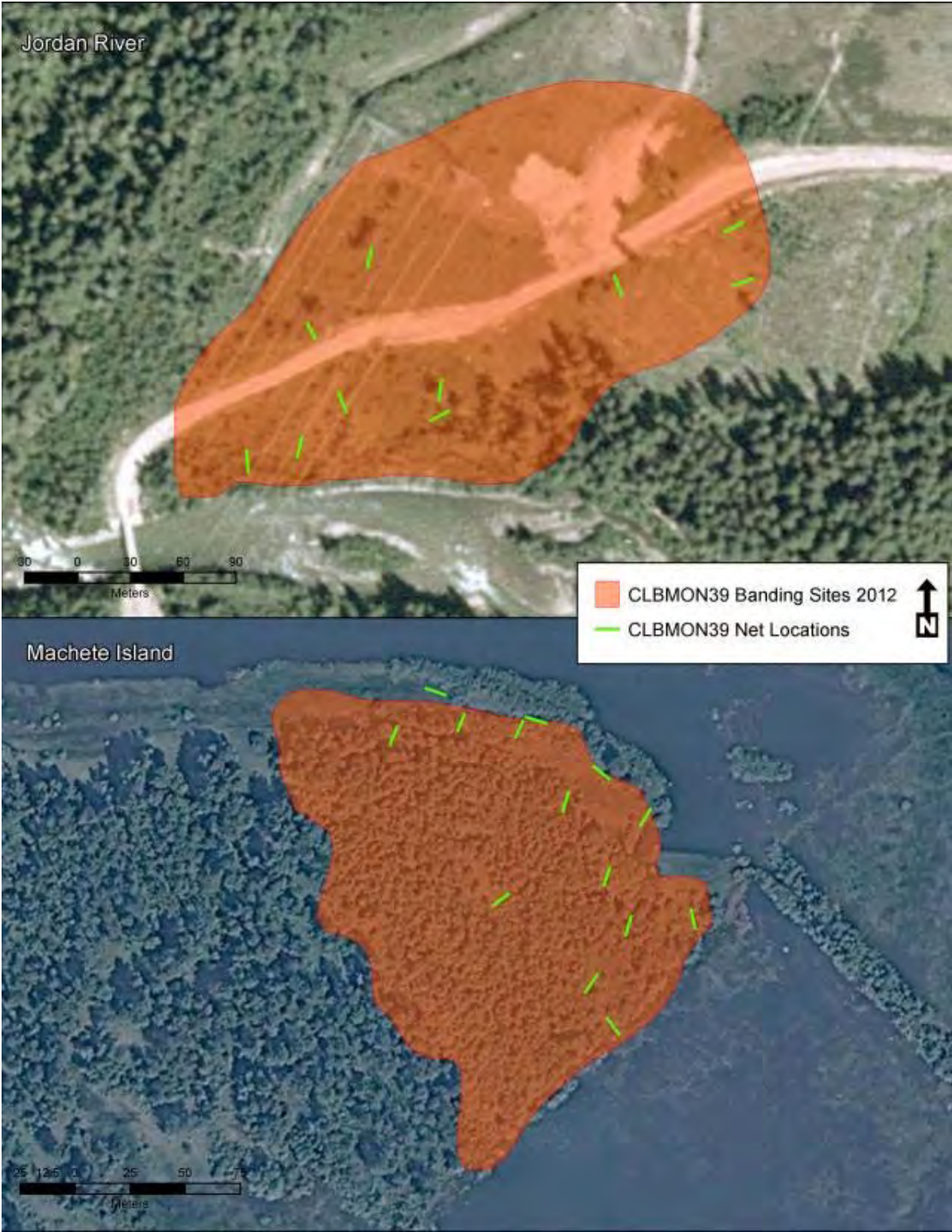
Appendix 4: Random plot layout in Revelstoke Reach in 2012





Appendix 5: Banding stations layout with mist net locations in Revelstoke Reach in 2012







Appendix 6: Birds species detected during CLBMON 39 in 2012 (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	<i>Empidonax alhorum</i>	ALFL		x				x		x	x
American Coot	<i>Fulica americana</i>	AMCO		x	x	x				x	
American Crow	<i>Corvus brachyrhynchos</i>	AMCR	x	x	x	x		x		x	
American Goldfinch	<i>Spinus tristis</i>	AMGO	x	x	x	x	x	x		x	
American Kestrel	<i>Falco sparverius</i>	AMKE		x						x	
American Pipit	<i>Anthus rubescens</i>	AMPI	x	x	x	x	x	x		x	
American Redstart	<i>Setophaga ruticilla</i>	AMRE	x	x	x	x	x	x		x	x
American Robin	<i>Turdus migratorius</i>	AMRO	x	x	x	x	x	x		x	x
American Tree Sparrow	<i>Spizella arborea</i>	ATSP			x						
American Wigeon	<i>Anas americana</i>	AMWI		x	x	x		x		x	
Anna's Hummingbird	<i>Calypte anna</i>	ANHU		x							
Bald Eagle	<i>Haliaeetus leucocephalus</i>	BAEA		x	x	x			x		x
Bank Swallow	<i>Riparia riparia</i>	BANS			x					x	
Barn Swallow	<i>Hirundo rustica</i>	BARS		x	x	x			x		x
Barred Owl	<i>Strix varia</i>	BADO								x	
Barrow's Goldeneye	<i>Bucephala islandica</i>	BAGO		x	x						
Belted Kingfisher	<i>Megaceryle alcyon</i>	BEKI		x	x	x			x		x
Black Swift	<i>Cypseloides niger</i>	BLSW		x	x	x			x		x
Black-and-white Warbler	<i>Mniotilta varia</i>	BAWW						x			
Black-billed Magpie	<i>Pica hudsonia</i>	BBMA			x						
Black-capped Chickadee	<i>Poecile atricapillus</i>	BCCH	x	x	x	x		x	x		x
Blue-winged Teal	<i>Anas discors</i>	BWTE								x	
Bobolink	<i>Dolichonyx oryzivorus</i>	BOBO						x			
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	BRBL	x	x	x				x		x
Broad-winged Hawk	<i>Buteo platypterus</i>	BWHA								x	
Brown Creeper	<i>Certhia americana</i>	BRCR		x							x
Brown-headed Cowbird	<i>Molothrus ater</i>	BHCO	x	x	x	x		x	x		x
Bufflehead	<i>Bucephala albeola</i>	BUFF		x	x					x	
Bullock's Oriole	<i>Icterus bullockii</i>	BUOR		x						x	
California Gull	<i>Larus californicus</i>	CAGU		x			x			x	
Canada Goose	<i>Branta canadensis</i>	CANG		x	x	x			x		x
Cassin's Vireo	<i>Vireo cassinii</i>	CAVI		x	x	x			x		x
Cedar Waxwing	<i>Bombycilla cedrorum</i>	CEDW	x	x		x			x		x
Chestnut-backed Chickadee	<i>Poecile rufescens</i>	CBCH		x	x					x	x
Chipping Sparrow	<i>Spizella passerina</i>	CHSP	x	x	x	x		x		x	
Cinnamon Teal	<i>Anas cyanoptera</i>	CITE		x							
Clay-colored Sparrow	<i>Spizella pallida</i>	CCSP	x	x	x						x
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	CLSW	x		x						
Common Loon	<i>Gavia immer</i>	COLO	x	x	x				x		x
Common Merganser	<i>Mergus merganser</i>	COME		x	x					x	
Common Nighthawk	<i>Chordeiles minor</i>	CONI								x	
Common Raven	<i>Corvus corax</i>	CORA	x	x	x	x			x		x
Common Redpoll	<i>Acanthis flammea</i>	CORE			x						
Common Yellowthroat	<i>Geothlypis trichas</i>	COYE	x	x	x	x		x	x		x
Cooper's Hawk	<i>Accipiter cooperii</i>	COHA		x	x					x	
Dark-eyed Junco	<i>Junco hyemalis</i>	DEJU		x	x	x		x	x		x
Downy Woodpecker	<i>Picoides pubescens</i>	DOWO		x	x				x		x
Dusky Flycatcher	<i>Empidonax oberholseri</i>	DUFL	x		x				x		
Eastern Kingbird	<i>Tyrannus tyrannus</i>	EAKI		x	x	x			x	x	x
Eurasian Collared-dove	<i>Streptopelia decaocto</i>	EUCD								x	

Common Name	Scientific Name	Code	Permanent Plots		Random Plots		EM plots		Banding	
			S	F	S	F	S	F	Observed	Captured
European Starling	<i>Sturnus vulgaris</i>	EUST			x				x	
Evening Grosbeak	<i>Coccothraustes vespertinus</i>	EVGR		x	x				x	
Fox Sparrow	<i>Passerella iliaca</i>	FOSP		x		x				x
Golden-crowned Kinglet	<i>Regulus satrapa</i>	GCKI		x	x				x	x
Golden-crowned Sparrow	<i>Zonotrichia atricapilla</i>	GCSP	x							
Gray Catbird	<i>Dumetella carolinensis</i>	GRCA	x	x	x	x		x	x	x
Great Blue Heron	<i>Ardea herodias</i>	GBHE	x	x	x	x		x	x	
Great Horned Owl	<i>Bubo virginianus</i>	GHOW							x	
Greater Scaup	<i>Aythya marila</i>	GRSC			x					
Greater Yellowlegs	<i>Tringa melanoleuca</i>	GRYE			x	x			x	
Green-winged Teal	<i>Anas crecca</i>	GWTE		x	x	x		x	x	
Hairy Woodpecker	<i>Picoides villosus</i>	HAWO	x	x	x	x			x	
Hammond's Flycatcher	<i>Empidonax hammondi</i>	HAFL		x	x			x	x	x
Hermit Thrush	<i>Catharus guttatus</i>	HETH								x
Herring Gull	<i>Larus argentatus</i>	HERG		x		x		x	x	
Hooded Merganser	<i>Lophodytes cucullatus</i>	HOME		x					x	
Horned Lark	<i>Eremophila alpestris</i>	HOLA			x					
House Wren	<i>Troglodytes aedon</i>	HOWR						x		
Killdeer	<i>Charadrius vociferus</i>	KILL	x	x	x			x	x	
Lapland Longspur	<i>Calcarius lapponicus</i>	LALO	x	x					x	
Lazuli Bunting	<i>Passerina amoena</i>	LAZB	x	x	x	x		x	x	x
Least Flycatcher	<i>Empidonax minimus</i>	LEFL	x	x	x	x			x	x
Least Sandpiper	<i>Calidris minutilla</i>	LESA		x		x			x	
Lesser Yellowlegs	<i>Tringa flavipes</i>	LEYE				x		x		
Lincoln's Sparrow	<i>Melospiza lincolni</i>	LISP	x	x	x			x	x	x
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	LBDO				x			x	
Long-eared Owl	<i>Asio otus</i>	LEOW			x					
MacGillivray's Warbler	<i>Geothlypis tolmiei</i>	MGWA	x	x	x	x		x	x	x
Mallard	<i>Anas platyrhynchos</i>	MALL	x	x	x	x		x	x	
Marsh Wren	<i>Cistothorus palustris</i>	MAWR		x	x			x		
Merlin	<i>Falco columbarius</i>	MERL	x	x	x	x		x	x	
Mountain Bluebird	<i>Sialia currucoides</i>	MOBL	x		x			x		
Mountain Chickadee	<i>Poecile gambeli</i>	MOCH								x
Mourning Dove	<i>Zenaidura macroura</i>	MODO	x					x		
Nashville Warbler	<i>Oreothlypis ruficapilla</i>	NAWA		x		x		x	x	x
Northern Flicker	<i>Colaptes auratus</i>	NOFL	x	x	x	x		x	x	
Northern Harrier	<i>Circus cyaneus</i>	NOHA	x	x	x			x	x	
Northern Pintail	<i>Anas acuta</i>	NOPI		x	x			x	x	
Northern Pygmy-owl	<i>Glaucidium gnoma</i>	NOPO							x	
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	NRWS	x	x	x	x		x	x	
Northern Shoveler	<i>Anas clypeata</i>	NSHO			x				x	
Northern Shrike	<i>Lanius excubitor</i>	NSHR	x		x					
Northern Waterthrush	<i>Parkesia noveboracensis</i>	NOWA		x					x	x
Orange-crowned Warbler	<i>Oreothlypis celata</i>	OCWA	x	x	x			x	x	x
Osprey	<i>Pandion haliaetus</i>	OSPR	x	x	x	x		x	x	
Pacific Wren	<i>Troglodytes pacificus</i>	PAWR			x				x	x
Pacific-slope Flycatcher	<i>Empidonax difficilis</i>	PSFL								x
Pectoral Sandpiper	<i>Calidris melanotos</i>	PESA							x	
Peregrine Falcon	<i>Falco peregrinus</i>	PEFA	x		x				x	
Pied-billed Grebe	<i>Podilymbus podiceps</i>	PBGR		x	x	x			x	
Pileated Woodpecker	<i>Dryocopus pileatus</i>	PIWO		x	x				x	
Pine Siskin	<i>Spinus pinus</i>	PISI	x	x	x	x		x	x	x
Purple Finch	<i>Carpodacus purpureus</i>	PUFI		x					x	

Common Name	Scientific Name	Code	Permanent Plots		Random Plots		EM plots		Banding	
			S	F	S	F	S	F	Observed	Captured
Red Crossbill	<i>Loxia curvirostra</i>	RECR		x		x				x
Red-breasted Merganser	<i>Mergus serrator</i>	RBME						x		
Red-breasted Nuthatch	<i>Sitta canadensis</i>	RBNU	x	x	x	x		x		x
Red-eyed Vireo	<i>Vireo olivaceus</i>	REVI	x	x	x	x		x		x
Red-naped Sapsucker	<i>Sphyrapicus nuchalis</i>	RNSA		x						
Red-necked Grebe	<i>Podiceps griseogen</i>	RNGR						x		x
Red-necked Phalarope	<i>Phalaropus lobatus</i>	RNPH								x
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RTHA		x	x			x		x
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	RWBL		x	x	x				x
Ring-billed Gull	<i>Larus delawarensis</i>	RBGU		x		x				x
Ring-necked Duck	<i>Aythya collaris</i>	RNDU		x	x					x
Ruby-crowned Kinglet	<i>Regulus calendula</i>	RCKI	x	x	x	x	x	x		x
Ruffed Grouse	<i>Bonasa umbellus</i>	RUGR	x	x						x
Rufous Hummingbird	<i>Selasphorus rufus</i>	RUHU	x	x	x	x	x	x		x
Rusty Blackbird	<i>Euphagus carolinus</i>	RUBL			x					
Sanderling	<i>Calidris alba</i>	SAND						x		
Sandhill Crane	<i>Grus canadensis</i>	SACR					x			
Savannah Sparrow	<i>Passerculus sandwichensis</i>	SAVS	x	x	x	x	x	x		x
Say's Phoebe	<i>Sayornis saya</i>	SAPH	x							
Semipalmated Plover	<i>Charadrius semipalmatus</i>	SEPL		x						x
Semipalmated Sandpiper	<i>Calidris pusilla</i>	SESA								x
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SSHA		x			x	x		x
Short-eared Owl	<i>Asio flammeus</i>	SEOW			x					
Snow Goose	<i>Chen caerulescens</i>	SNGO			x					
Solitary Sandpiper	<i>Tringa solitaria</i>	SOSA		x		x				x
Song Sparrow	<i>Melospiza melodia</i>	SOSP	x	x	x	x	x	x		x
Sora	<i>Porzana carolina</i>	SORA		x	x			x		x
Spotted Sandpiper	<i>Actitis macularius</i>	SPSA	x	x	x	x		x		x
Steller's Jay	<i>Cyanocitta stelleri</i>	STJA		x						x
Swainson's Thrush	<i>Catharus ustulatus</i>	SWTH		x	x	x				x
Swamp Sparrow	<i>Melospiza georgiana</i>	SWSP		x				x		x
Tennessee Warbler	<i>Oreothlypis peregrina</i>	TEWA	x	x						x
Townsend's Solitaire	<i>Myadestes townsendi</i>	TOSO		x						x
Townsend's Warbler	<i>Setophaga townsendi</i>	TOWA		x	x					x
Traill's Flycatcher	<i>Empidonax alnorum/traillii</i>	TRFL		x		x		x		x
Tree Swallow	<i>Tachycineta bicolor</i>	TRES	x	x	x		x	x		x
Turkey Vulture	<i>Cathartes aura</i>	TUVU		x	x	x		x		x
Unidentified Accipiter Hawk	<i>Accipiter (sp)</i>	UAHA								x
Unidentified Bird	Aves (gen, sp)	UNBI	x	x	x	x	x	x		
Unidentified Blackbird	Icteridae (gen, sp)	UNBL		x	x	x		x		x
Unidentified <i>Calidris</i> Sandpiper	<i>Calidris (sp)</i>	UCSA		x		x				x
Unidentified Dowitcher	<i>Limnodromus (sp)</i>	UNDO								x
Unidentified Duck	Anatinae (gen, sp)	UNDU		x	x	x		x		x
Unidentified <i>Empidonax</i> Flycatcher	<i>Empidonax (sp)</i>	UEFL		x	x	x		x		
Unidentified Goldeneye sp.	<i>Bucephala (sp)</i>	GOLD		x		x				
Unidentified Hummingbird	Trochilidae (gen, sp)	UNHU		x	x	x	x			
Unidentified <i>Larus</i> Gull	<i>Larus (sp)</i>	UNLG		x		x		x		x
Unidentified Shorebird		UNSH			x	x				
Unidentified Songbird	Passeriformes (gen, sp)	UNSO		x	x	x	x	x		
Unidentified Sparrow	Emberizidae (gen, sp)	UNSP	x	x	x	x	x	x		x
Unidentified Swallow	Hirundidae (gen, sp)	UNSW	x	x	x		x			x
Unidentified Swan	<i>Cygnus (sp)</i>	SWAN			x					
Unidentified Teal		UNTE		x				x		x

Common Name	Scientific Name	Code	Permanent Plots		Random Plots		EM plots		Banding	
			S	F	S	F	S	F	Observed	Captured
Unidentified Warbler	Parulidae (gen, sp)	UNWA	x	x		x	x	x		
Unidentified Woodpecker	Picidae (gen, sp)	UNWO							x	
Unidentified Yellowlegs	<i>Tringa melanoleuca/flavipes</i>	UNYE							x	
Varied Thrush	<i>Ixoreus naevius</i>	VATH		x	x		x		x	x
Vaux's Swift	<i>Chaetura vauxi</i>	VASW	x	x	x		x	x	x	
Veery	<i>Catharus fuscescens</i>	VEER		x	x				x	x
Vesper Sparrow	<i>Poocetes gramineus</i>	VESP			x					
Violet-green Swallow	<i>Tachycineta thalassina</i>	VGSW	x		x		x			
Virginia Rail	<i>Rallus limicola</i>	VIRA			x					
Warbling Vireo	<i>Vireo gilvus</i>	WAVI	x	x	x	x	x		x	x
Western Meadowlark	<i>Sturnella neglecta</i>	WEME	x		x		x			
Western Sandpiper	<i>Calidris mauri</i>	WESA				x				
Western Tanager	<i>Piranga ludoviciana</i>	WETA		x	x	x			x	
Western Wood-pewee	<i>Contopus sordidulus</i>	WEWP	x	x	x	x		x	x	x
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	WCSP	x	x	x		x	x		x
White-throated Sparrow	<i>Zonotrichia albicollis</i>	WTSP		x						
White-winged Crossbill	<i>Loxia leucoptera</i>	WWCR				x				
Willow Flycatcher	<i>Empidonax traillii</i>	WIFL	x	x		x		x	x	x
Wilson's Snipe	<i>Gallinago delicata</i>	WISN	x	x	x	x		x	x	x
Wilson's Warbler	<i>Cardellina pusilla</i>	WIWA	x	x	x		x			x
Wood Duck	<i>Aix sponsa</i>	WODU		x		x			x	
Yellow Warbler	<i>Setophaga petechia</i>	YWAR	x	x	x	x	x	x	x	x
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	YHBL		x	x	x				
Yellow-rumped Warbler	<i>Setophaga coronata</i>	YRWA	x	x	x	x	x	x	x	x

Appendix 7: Species and number of birds recorded during permanent plot surveys in Revelstoke Reach in spring 2012

Common Name	On Plot	Off Plot	Overhead	Total
American Pipit	.	19	72	91
Yellow-rumped Warbler	47	24	5	76
Violet-green Swallow	.	.	53	53
Ruby-crowned Kinglet	37	5	.	42
Unidentified Swallow	.	2	35	37
Tree Swallow	.	2	33	35
White-crowned Sparrow	31	3	1	35
Savannah Sparrow	20	11	.	31
Yellow Warbler	6	23	.	29
Vaux's Swift	.	.	28	28
Cliff Swallow	.	.	27	27
Northern Rough-winged Swallow	.	.	21	21
Common Yellowthroat	14	6	.	20
Pine Siskin	.	15	2	17
Black-capped Chickadee	7	9	.	16
Wilson's Warbler	13	1	.	14
Unidentified Sparrow	4	2	7	13
Least Flycatcher	2	10	.	12
American Goldfinch	.	.	9	9
American Robin	3	6	.	9
Northern Flicker	4	4	.	8
Warbling Vireo	3	5	.	8
American Redstart	6	1	.	7
Clay-colored Sparrow	7	.	.	7
Lazuli Bunting	1	5	.	6
Lincoln's Sparrow	6	.	.	6
Orange-crowned Warbler	4	1	.	5
Brown-headed Cowbird	.	3	1	4
Western Meadowlark	3	1	.	4
Common Raven	1	.	2	3
Gray Catbird	1	2	.	3
Macgillivray's Warbler	2	1	.	3
Song Sparrow	1	2	.	3
Western Wood-pewee	.	3	.	3
American Crow	2	.	.	2
Brewer's Blackbird	.	.	2	2
Common Loon	.	2	.	2
Golden-crowned Sparrow	2	.	.	2
Mallard	.	2	.	2
Merlin	1	1	.	2
Mountain Bluebird	1	1	.	2
Red-breasted Nuthatch	.	2	.	2
Willow Flycatcher	2	.	.	2
Cedar Waxwing	.	1	.	1
Chipping Sparrow	.	1	.	1
Dusky Flycatcher	1	.	.	1

Common Name	On Plot	Off Plot	Overhead	Total
Great Blue Heron	.	.	1	1
Hairy Woodpecker	.	.	1	1
Killdeer	.	.	1	1
Lapland Longspur	.	.	1	1
Mourning Dove	.	1	.	1
Northern Harrier	.	1	.	1
Northern Shrike	1	.	.	1
Osprey	.	1	.	1
Peregrine Falcon	.	.	1	1
Red-eyed Vireo	1	.	.	1
Ruffed Grouse	1	.	.	1
Rufous Hummingbird	.	.	1	1
Say's Phoebe	1	.	.	1
Spotted Sandpiper	.	1	.	1
Tennessee Warbler	.	1	.	1
Unidentified Bird	.	.	1	1
Unidentified Warbler	.	1	.	1
Wilson's Snipe	1	.	.	1
Grand Total	237	182	305	724

Appendix 8: 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 2012

Species Code*	Elev. Band (m ASL)	431	432	433	434	435	436	437	438	439
		<i>N</i>	1	.	2	2	2	5	5	2	4
YRWA	47	.	.	.	.	.	0.20	5.80	0.50	4.00
RCKI	37	.	.	.	.	.	0.20	2.00	1.00	6.00
WCSP	31	.	.	.	.	.	.	5.20	1.50	0.50
SAVS	20	.	.	.	.	.	1.60	0.80	.	2.00
COYE	14	.	.	.	.	.	0.40	1.60	.	1.00
WIWA	13	.	.	.	.	.	.	0.80	1.00	1.75
CCSP	7	.	.	.	.	.	0.20	1.20	.	.
AMRE	6	.	.	.	.	.	0.20	.	.	1.25
LISP	6	.	.	.	.	.	.	0.40	.	1.00
YWAR	6	.	.	.	.	.	.	0.40	.	1.00
OCWA	4	.	.	.	.	.	.	0.20	.	0.75
UNSP	4	.	.	.	.	.	.	0.40	0.50	0.25
AMRO	3	.	.	.	.	.	.	0.60	.	.
WAVI	3	.	.	.	.	.	.	0.40	.	0.25
WEME	3	.	.	.	.	.	0.20	.	.	0.50
GCSP	2	.	.	.	.	.	.	.	.	0.50
LEFL	2	.	.	.	.	.	0.20	.	.	0.25
MGWA	2	.	.	.	.	.	.	0.20	.	0.25
WIFL	2	.	.	.	.	.	.	.	.	0.50
DUFL	1	.	.	.	.	.	.	0.20	.	.
GRCA	1	.	.	.	.	.	.	.	.	0.25
LAZB	1	.	.	.	.	.	.	.	.	0.25
MOBL	1	.	.	.	.	.	.	.	.	0.25
REVI	1	.	.	.	.	.	.	.	.	0.25
SAPH	1	.	.	.	.	.	.	.	.	0.25
SOSP	1	.	.	.	.	.	.	.	.	0.25
Grand Total	219	.	.	.	.	.	3.20	20.20	4.50	23.25

* Species Code: see definition in Appendix 6

Appendix 9: Species and number of birds recorded during permanent plot surveys in Revelstoke Reach in fall 2012

Common Name	On Plot	Off Plot	Overhead	Total
Pine Siskin	209	32	497	738
Canada Goose	103	190	14	307
Common Yellowthroat	203	40	.	243
Yellow-rumped Warbler	101	29	71	201
Cedar Waxwing	93	40	62	195
Black-capped Chickadee	92	24	.	116
Savannah Sparrow	72	17	18	107
Mallard	59	30	7	96
Yellow Warbler	69	12	5	86
American Pipit	2	.	76	78
Common Raven	3	50	24	77
Unidentified Bird	57	3	8	68
Unidentified Duck	51	3	2	56
American Robin	38	6	11	55
Red-eyed Vireo	32	22	.	54
Song Sparrow	41	13	.	54
Gray Catbird	30	17	.	47
American Goldfinch	7	8	31	46
American Redstart	41	5	.	46
Red Crossbill	.	9	36	45
American Coot	44	.	.	44
Tree Swallow	.	3	31	34
American Crow	10	14	8	32
Unidentified Sparrow	25	2	5	32
Wilson's Snipe	27	3	2	32
Ring-billed Gull	.	28	3	31
Northern Flicker	14	10	3	27
Black Swift	.	13	13	26
Warbling Vireo	20	3	.	23
Willow Flycatcher	20	3	.	23
Great Blue Heron	12	6	4	22
Lincoln's Sparrow	14	8	.	22
Northern Rough-winged Swallow	.	.	22	22
Macgillivray's Warbler	17	4	.	21
White-crowned Sparrow	17	1	3	21
Western Wood-pewee	11	7	.	18
Lazuli Bunting	10	6	.	16
Red-breasted Nuthatch	12	3	.	15
Least Sandpiper	6	4	4	14
Unidentified Warbler	4	3	7	14
Trill's Flycatcher	11	2	.	13
Barn Swallow	.	2	10	12
Downy Woodpecker	6	5	.	11
Green-winged Teal	7	3	1	11
Ruby-crowned Kinglet	10	1	.	11
Unidentified <i>Calidris</i> Sandpiper	.	8	3	11

Common Name	On Plot	Off Plot	Overhead	Total
Eastern Kingbird	2	6	2	10
Herring Gull	.	5	5	10
Orange-crowned Warbler	8	2	.	10
Alder Flycatcher	6	3	.	9
Dark-eyed Junco	4	5	.	9
Least Flycatcher	8	1	.	9
Osprey	.	3	6	9
Semipalmated Plover	.	2	7	9
Swainson's Thrush	5	4	.	9
Bald Eagle	.	5	3	8
Chipping Sparrow	3	4	1	8
Common Loon	1	6	1	8
Golden-crowned Kinglet	5	3	.	8
Rufous Hummingbird	6	.	2	8
Western Tanager	5	1	2	8
Northern Waterthrush	7	.	.	7
Wood Duck	6	.	1	7
American Wigeon	4	.	2	6
Hooded Merganser	3	.	3	6
Red-winged Blackbird	5	1	.	6
Solitary Sandpiper	2	1	3	6
Unidentified <i>Empidonax</i> Flycatcher	6	.	.	6
Unidentified Songbird	3	2	1	6
Pied-billed Grebe	2	3	.	5
Unidentified Teal	1	4	.	5
Belted Kingfisher	1	1	2	4
Brown-headed Cowbird	3	1	.	4
Killdeer	.	4	.	4
Red-naped Sapsucker	4	.	.	4
Sora	4	.	.	4
Tennessee Warbler	4	.	.	4
Wilson's Warbler	2	2	.	4
Yellow-headed Blackbird	1	2	1	4
California Gull	.	.	3	3
Common Merganser	1	2	.	3
Nashville Warbler	2	1	.	3
Red-tailed Hawk	.	1	2	3
Ruffed Grouse	2	1	.	3
Spotted Sandpiper	.	3	.	3
Swamp Sparrow	2	1	.	3
Unidentified <i>Larus</i> Gull	1	.	2	3
Vaux's Swift	.	.	3	3
American Kestrel	.	2	.	2
Brewer's Blackbird	.	2	.	2
Brown Creeper	1	1	.	2
Chestnut-backed Chickadee	2	.	.	2
Cinnamon Teal	2	.	.	2
Cooper's Hawk	.	1	1	2

Common Name	On Plot	Off Plot	Overhead	Total
Evening Grosbeak	.	2	.	2
Fox Sparrow	2	.	.	2
Unidentified Goldeneye	.	2	.	2
Hammond's Flycatcher	2	.	.	2
Ring-necked Duck	.	.	2	2
Sharp-shinned Hawk	1	.	1	2
Steller's Jay	2	.	.	2
Townsend's Warbler	1	.	1	2
White-throated Sparrow	2	.	.	2
Anna's Hummingbird	1	.	.	1
Barrow's Goldeneye	.	1	.	1
Bufflehead	.	.	1	1
Bullock's Oriole	1	.	.	1
Cassin's Vireo	.	1	.	1
Clay-colored Sparrow	1	.	.	1
Hairy Woodpecker	.	1	.	1
Lapland Longspur	.	.	1	1
Marsh Wren	1	.	.	1
Merlin	.	.	1	1
Northern Harrier	.	1	.	1
Northern Pintail	.	.	1	1
Pileated Woodpecker	.	1	.	1
Purple Finch	1	.	.	1
Townsend's Solitaire	.	1	.	1
Turkey Vulture	.	.	1	1
Unidentified Blackbird	1	.	.	1
Unidentified Hummingbird	.	.	1	1
Unidentified Swallow	.	.	1	1
Varied Thrush	1	.	.	1
Veery	1	.	.	1
Grand Total	1,742	788	1,045	3,575

* Species Code: see definition in Appendix 6

Appendix 10: Number of neotropical migrant songbirds detected on plot during permanent plot surveys in and outside of the drawdown zone in Revelstoke Reach in fall 2012, 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
PISI	13	94	107	56	46	102	.	.	.	.	.	.	69	140	209
COYE	57	10	67	58	45	103	33	.	33	.	.	.	148	55	203
YRWA	18	24	42	53	6	59	.	.	.	.	.	.	71	30	101
CEDW	28	23	51	18	24	42	.	.	.	.	.	.	46	47	93
SAVS	4	3	7	14	.	14	19	32	51	.	.	.	37	35	72
YWAR	31	13	44	15	10	25	.	.	.	.	.	.	46	23	69
AMRE	26	9	35	5	1	6	.	.	.	.	.	.	31	10	41
SOSP	8	2	10	5	24	29	2	.	2	.	.	.	15	26	41
AMRO	24	11	35	.	3	3	.	.	.	.	.	.	24	14	38
REVI	15	16	31	1	.	1	.	.	.	.	.	.	16	16	32
GRCA	5	12	17	2	11	13	.	.	.	.	.	.	7	23	30
UNSP	.	3	3	8	.	8	9	5	14	.	.	.	17	8	25
WAVI	1	13	14	2	4	6	.	.	.	.	.	.	3	17	20
WIFL	8	4	12	.	8	8	.	.	.	.	.	.	8	12	20
MGWA	3	12	15	1	1	2	.	.	.	.	.	.	4	13	17
WCSP	1	3	4	1	11	12	1	.	1	.	.	.	3	14	17
LISP	5	2	7	4	2	6	.	1	1	.	.	.	9	5	14
TRFL	3	1	4	5	2	7	.	.	.	.	.	.	8	3	11
WEWP	11	.	11	.	.	.	.	.	.	.	.	.	11	.	11
LAZB	.	4	4	1	2	3	3	.	3	.	.	.	4	6	10
RCKI	1	4	5	3	2	5	.	.	.	.	.	.	4	6	10
LEFL	3	5	8	.	.	.	.	.	.	.	.	.	3	5	8
OCWA	3	1	4	4	.	4	.	.	.	.	.	.	7	1	8
AMGO	4	1	5	1	.	1	1	.	1	.	.	.	6	1	7
NOWA	6	.	6	1	.	1	.	.	.	.	.	.	7	.	7
ALFL	1	2	3	2	1	3	.	.	.	.	.	.	3	3	6
UEFL	.	1	1	5	.	5	.	.	.	.	.	.	5	1	6
GCKI	2	3	5	.	.	.	.	.	.	.	.	.	2	3	5
RWBL	2	.	2	.	1	1	2	.	2	.	.	.	4	1	5
SWTH	1	2	3	.	2	2	.	.	.	.	.	.	1	4	5
WETA	1	4	5	.	.	.	.	.	.	.	.	.	1	4	5
DEJU	.	4	4	.	.	.	.	.	.	.	.	.	.	4	4
TEWA	3	1	4	.	.	.	.	.	.	.	.	.	3	1	4
UNWA	1	1	2	2	.	2	.	.	.	.	.	.	3	1	4
BHCO	3	.	3	.	.	.	.	.	.	.	.	.	3	.	3
CHSP	2	1	3	.	.	.	.	.	.	.	.	.	2	1	3
UNSO	.	1	1	1	.	1	.	1	1	.	.	.	1	2	3
AMPI	.	.	.	2	.	2	.	.	.	.	.	.	2	.	2
EAKI	.	.	.	.	2	2	.	.	.	.	.	.	.	2	2
FOSP	.	.	.	.	2	2	.	.	.	.	.	.	.	2	2
HAFL	.	2	2	.	.	.	.	.	.	.	.	.	.	2	2
NAWA	.	.	.	2	.	2	.	.	.	.	.	.	2	.	2
SWSP	2	.	2	.	.	.	.	.	.	.	.	.	2	.	2
WIWA	.	1	1	1	.	1	.	.	.	.	.	.	1	1	2
BUOR	.	.	.	1	.	1	.	.	.	.	.	.	1	.	1
CCSP	1	.	1	.	.	.	.	.	.	.	.	.	1	.	1
MAWR	.	.	.	.	.	.	1	.	1	.	.	.	1	.	1
TOWA	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1
UNBL	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1
VEER	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1
YHBL	.	.	.	1	.	1	.	.	.	.	.	.	1	.	1
Grand Total	297	296	593	275	210	485	71	39	110	.	.	.	643	545	1,188

* Species Code: see definition in Appendix 6

Appendix 11: Number of neotropical migrant songbirds detected on plot during permanent plot surveys in Revelstoke Reach in fall 2012 in different weeks of survey

Species Code	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Total
	28.7-3.8.	4-10.8.	11-17.8.	18-24.8.	25-31.8.	1-7.9.	8-14.9.	15-21.9.	22-28.9.	
PISI	32	28	18	20	40	21	.	50	.	209
COYE	9	10	20	5	19	57	33	27	23	203
YRWA	.	2	.	.	10	53	17	10	9	101
CEDW	14	19	26	15	11	7	.	1	.	93
SAVS	4	4	7	6	11	19	11	3	7	72
YWAR	21	13	20	6	7	2	.	.	.	69
AMRE	9	5	16	5	2	3	1	.	.	41
SOSP	5	4	9	6	8	2	3	2	2	41
AMRO	2	2	9	1	.	23	1	.	.	38
REVI	12	6	7	1	1	5	.	.	.	32
GRCA	4	4	6	6	1	4	5	.	.	30
UNSP	.	.	.	.	5	3	2	14	1	25
WAVI	3	4	5	.	2	3	3	.	.	20
WIFL	9	7	3	.	1	.	.	.	.	20
MGWA	4	2	1	3	3	2	2	.	.	17
WCSP	.	.	.	.	.	1	3	6	7	17
LISP	.	.	.	.	1	6	2	2	3	14
TRFL	1	.	4	3	2	1	.	.	.	11
WEWP	5	1	5	.	.	.	.	.	.	11
LAZB	2	.	6	.	2	.	.	.	.	10
RCKI	.	.	.	.	.	2	1	2	5	10
LEFL	6	.	1	.	.	1	.	.	.	8
OCWA	.	.	.	1	.	5	.	2	.	8
AMGO	5	.	.	1	1	.	.	.	.	7
NOWA	.	4	2	1	.	.	.	.	.	7
ALFL	6	.	.	.	.	.	.	.	.	6
UEFL	.	.	.	.	.	6	.	.	.	6
GCKI	.	.	2	.	.	3	.	.	.	5
RWBL	.	.	2	1	1	.	.	.	1	5
SWTH	.	1	1	.	1	1	1	.	.	5
WETA	.	2	2	1	.	.	.	.	.	5
DEJU	.	.	.	.	2	1	1	.	.	4
TEWA	.	.	1	.	.	.	.	.	3	4
UNWA	.	.	.	1	1	1	.	1	.	4
BHCO	1	.	2	.	.	.	.	.	.	3
CHSP	2	.	.	.	1	.	.	.	.	3
UNSO	.	.	2	.	.	.	1	.	.	3
AMPI	.	.	.	.	.	.	2	.	.	2
EAKI	.	.	.	.	2	.	.	.	.	2
FOSP	.	.	.	.	.	.	.	1	1	2
HAFL	1	.	.	1	.	.	.	.	.	2
NAWA	.	.	.	.	.	.	.	2	.	2
SWSP	.	.	.	.	.	.	.	1	1	2
WIWA	.	.	.	1	1	.	.	.	.	2
BUOR	1	.	.	.	.	.	.	.	.	1
CCSP	.	.	.	.	.	1	.	.	.	1
MAWR	.	.	.	.	.	.	1	.	.	1
TOWA	.	.	.	1	.	.	.	.	.	1
UNBL	.	.	.	.	.	.	1	.	.	1
VEER	.	.	.	.	1	.	.	.	.	1
YHBL	.	.	.	.	1	.	.	.	.	1
Grand Total	158	118	177	86	138	233	91	124	63	1,188

* Species Code: see definition in Appendix 6

Appendix 12: 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 2012

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
PISI	209	.	.	.	.	.	.	.	3.11	1.08	12.25	2.57	1.60
COYE	203	.	.	.	.	.	1.44	1.79	4.39	2.58	3.88	0.71	1.27
YRWA	101	.	.	.	.	.	0.56	2.43	1.44	0.50	1.88	0.29	0.87
CEDW	93	.	.	.	.	.	.	0.21	1.39	1.50	3.75	0.71	0.80
SAVS	72	.	.	.	.	1.25	0.56	0.64	0.78	0.33	.	1.86	1.47
YWAR	69	.	.	.	.	.	0.11	0.86	0.94	1.33	1.50	0.86	0.33
AMRE	41	.	.	.	.	.	.	.	0.72	1.50	0.63	0.29	0.20
SOSP	41	.	.	.	.	.	0.11	.	0.44	0.50	1.88	.	0.73
AMRO	38	.	.	.	.	.	.	0.14	.	1.83	1.13	0.43	0.13
REVI	32	.	.	.	.	.	.	0.07	0.17	1.00	0.13	1.71	0.20
GRCA	30	.	.	.	.	.	.	.	0.22	0.25	0.63	0.57	0.93
UNSP	25	.	.	.	.	.	0.22	0.43	0.50	.	.	0.71	0.20
WAVI	20	.	.	.	.	.	.	.	0.11	0.08	0.50	0.29	0.73
WIFL	20	.	.	.	.	.	.	0.29	0.17	0.08	1.13	.	0.20
MGWA	17	.	.	.	.	.	.	0.07	.	0.25	0.75	.	0.47
WCSP	17	.	.	.	.	.	.	.	0.11	0.08	.	.	0.93
LISP	14	.	.	.	.	.	0.22	0.21	0.17	0.08	.	0.14	0.27
TRFL	11	.	.	.	.	.	0.11	0.07	0.22	0.17	.	0.14	0.13
WEWP	11	.	.	.	.	.	.	.	.	0.92	.	.	.
LAZB	10	.	.	.	.	.	.	.	0.06	0.25	0.25	0.29	0.13
RCKI	10	.	.	.	.	.	.	0.07	0.17	.	0.25	0.14	0.20
LEFL	8	.	.	.	.	.	.	.	0.11	0.08	.	0.71	.
OCWA	8	.	.	.	.	.	.	.	0.22	0.25	.	.	0.07
AMGO	7	.	.	.	.	.	.	.	0.11	0.33	.	0.14	.
NOWA	7	.	.	.	.	.	.	.	0.11	0.42	.	.	.
ALFL	6	.	.	.	.	.	.	0.07	0.11	.	.	.	0.20
UEFL	6	.	.	.	.	.	.	0.36	.	.	0.13	.	.
GCKI	5	.	.	.	.	.	.	.	.	0.17	.	.	0.20
RWBL	5	.	.	.	.	.	.	0.14	0.11	.	.	.	0.07
SWTH	5	.	.	.	.	.	.	.	.	0.08	.	0.14	0.20
WETA	5	.	.	.	.	.	.	.	.	0.08	0.50	.	.
DEJU	4	.	.	.	.	.	.	.	.	.	0.38	0.14	.
TEWA	4	.	.	.	.	.	.	.	.	0.25	.	.	0.07
UNWA	4	.	.	.	.	.	.	0.07	0.11	.	.	.	0.07
BHCO	3	.	.	.	.	.	.	.	0.11	0.08	.	.	.
CHSP	3	.	.	.	.	.	.	0.07	.	0.08	.	.	0.07
UNSO	3	.	.	.	.	.	.	.	0.06	.	.	.	0.13
AMPI	2	.	.	.	.	.	0.22	.	.	.	.	.	.
EAKI	2	.	.	.	.	.	.	.	.	.	.	.	0.13
FOSP	2	.	.	.	.	.	.	.	.	.	.	.	0.13
HAFL	2	.	.	.	.	.	.	.	.	.	0.13	0.14	.
NAWA	2	.	.	.	.	.	.	.	0.11	.	.	.	.
SWSP	2	.	.	.	.	.	.	.	0.11	.	.	.	.
WIWA	2	.	.	.	.	.	.	.	0.06	.	.	.	0.07
BUOR	1	.	.	.	.	.	.	.	0.06	.	.	.	.
CCSP	1	.	.	.	.	.	.	.	.	0.08	.	.	.
MAWR	1	.	.	.	.	.	.	.	0.06	.	.	.	.
TOWA	1	.	.	.	.	.	.	.	.	.	0.13	.	.
UNBL	1	.	.	.	.	.	.	.	.	.	.	.	0.07
VEER	1	.	.	.	.	.	.	.	.	.	.	.	0.07
YHBL	1	.	.	.	.	.	0.11	.	.	.	.	.	.
Total	1,188	.	.	.	.	1.25	3.67	8.00	16.56	16.25	31.75	13.00	13.33

* Species Code: see definition in Appendix 6

Appendix 13: Species and number of birds detected on effectiveness monitoring plots during surveys in spring 2012

Common Name	On Plot	Off Plot	Overhead	Total
Yellow-rumped Warbler	28	81	110	219
White-crowned Sparrow	12	41	40	93
Vaux's Swift	.	12	74	86
Unidentified Songbird	.	.	79	79
Unidentified Bird	.	36	21	57
Savannah Sparrow	8	39	2	49
American Pipit	1	7	33	41
Unidentified Sparrow	3	23	15	41
Unidentified Swallow	.	5	26	31
Yellow Warbler	2	21	3	26
American Robin	3	15	4	22
Pine Siskin	.	5	17	22
Northern Rough-winged Swallow	.	5	16	21
Common Yellowthroat	3	17	.	20
Ruby-crowned Kinglet	2	17	.	19
American Goldfinch	.	8	8	16
Wilson's Warbler	5	10	1	16
Chipping Sparrow	2	3	4	9
Mountain Bluebird	7	.	1	8
Black-capped Chickadee	.	7	.	7
Dusky Flycatcher	.	6	.	6
Merlin	.	5	1	6
Violet-green Swallow	.	.	6	6
Lincoln's Sparrow	2	3	.	5
Orange-crowned Warbler	2	3	.	5
Brown-headed Cowbird	.	4	.	4
Killdeer	1	2	.	3
Lazuli Bunting	2	1	.	3
Mourning Dove	.	3	.	3
Tree Swallow	.	.	3	3
Turkey Vulture	.	2	1	3
Dark-eyed Junco	1	.	1	2
Eastern Kingbird	1	1	.	2
Mallard	.	.	2	2
Rufous Hummingbird	1	1	.	2
Sharp-shinned Hawk	.	1	1	2
Unidentified Blackbird	.	2	.	2
Unidentified Warbler	.	.	2	2
Alder Flycatcher	.	1	.	1
American Redstart	.	1	.	1
Black-and-white Warbler	.	1	.	1
Bobolink	.	1	.	1
Downy Woodpecker	.	.	1	1
Nashville Warbler	1	.	.	1
Northern Harrier	.	1	.	1
Sandhill Crane	.	1	.	1
Song Sparrow	.	1	.	1
Unidentified Hummingbird	.	1	.	1
Varied Thrush	.	1	.	1
Warbling Vireo	.	1	.	1
Western Meadowlark	1	.	.	1
Grand Total	88	396	472	956

Appendix 14: Species and number of birds detected on effectiveness monitoring plots during surveys in fall 2012

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 <i>Larus</i> 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
Trill'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 <i>Empidonax</i> 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 15: Species and number of birds detected during random plot surveys in Revelstoke Reach in spring 2012

Common Name	On Plot	Off Plot	Overhead	Total
Vaux's Swift	.	14	296	310
American Robin	60	162	75	297
Unidentified Swallow	.	82	212	294
Canada Goose	8	244	26	278
American Pipit	4	49	155	208
Mallard	16	141	14	171
Yellow-rumped Warbler	83	60	20	163
Unidentified Duck	2	75	37	114
Violet-green Swallow	.	28	75	103
Tree Swallow	.	11	68	79
Horned Lark	.	4	70	74
Dark-eyed Junco	10	21	36	67
Northern Rough-winged Swallow	.	14	47	61
American Goldfinch	10	16	24	50
Pine Siskin	1	9	38	48
American Wigeon	.	36	7	43
Northern Pintail	.	25	15	40
Ruby-crowned Kinglet	15	20	.	35
Common Raven	.	23	11	34
Red-winged Blackbird	4	17	11	32
Savannah Sparrow	8	20	2	30
Killdeer	5	21	2	28
Black-capped Chickadee	4	21	.	25
Yellow Warbler	10	13	1	24
Wilson's Warbler	16	5	.	21
Common Yellowthroat	4	16	.	20
Song Sparrow	6	14	.	20
American Crow	.	10	9	19
Green-winged Teal	12	5	2	19
Northern Flicker	5	13	1	19
Varied Thrush	.	16	3	19
Unidentified Bird	.	2	16	18
Warbling Vireo	3	14	.	17
Greater Yellowlegs	.	6	10	16
Turkey Vulture	.	8	7	15
Unidentified Shorebird	.	15	.	15
American Coot	.	13	.	13
White-crowned Sparrow	6	6	.	12
Cliff Swallow	.	.	11	11
European Starling	3	.	7	10
Mountain Bluebird	.	10	.	10
Northern Shoveler	6	4	.	10
Great Blue Heron	1	7	1	9
Lazuli Bunting	7	2	.	9
Merlin	.	5	4	9
Red-breasted Nuthatch	3	6	.	9

Common Name	On Plot	Off Plot	Overhead	Total
Common Merganser	.	5	3	8
Common Redpoll	.	.	8	8
Bald Eagle	.	7	.	7
Barn Swallow	.	.	7	7
Osprey	.	6	1	7
Unidentified Songbird	.	.	7	7
American Redstart	5	1	.	6
Brown-headed Cowbird	3	3	.	6
Orange-crowned Warbler	4	2	.	6
Pileated Woodpecker	.	6	.	6
Rufous Hummingbird	3	2	1	6
Sora	1	5	.	6
Unidentified <i>Empidonax</i> Flycatcher	4	2	.	6
Unidentified Sparrow	3	1	2	6
Black Swift	.	.	5	5
Chipping Sparrow	3	2	.	5
Dusky Flycatcher	.	5	.	5
Evening Grosbeak	.	5	.	5
Lincoln's Sparrow	4	1	.	5
Red-eyed Vireo	2	3	.	5
Ring-necked Duck	.	5	.	5
Spotted Sandpiper	3	2	.	5
Western Tanager	.	5	.	5
Western Wood-pewee	.	4	1	5
Wilson's Snipe	2	3	.	5
Belted Kingfisher	.	4	.	4
Bufflehead	1	2	1	4
Cassin's Vireo	.	4	.	4
Golden-crowned Kinglet	1	3	.	4
Red-tailed Hawk	.	.	4	4
Unidentified Swan	.	.	4	4
Downy Woodpecker	2	1	.	3
Macgillivray's Warbler	2	1	.	3
Northern Harrier	.	3	.	3
Barrow's Goldeneye	2	.	.	2
Bank Swallow	.	.	2	2
Eastern Kingbird	2	.	.	2
Gray Catbird	.	2	.	2
Greater Scaup	.	2	.	2
Hammond's Flycatcher	.	2	.	2
Hairy Woodpecker	.	1	1	2
Least Flycatcher	.	2	.	2
Marsh Wren	1	1	.	2
Pied-billed Grebe	.	2	.	2
Rusty Blackbird	.	2	.	2
Swainson's Thrush	1	1	.	2
Unidentified Blackbird	.	2	.	2
Unidentified Hummingbird	1	1	.	2

Common Name	On Plot	Off Plot	Overhead	Total
Veery	1	1	.	2
American Tree Sparrow	.	.	1	1
Black-billed Magpie	.	1	.	1
Brewer's Blackbird	.	.	1	1
Chestnut-backed Chickadee	.	1	.	1
Clay-colored Sparrow	1	.	.	1
Cooper's Hawk	.	.	1	1
Common Loon	.	1	.	1
Long-eared Owl	.	1	.	1
Northern Shrike	.	1	.	1
Peregrine Falcon	.	1	.	1
Short-eared Owl	.	1	.	1
Snow Goose	.	1	.	1
Townsend's Warbler	.	1	.	1
Vesper Sparrow	1	.	.	1
Virginia Rail	.	1	.	1
Western Meadowlark	.	1	.	1
Winter Wren	.	1	.	1
Yellow-headed Blackbird	.	1	.	1
Grand Total	365	1,428	1363	3,156

Appendix 16: Average densities of on-plot neotropical migrant songbirds detected per random plot in each stratum over the entire season in spring 2012

Common Name	Forest	Shrub	Grassland	Unvegetated	Wetland	Total
Yellow-rumped Warbler	2.65	0.36	.	.	0.17	0.67
American Robin	1.96	0.32	.	.	.	0.49
Wilson's Warbler	0.15	0.43	.	.	.	0.13
Ruby-crowned Kinglet	0.46	0.11	.	.	.	0.12
American Goldfinch	0.38	.	.	.	.	0.08
Dark-eyed Junco	0.38	.	.	.	.	0.08
Yellow Warbler	0.04	0.25	0.04	.	0.04	0.08
Savannah Sparrow	.	0.18	0.07	.	0.04	0.07
Lazuli Bunting	.	0.25	.	.	.	0.06
Song Sparrow	0.08	0.04	.	.	0.13	0.05
White-crowned Sparrow	0.08	0.14	.	.	.	0.05
American Redstart	0.19	.	.	.	.	0.04
American Pipit	.	.	0.04	.	0.13	0.03
Common Yellowthroat	.	0.11	.	.	0.04	0.03
Lincoln's Sparrow	0.04	0.11	.	.	.	0.03
Orange-crowned Warbler	0.12	.	.	.	0.04	0.03
Red-winged Blackbird	.	.	.	.	0.17	0.03
Unidentified <i>Empidonax</i> Flycatcher	0.15	.	.	.	.	0.03
Brown-headed Cowbird	0.08	0.04	.	.	.	0.02
Chipping Sparrow	0.04	0.07	.	.	.	0.02
Unidentified Sparrow	.	0.04	0.07	.	.	0.02
Warbling Vireo	0.04	0.07	.	.	.	0.02
Eastern Kingbird	.	0.04	.	.	0.04	0.02
Macgillivray's Warbler	0.08	.	.	.	.	0.02
Red-eyed Vireo	0.04	0.04	.	.	.	0.02
Clay-colored Sparrow	.	0.04	.	.	.	0.01
Golden-crowned Kinglet	0.04	.	.	.	.	0.01
Marsh Wren	.	.	.	.	0.04	0.01
Pine Siskin	0.04	.	.	.	.	0.01
Swainson's Thrush	0.04	.	.	.	.	0.01
Veery	0.04	.	.	.	.	0.01
Vesper Sparrow	.	0.04	.	.	.	0.01
Grand Total	7.12	2.64	0.21	.	0.87	2.32

Appendix 17: Species and number of birds detected during random plot surveys in Revelstoke Reach in fall 2012

Common Name	On Plot	Off Plot	Overhead	Total
Canada Goose	17	242	11	270
Pine Siskin	26	20	144	190
Mallard	33	30	13	76
Cedar Waxwing	23	3	25	51
American Crow	.	30	12	42
American Wigeon	1	28	10	39
Yellow-rumped Warbler	26	2	10	38
Red Crossbill	.	.	26	26
Common Yellowthroat	17	6	.	23
Black-capped Chickadee	18	.	.	18
Northern Rough-winged Swallow	.	.	16	16
Red-winged Blackbird	4	11	.	15
American Robin	9	2	3	14
Song Sparrow	7	6	.	13
Northern Flicker	6	3	3	12
Pied-billed Grebe	.	9	.	9
Red-eyed Vireo	2	7	.	9
Unidentified <i>Larus</i> Gull	.	6	3	9
Wilson's Snipe	6	1	2	9
Gray Catbird	5	3	.	8
Warbling Vireo	6	2	.	8
Eastern Kingbird	.	3	4	7
Yellow Warbler	5	2	.	7
Spotted Sandpiper	3	3	.	6
Least Sandpiper	4	.	1	5
Ring-billed Gull	.	4	1	5
Trail's Flycatcher	3	2	.	5
Unidentified Blackbird	1	4	.	5
Unidentified Duck	1	3	1	5
Unidentified Songbird	3	1	1	5
Willow Flycatcher	2	3	.	5
American Coot	.	4	.	4
American Pipit	.	.	4	4
American Redstart	2	2	.	4
Lazuli Bunting	1	3	.	4
Long-billed Dowitcher	.	4	.	4
Least Flycatcher	.	4	.	4
Macgillivray's Warbler	2	2	.	4
Osprey	.	4	.	4
Unidentified Shorebird	4	.	.	4
Yellow-headed Blackbird	.	2	2	4
Chipping Sparrow	.	2	1	3
Common Raven	.	2	1	3
Great Blue Heron	.	3	.	3
Turkey Vulture	.	2	1	3
Unidentified Sparrow	1	2	.	3

Common Name	On Plot	Off Plot	Overhead	Total
Unidentified Warbler	.	.	3	3
Western Tanager	.	3	.	3
American Goldfinch	.	.	2	2
Bald Eagle	.	2	.	2
Barn Swallow	.	.	2	2
Belted Kingfisher	.	1	1	2
Black Swift	.	.	2	2
California Gull	.	1	1	2
Greater Yellowlegs	2	.	.	2
Herring Gull	.	1	1	2
Merlin	.	2	.	2
Nashville Warbler	1	1	.	2
Red-breasted Nuthatch	.	2	.	2
Savannah Sparrow	.	1	1	2
Swainson's Thrush	1	1	.	2
Unidentified <i>Empidonax</i> Flycatcher	2	.	.	2
Brown-headed Cowbird	.	1	.	1
Cassin's Vireo	1	.	.	1
Dark-eyed Junco	1	.	.	1
Fox Sparrow	1	.	.	1
Unidentified Goldeneye	.	1	.	1
Green-winged Teal	1	.	.	1
Hairy Woodpecker	.	.	1	1
Lesser Yellowlegs	1	.	.	1
Ruby-crowned Kinglet	1	.	.	1
Rufous Hummingbird	1	.	.	1
Solitary Sandpiper	.	.	1	1
Unidentified <i>Calidris</i> Sandpiper	.	1	.	1
Unidentified Bird	.	.	1	1
Unidentified Hummingbird	1	.	.	1
Western Sandpiper	.	.	1	1
Western Wood-pewee	.	1	.	1
Wood Duck	.	1	.	1
White-winged Crossbill	.	1	.	1
Grand Total	252	493	312	1,057

Appendix 18: Average densities of on-plot neotropical migrant songbirds detected per random plot in each stratum over the entire season in fall 2012

Common Name	Forest	Shrub	Grassland	Unvegetated	Wetland	Total
Pine Siskin	0.50	0.82	.	.	.	0.39
Yellow-rumped Warbler	0.94	0.41	.	.	0.11	0.39
Cedar Waxwing	1.25	0.14	.	.	.	0.34
Common Yellowthroat	0.38	0.36	.	.	0.17	0.25
American Robin	0.50	0.05	.	.	.	0.13
Song Sparrow	.	0.32	.	.	.	0.10
Warbling Vireo	0.06	0.23	.	.	.	0.09
Gray Catbird	0.13	0.14	.	.	.	0.07
Yellow Warbler	0.06	0.18	.	.	.	0.07
Red-winged Blackbird	.	0.05	.	.	0.17	0.06
Trail's Flycatcher	0.06	0.09	.	.	.	0.04
Unidentified Songbird	.	0.05	0.10	.	0.06	0.04
American Redstart	0.13	.	.	.	.	0.03
Macgillivray's Warbler	0.13	.	.	.	.	0.03
Red-eyed Vireo	0.13	.	.	.	.	0.03
Unidentified <i>Empidonax</i> Flycatcher	0.13	.	.	.	.	0.03
Willow Flycatcher	.	0.09	.	.	.	0.03
Cassin's Vireo	0.06	.	.	.	.	0.01
Dark-eyed Junco	.	.	.	.	0.06	0.01
Fox Sparrow	.	0.05	.	.	.	0.01
Lazuli Bunting	0.06	.	.	.	.	0.01
Nashville Warbler	0.06	.	.	.	.	0.01
Ruby-crowned Kinglet	0.06	.	.	.	.	0.01
Swainson's Thrush	0.06	.	.	.	.	0.01
Unidentified Blackbird	.	0.05	.	.	.	0.01
Unidentified Sparrow	.	0.05	.	.	.	0.01
Grand Total	4.69	3.05	0.10	.	0.56	2.28

Appendix 19: Banding data summary from Airport Islands Banding Station, Revelstoke Reach, 2012

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***
YRWA	47	48.0	0.1156	3	6.4	4	8.5	7	.	54	0.1328
COYE	22	22.4	0.0541	8	36.4	.	.	8	.	30	0.0738
SAVS	15	15.3	0.0369	.	.	.	.	.	.	15	0.0369
LISP	4	4.1	0.0098	.	.	.	.	.	1	5	0.0123
SWSP	2	2.0	0.0049	.	.	.	.	.	2	4	0.0098
CCSP	2	2.0	0.0049	1	50.0	.	.	1	.	3	0.0074
SOSP	1	1.0	0.0025	2	200.0	.	.	2	.	3	0.0074
WISN	2	2.0	0.0049	.	.	.	.	.	1	3	0.0074
BHCO	1	1.0	0.0025	.	.	.	.	.	.	1	0.0025
OCWA	1	1.0	0.0025	.	.	.	.	.	.	1	0.0025
YWAR	1	1.0	0.0025	.	.	.	.	.	.	1	0.0025
Total	98	100.0	0.2409	14	14.3	4	4.1	18	4	120	0.2950

* Species Code: see definition in Appendix 6

** No. of Newly Captured: for CLBMON 39 in 2012 (included recaptures of birds banded in previous year)

*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 20: Banding data summary from Rob's Willows Banding Station, Revelstoke Reach, 2012

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***
YRWA	33	26.4	0.1189	1	3.0	.	.	1	.	34	0.1225
COYE	17	13.6	0.0613	1	5.9	.	.	1	.	18	0.0649
LISP	12	9.6	0.0432	.	.	.	.	.	.	12	0.0432
BCCH	9	7.2	0.0324	.	.	1	11.1	1	.	10	0.0360
OCWA	9	7.2	0.0324	.	.	.	.	.	.	9	0.0324
RCKI	9	7.2	0.0324	.	.	.	.	.	.	9	0.0324
DEJU	7	5.6	0.0252	.	.	.	.	.	.	7	0.0252
SOSP	5	4.0	0.0180	.	.	1	20.0	1	.	6	0.0216
SAVS	5	4.0	0.0180	.	.	.	.	.	.	5	0.0180
MGWA	4	3.2	0.0144	.	.	.	.	.	.	4	0.0144
WIWA	4	3.2	0.0144	.	.	.	.	.	.	4	0.0144
WCSP	3	2.4	0.0108	.	.	.	.	.	.	3	0.0108
PISI	2	1.6	0.0072	.	.	.	.	.	.	2	0.0072
AMRE	1	0.8	0.0036	.	.	.	.	.	.	1	0.0036
CCSP	1	0.8	0.0036	.	.	.	.	.	.	1	0.0036
FOSP	1	0.8	0.0036	.	.	.	.	.	.	1	0.0036
GRCA	1	0.8	0.0036	.	.	.	.	.	.	1	0.0036
SWTH	1	0.8	0.0036	.	.	.	.	.	.	1	0.0036
TEWA	1	0.8	0.0036	.	.	.	.	.	.	1	0.0036
Total	125	100.0	0.4505	2	1.6	2	1.6	4	0	129	0.4649

* Species Code: see definition in Appendix 6

** No. of Newly Captured: for CLBMON 39 in 2012 (included recaptures of birds banded in previous year)

*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 21: Banding data summary from Machete Island Banding Station, Revelstoke Reach, 2012

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	68	28.2	0.1324	10	14.7	35	51.5	45	2	115	0.2240
YRWA	35	14.5	0.0682	1	2.9	4	11.4	5	1	41	0.0798
AMRE	13	5.4	0.0253	2	15.4	6	46.2	8	.	21	0.0409
REVI	8	3.3	0.0156	2	25.0	6	75.0	8	2	18	0.0351
SWTH	15	6.2	0.0292	.	.	2	13.3	2	1	18	0.0351
WIFL	9	3.7	0.0175	1	11.1	7	77.8	8	.	17	0.0331
PISI	13	5.4	0.0253	.	.	1	7.7	1	.	14	0.0273
BCCH	4	1.7	0.0078	.	.	9	225.0	9	.	13	0.0253
OCWA	11	4.6	0.0214	2	18.2	.	.	2	.	13	0.0253
TRFL	7	2.9	0.0136	1	14.3	4	57.1	5	.	12	0.0234
YWAR	10	4.1	0.0195	1	10.0	1	10.0	2	.	12	0.0234
GRCA	5	2.1	0.0097	.	.	5	100.0	5	.	10	0.0195
ALFL	7	2.9	0.0136	1	14.3	.	.	1	.	8	0.0156
SOSP	4	1.7	0.0078	1	25.0	2	50.0	3	.	7	0.0136
WAVI	4	1.7	0.0078	1	25.0	2	50.0	3	.	7	0.0136
LISP	4	1.7	0.0078	.	.	.	.	.	.	4	0.0078
WIWA	4	1.7	0.0078	.	.	.	.	.	.	4	0.0078
LEFL	3	1.2	0.0058	.	.	.	.	.	.	3	0.0058
EAKI	2	0.8	0.0039	.	.	.	.	.	.	2	0.0039
MGWA	2	0.8	0.0039	.	.	.	.	.	.	2	0.0039
NOWA	1	0.4	0.0019	.	.	1	100.0	1	.	2	0.0039
SWSP	1	0.4	0.0019	1	100.0	.	.	1	.	2	0.0039
VEER	2	0.8	0.0039	.	.	.	.	.	.	2	0.0039
AMRO	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
CBCH	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
DEJU	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
GCKI	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
RCKI	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
SSHA	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
TEWA	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
WCSP	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
WWPE	1	0.4	0.0019	.	.	.	.	.	.	1	0.0019
Total	241	100.0	0.4693	24	10.0	85	35.3	109	6	356	0.6933

* Species Code: see definition in Appendix 6

** No. of Newly Captured: for CLBMON 39 in 2012 (included recaptures of birds banded in previous year)

*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 22: Banding data summary from Cartier Point Banding Station, Revelstoke Reach, 2012

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***
PISI	24	34.3	0.0928	.	.	.	.	.	1	25	0.0966
BCCH	8	11.4	0.0309	.	.	7	87.5	7	.	15	0.0580
SWTH	6	8.6	0.0232	.	.	.	.	.	.	6	0.0232
COYE	4	5.7	0.0155	1	25.0	.	.	1	.	5	0.0193
GRCA	4	5.7	0.0155	1	25.0	.	.	1	.	5	0.0193
AMRE	2	2.9	0.0077	.	.	1	50.0	1	.	3	0.0116
MGWA	2	2.9	0.0077	1	50.0	.	.	1	.	3	0.0116
BRCR	2	2.9	0.0077	.	.	.	.	.	.	2	0.0077
CBCH	2	2.9	0.0077	.	.	.	.	.	.	2	0.0077
CEDW	2	2.9	0.0077	.	.	.	.	.	.	2	0.0077
DEJU	2	2.9	0.0077	.	.	.	.	.	.	2	0.0077
RBNU	2	2.9	0.0077	.	.	.	.	.	.	2	0.0077
TRFL	1	1.4	0.0039	1	100.0	.	.	1	.	2	0.0077
CAVI	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
LISP	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
REVI	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
RUHU	0	0.0	0.0000	.	.	.	.	.	1	1	0.0039
SAVS	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
SOSP	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
SPSA	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
WIWA	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
YRWA	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
YWAR	1	1.4	0.0039	.	.	.	.	.	.	1	0.0039
Total	70	100.0	0.2705	4	5.7	8	11.4	12	2	84	0.3246

* Species Code: see definition in Appendix 6

** No. of Newly Captured: for CLBMON 39 in 2012 (included recaptures of birds banded in previous year)

*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 23: Banding data summary from Jordan River Banding Station, Revelstoke Reach, 2012

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	79	16.5	0.1150	7	8.9	20	25.3	27	.	106	0.1543
SWTH	86	17.9	0.1252	3	3.5	9	10.5	12	.	98	0.1426
MGWA	35	7.3	0.0509	1	2.9	16	45.7	17	1	53	0.0771
AMRE	31	6.5	0.0451	5	16.1	10	32.3	15	.	46	0.0670
YRWA	28	5.8	0.0408	1	3.6	2	7.1	3	1	32	0.0466
SOSP	19	4.0	0.0277	1	5.3	11	57.9	12	.	31	0.0451
YWAR	19	4.0	0.0277	2	10.5	6	31.6	8	.	27	0.0393
ALFL	14	2.9	0.0204	1	7.1	3	21.4	4	.	18	0.0262
REVI	14	2.9	0.0204	2	14.3	1	7.1	3	.	17	0.0247
CEDW	12	2.5	0.0175	.	.	3	25.0	3	.	15	0.0218
DEJU	13	2.7	0.0189	1	7.7	1	7.7	2	.	15	0.0218
BCCH	10	2.1	0.0146	.	.	4	40.0	4	.	14	0.0204
GCKI	12	2.5	0.0175	.	.	.	.	.	.	12	0.0175
WIWA	10	2.1	0.0146	.	.	1	10.0	1	.	11	0.0160
GRCA	7	1.5	0.0102	.	.	3	42.9	3	.	10	0.0146
AMRO	9	1.9	0.0131	.	.	.	.	.	.	9	0.0131
TEWA	4	0.8	0.0058	.	.	4	100.0	4	.	8	0.0116
WIFL	6	1.3	0.0087	1	16.7	1	16.7	2	.	8	0.0116
TOWA	7	1.5	0.0102	.	.	.	.	.	.	7	0.0102
HAFL	5	1.0	0.0073	.	.	1	20.0	1	.	6	0.0087
NAWA	6	1.3	0.0087	.	.	.	.	.	.	6	0.0087
CBCH	5	1.0	0.0073	.	.	.	.	.	.	5	0.0073
LISP	5	1.0	0.0073	.	.	.	.	.	.	5	0.0073
TRFL	4	0.8	0.0058	.	.	1	25.0	1	.	5	0.0073
COYE	4	0.8	0.0058	.	.	.	.	.	.	4	0.0058
LEFL	4	0.8	0.0058	.	.	.	.	.	.	4	0.0058
OCWA	4	0.8	0.0058	.	.	.	.	.	.	4	0.0058
RUHU	.	.	.	.	.	.	.	.	4	4	0.0058
NOWA	3	0.6	0.0044	.	.	.	.	.	.	3	0.0044
RCKI	3	0.6	0.0044	.	.	.	.	.	.	3	0.0044
LAZB	2	0.4	0.0029	.	.	.	.	.	.	2	0.0029
PSFL	2	0.4	0.0029	.	.	.	.	.	.	2	0.0029
SAVS	2	0.4	0.0029	.	.	.	.	.	.	2	0.0029
SSHA	2	0.4	0.0029	.	.	.	.	.	.	2	0.0029
VATH	2	0.4	0.0029	.	.	.	.	.	.	2	0.0029
VEER	2	0.4	0.0029	.	.	.	.	.	.	2	0.0029
BRCR	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
CAVI	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
CCSP	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
FOSP	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
HETH	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
MOCH	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
PAWR	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
PISI	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
RBNU	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
STJA	1	0.2	0.0015	.	.	.	.	.	.	1	0.0015
Total	480	100.0	0.6987	25	5.2	97	20.2	122	6	608	0.8850

* Species Code: see definition in Appendix 6

** No. of Newly Captured: for CLBMON 39 in 2012 (included recaptures of birds banded in previous year)

*** Capture Rate/Total Capture Rate: in birds/net-hour