Columbia River Project Water Use Plan

Arrow Reservoir Operations Management Plan

Arrow Lakes Reservoirs Neotropical Migrant Use of the Drawdown Zone

Implementation Year 8

Reference: CLBMON-39

Study Period: 2015

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

Year 8 (2015)

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Cover photo: Western Meadowlark (*Sturnella neglecta*), Airport Islands banding station, Revelstoke Reach, 2015. Photo: Catherine Craig, CBA Ltd.

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. This report summarizes the work that was conducted in Year 8 (2015) and briefly reviews overall progress.

In 2015, two sites in the drawdown zone (Airport Islands and Machete Island) and one site outside of the drawdown zone (Jordan River) were monitored by constant effort mist netting.

At Machete Island banding station, 40 surveys were conducted for a total of 2311.5 net-hours. The first survey was conducted on August 5, 2015 and the last one on September 28, 2015. The average number of mist nets per day was 12.1 ± 0.25 (mean ± SE). A total of 2686 birds of 60 species were captured, with an overall capture rate of 1.1620 birds/net-hour. Common Yellowthroat (*Geothlypis trichas*) was the most frequently captured species (30.8% of all captured birds) with an overall capture rate of 0.3573 birds/net-hour. At Machete Island, we captured three species that have not been previously captured under CLBMON 39 at any station: European Starling (*Sturnus vulgaris*), Indigo Bunting (*Passerina cyanea*) and Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*).

In total, 1977 individuals of 57 species were newly captured (new individuals for the season) and the capture rate for newly captured birds was 0.8553 birds/net-hour. Of the birds of known age (99.7% of all newly-captured birds), 83.0% were HY (juvenile birds hatched in 2015), and 17% were AHY (adult birds more than one year old). 422 individuals of 31 species were recaptured at least once (641 recaptures total). The overall recapture rate was 22.2 % and the overall same day recapture rate was 10.3%.

At Airport Islands banding station, 7 surveys were conducted for a total of 283.0 net-hours. The average number of open nets per day was 8.1 ± 0.26 (mean ± SE). The overall capture rate was 0.4543 birds/net-hour. In total, 128 birds from 17 species were captured, with Common Yellowthroat being the most frequently captured species (0.1413 birds/net-hour). The capture rate for newly banded birds was 0.3816 birds/net-hour and the overall recapture rate was 1.9%. The recapture rate for same day recaptures was 13.0%. The capture and banding of two Western Meadowlarks (*Sturnella neglecta*) at this station in 2015 was the first time this species was captured under CLBMON 39 at any station.

At Jordan River banding station, 7 surveys were conducted for a total of 265.5 net-hours. The average number of open nets per day was 6.7 ± 0.18 (mean ± SE). In total, 266 birds of 35 species were captured, with an overall capture rate of 1.0019 birds/net-hour. The most frequently captured species was Warbling Vireo (*Vireo gilvus*; 0.2373 birds/net-hour). The capture rate for newly banded birds was 0.8588 birds/net-hour and the overall recapture rate was 6.1%. The recapture rate for same day recaptures was 7.9%.

In 2015, the Arrow Lakes Reservoir water levels were the lowest during the entire CLBMON 39 study period. Water levels did not directly affect net lines or the surrounding habitat even at the lowest elevation sampling site. Results to date suggest that reservoir levels affect some species abundance and use of habitat at sample sites. Common Yellowthroat, a neotropical songbird strongly associated with shallow wetland habitat,

has been the most common species captured at Machete Island, but numbers are higher in low water years and lower in high water years. We suspect this may be partially related to an assumed lower production of young as more nests are flooded in high water years.

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

Of the nine management questions posed for CLBMON 39, one (MQ5) has been answered. Studies on physiological responses to reservoir operations showed that fattening rates were not influenced by reservoir operations (MQ5). This means that the body condition of migrants, which is an important factor for survival during migration, was not affected. The other management questions have been partially addressed by the 5 year interim review, and our study design is such that all MQs will be addressed satisfactorily at the end of the project.

Key recommendation for Years 9-10 of CLBMON 39 are: (1) continue daily constant effort capture-banding surveys at Machete Island during the fall migration period, (2) continue once-weekly capture-banding surveys at the two satellite banding sites (Jordan River and Airport Islands), and (3) conduct fall surveys of effectiveness monitoring plots.

KEYWORDS

reservoir operations, neotropical migrants, songbirds, fall migration, stopover habitat, Revelstoke Reach, Arrow Lakes Reservoir, British Columbia, BC Hydro

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CBA collaborates with the Okanagan Nation Alliance (ONA) for delivery of CLBMON 39, with ONA biologists and technicians providing field and technical support, and insight into the perspectives and protocols of the Syilx (Okanagan) people. Karle Zelmer and Alexis Friesen of the ONA contributed to field studies. Al Peatt managed the ONA's involvement.

Field studies were completed by CBA staff (Devon Anderson, Corey Bird, Catherine Craig, and Michal Pavlik) and ONA staff (Karle Zelmer and Alexis Friesen). Michal Pavlik planned the 2015 field study program and worked as bander-in-charge. John Cooper acted as Project Manager. Suzanne Beauchesne provided supervisory and technical assistance throughout the project. Al Peatt provided a review of the manuscript.

Lesley-Anne Howes and Louise Laurin (Canadian Wildlife Service [CWS] Bird Banding Office) processed bird banding and capture permits. We also thank the community of Revelstoke for providing a safe and enjoyable home base for the field crew during the field season.

Michal Pavlik and John Cooper prepared this report.

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1 INTRODUCTION

Since the late 1980s, neotropical migrant birds have become a focus of wildlife managers due to population declines and threats to habitats in their breeding and wintering ranges (Terborgh 1989, DeSante and George 1994, Sherry and Holmes 1996). In Canada, neotropical migrants, and in particular long distance migrants, are declining at a faster rate compared to short distance migrants and resident birds (NABCIC 2012). Nearctic-Neotropical migrant birds (neotropical migrants) 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 can be up to 15 times higher than mortality rates on breeding or wintering grounds (Sillett and Holmes 2002). However, the extent to which mortality is affected by loss of suitable stopover habitat is less well known. Reductions in the availability of stopover habitat may lead to increased competition for limited food resources, thereby increasing stress levels or reducing the ability of migratory birds to gain the weight necessary to continue along their migration route. Both increased stress and reduced refuelling rates can lead to increased mortality during migration, thus resulting in a negative impact on migratory songbird populations (Alerstam and Hedenström 1998). To accommodate the needs of all migrant songbird species a wide variety of habitat types are needed (Suomala et al. 2010).

Revelstoke Reach is unique in the Columbia River reservoir network because it has a relatively flat, well vegetated floodplain that is usually 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 2010a, 2011a, 2012, 2013a, 2013b, 2013c). In part, this habitat is the result of revegetation programs undertaken by BC Hydro to control dust in Revelstoke Reach (McPhee and Hill 2003).

CLBMON 39 Arrow Lakes Reservoir Neotropical Migrant Use of the Drawdown Zone Monitoring Program is one of several wildlife monitoring programs initiated by BC Hydro in 2008 as a result of the water use planning process. The Columbia River Water Use Planning Consultative Committee (BC Hydro 2005) recommended that monitoring be conducted to determine how variation in reservoir levels 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 2010b, 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).

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.

The CLBMON 39 program was initiated in 2008 with constant effort mist-netting surveys at Machete Island banding station. 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. In 2008–2013, in addition to population monitoring, fattening rates of neotropical migrants were assessed through analyses of blood plasma metabolites assays. The 2014 study recommended that permanent and random plots be discontinued, and that fall surveys of effectiveness monitoring be temporarily discontinued. For 2015, these recommendations were accepted and implemented. In 2015, the original CLBMON 39 Terms of Reference (ToR) were revised and this report reflects changes incorporated in the revised ToR.

This report provides results of Year 8 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 neotropical migrants in Revelstoke Reach over time (within season, across seasons, and across years).
2) 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 fattening rate of neotropical migrants in Revelstoke Reach.
    b) Identify species that have a higher likelihood of being affected by reservoir operations.
3) 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 neotropical migrants.
4) Provide information with respect to how wildlife physical works or revegetation can increase utilization of treated riparian habitat by neotropical migrants.
5) 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.

1.2 Management Questions

BC Hydro has provided nine specific management questions that are to be addressed at the completion of CLBMON 39. The management questions are as follows:

1) What is the seasonal and annual variation in the abundance and species richness of neotropical migrants in Revelstoke Reach during fall migration?

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

3) Do reservoir operations influence the species richness or abundance of neotropical migrants using habitat in the drawdown zone during fall migration? If so, how do reservoir operations influence the species richness or abundance?

4) Which neotropical migrants are most affected by reservoir operations?

5) Do reservoir operations affect the fattening rates of neotropical migrants using the drawdown zone during fall migration?

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

7) *Original question 7 deleted (as per updated ToR).*

8) Are the ongoing revegetation projects effective at improving utilization of the treated habitat in the drawdown zone by neotropical migrants?

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

1.3 Management Hypotheses

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

H1: Annual and seasonal variation in reservoir levels do not influence neotropical migrant abundance or species richness in habitats in the drawdown zone of Revelstoke Reach during fall migration.

H_{1A}: Changes in the diversity (species richness) 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 do not influence fattening rates of neotropical migrants in Revelstoke Reach during fall migration.

H3: Annual and seasonal variation in reservoir levels do not influence the availability or quality of habitat for neotropical migrants

H4: Revegetation does not affect utilization of the area by neotropical migrants as measured by migrant species richness or abundance.

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

1.4 Study Areas

The CLBMON 39 study area was defined as the drawdown zone of Revelstoke Reach. Revelstoke Reach is the northernmost arm of the Arrow Lakes Reservoir south of Revelstoke, BC, 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).

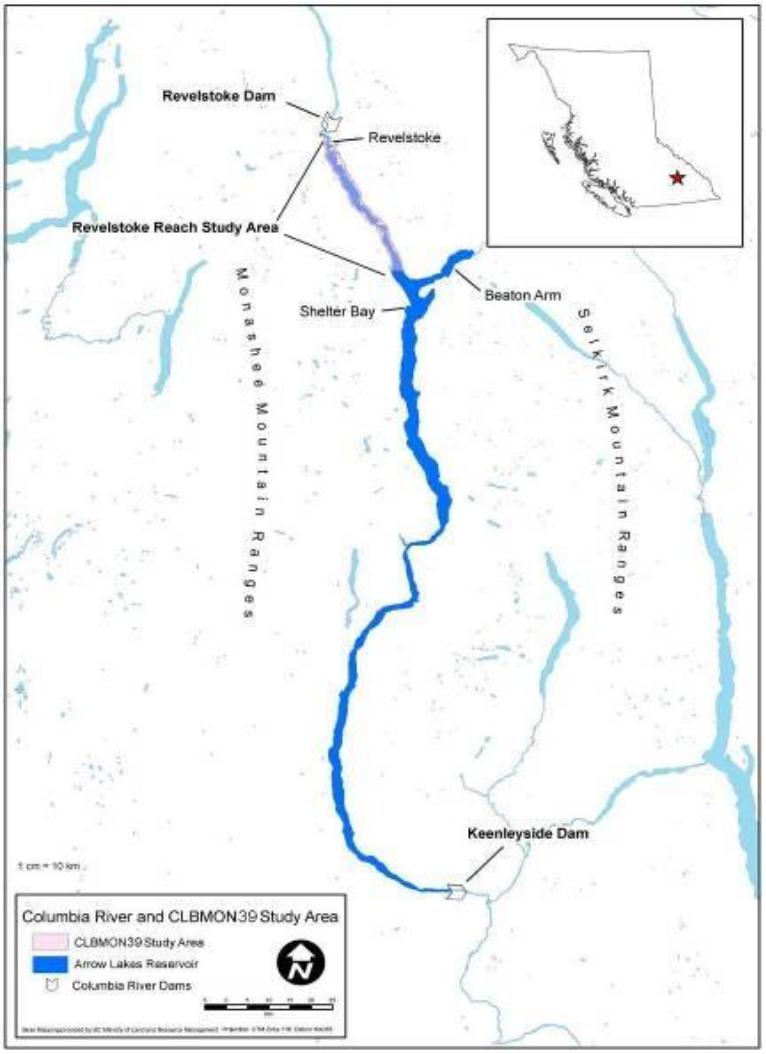

Figure 1: CLBMON 39 study area in Revelstoke Reach, Arrow Lakes Reservoir

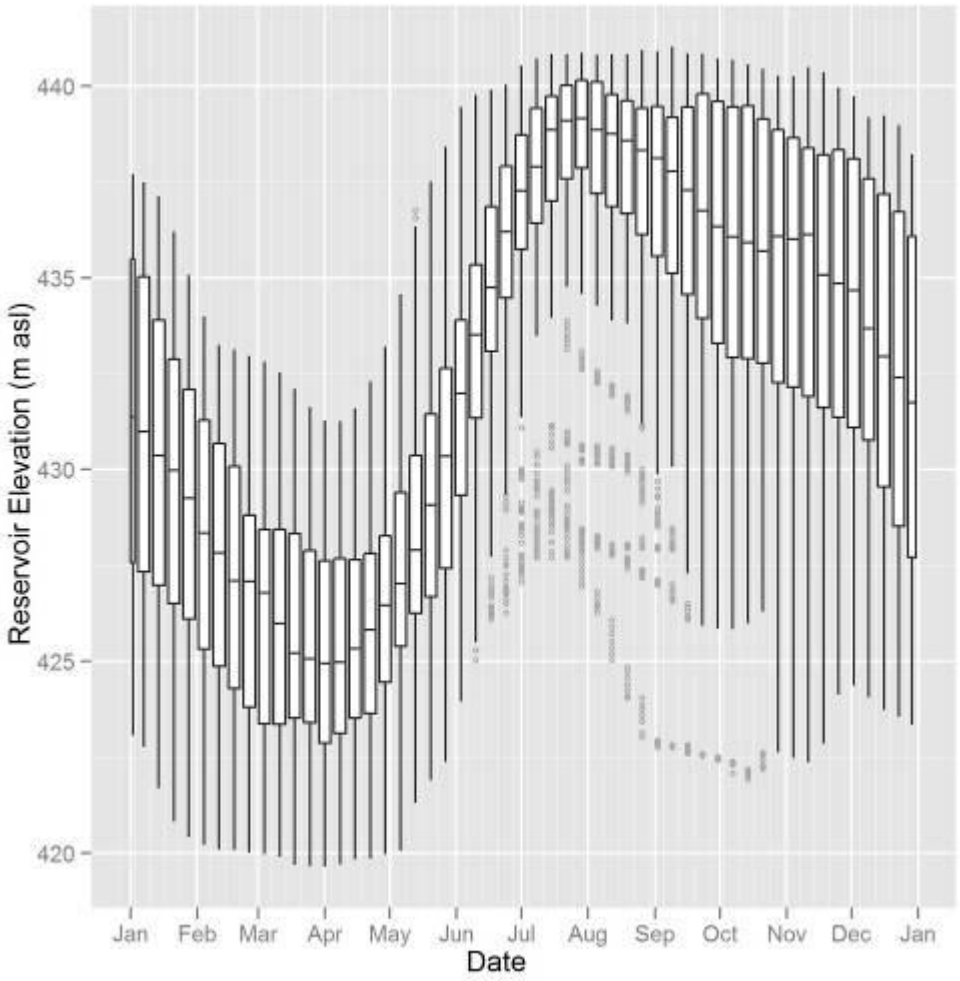

Figure 2: **Historical hydrological data from Arrow Lakes Reservoir (1968–2008) plotted in weekly intervals**

Revelstoke Reach contains the Columbia River as it flows south from the Revelstoke Dam towards the Arrow Lakes Reservoir, and is comprised largely of drawdown zone habitats. The Revelstoke Reach drawdown zone includes most of the level valley bottom habitat in the area.

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* ssp. *trichocarpa*). 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. 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 ~432 m), 12 Mile area

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**

Figure 5: **Example of shrub habitat in Revelstoke Reach (elevation ~438 m), Rob's Willows area**

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), Machete Island

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), McKay creek area, April 29, 2014

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 2015 is provided below. For a detailed account of these methods, refer to the CLBMON 39 protocol report (CBA 2015a).

2.1 Constant Effort Mist Netting

Constant effort mist netting, with its largely consistent capture effort each year, provides a standardized and comprehensive means of assessing seasonal and annual variation in the abundance, diversity, juvenile/adult ratio and stopover length of neotropical migrants. 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 (MQ1);
- assess whether reservoir operations affect populations of neotropical migrants that use this area as a stopover site (MQ3 and MQ4); 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 (MQ6).

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

2.1.1 Monitoring Sites in 2015

In 2015, we monitored three constant effort mist-netting sites: Machete Island banding station, Airport Islands banding station and Jordan River banding station (Table 1).

Table 1: CLBMON 39 constant effort mist netting sites in 2015 (DDZ = drawdown zone)

Banding Site	Within DDZ?	Mean Elevation (m ASL)	Survey Intensity	Description
Machete Island	Yes	439	Daily	Large riparian site positioned high in the drawdown zone
Airport Islands	Yes	437	Weekly	Smaller riparian site positioned low in the drawdown zone
Jordan River	No	475	Weekly	Control riparian site outside of the drawdown zone

Machete Island banding station is situated at the eastern end of Machete Island, a forested upland area of about 20 ha located between the north end of the Revelstoke Airport and the confluence of the Columbia and Illecillewaet Rivers (Appendix 3). Mist-netting surveys at this site were initiated in 2008. Machete Island lies within the drawdown zone of Arrow Lakes Reservoir, with small portions being slightly above water levels when the reservoir reaches full pool at 440.1m ASL. Machete Island is forested primarily with mature black cottonwood with smaller amounts of alder, willow, spruce and western redcedar. Common understorey shrubs are red-osier dogwood, willow, alder, beaked hazelnut (*Corylus cornuta*), snowberry, twinberry and rose (*Rosa* sp.). The edges of the cottonwood forest are covered mostly with willow shrubs surrounded by shrub savannah and grassland habitats. The area of Machete Island where the banding station is located is lacking the mature tree component and is dominated by black cottonwood, willow, alder, and red-osier dogwood. Snowberry, twinberry and reed canarygrass are abundant in the understory. In 2015, there were 13 nets installed at this site (Figure 8).

Figure 8: Machete Island banding station layout in 2015

Airport Islands banding station is situated in the drawdown zone of Arrow Lakes Reservoir, west of the Revelstoke Airport (Appendix 3). It is positioned approximately 2 meters lower in the drawdown zone compared to Machete Island. Due to lower relative position, this site has more variability in annual water level fluctuation (Figure 9), compared to Machete Island banding station.

Figure 9: Net line at Airport Island banding station in a year with high water levels (left, August 21, 2012) and the same net in a year with low water levels (right, August 25, 2014)

Airport Islands banding station is situated on slightly raised ground covered by patches of willow shrubs (with only a small amount of cottonwood) within grasslands, open shrub savannah and wetlands. Mist-netting surveys at this site were initiated in 2011, and in 2015 nine nets were installed at this site (Figure 10).

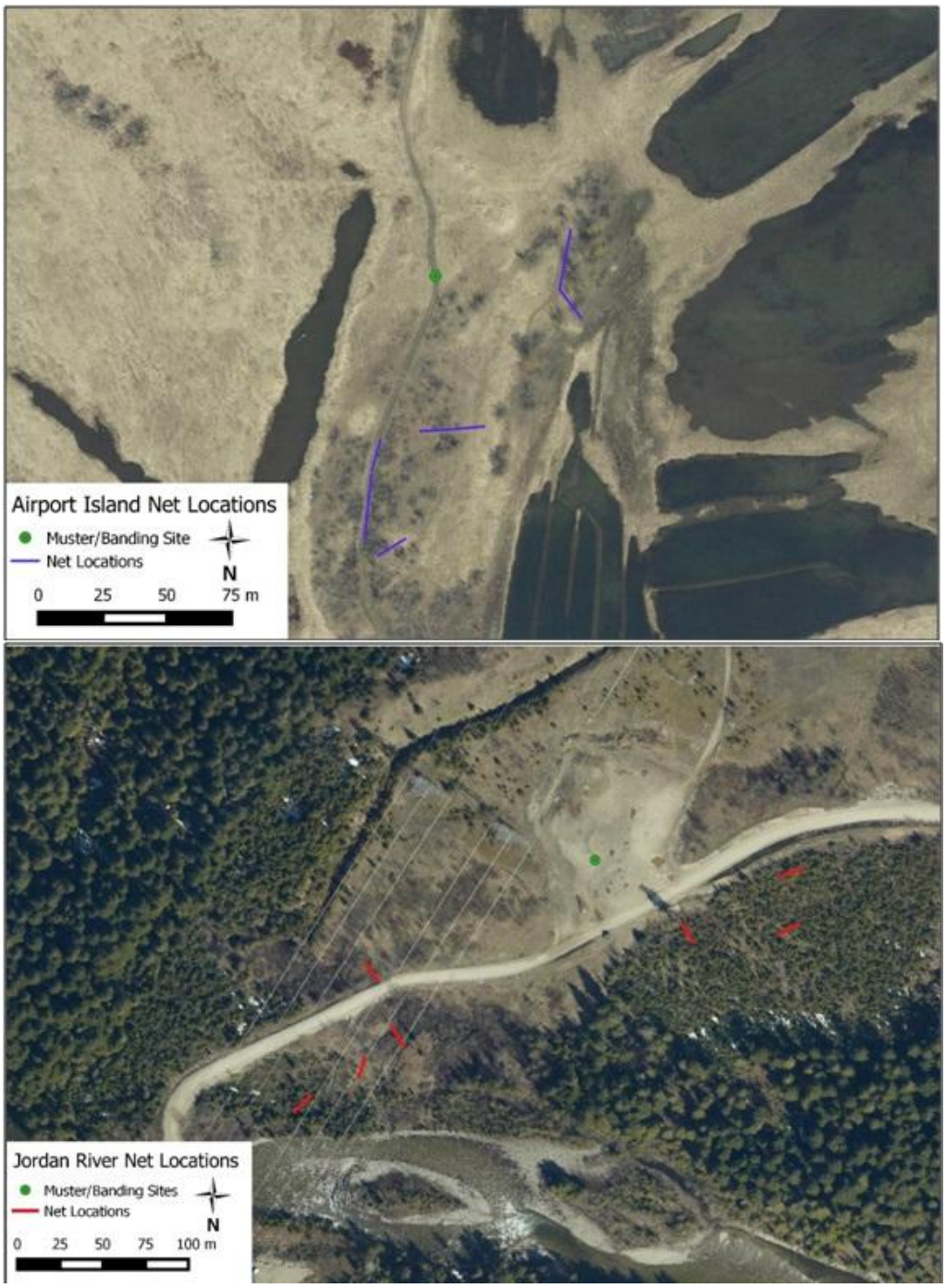

Figure 10: Airport Islands and Jordan River banding station layout in 2015

Jordan River banding station is positioned above the drawdown zone and located along Jordan river, upstream from its confluence with the Columbia river (Appendix 3) and consists of a mix of riparian habitat (similar to habitat found at Machete Island; Figure 11) and upland habitat. Surveys at Jordan River banding station were initiated in 2011 and in 2015 seven nets were installed at this site (Figure 10).

Figure 11: **Neotropical migrants captured in net line in riparian habitat dominated by black cottonwood, willow, alder, red-osier dogwood and black twinberry at Jordan River banding station**

2.1.2 Field Survey Procedures

In 2015, surveys at Machete Island were conducted daily (if possible) and surveys at the Jordan River and Airport Islands once per week. At Machete Island, net lines were prepared and nets were permanently installed on net poles. At Jordan River and Airport Islands only net poles were permanently installed, but nets were taken down after each survey. Usually all 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 could safely handle and band all birds captured. When it was necessary to close some nets to ensure the safe handling of birds, we prioritized the closing of nets further from the banding station and those with fewer captures (on average) in order to save time on checking nets.

Nets were opened 30 minutes before sunrise by unrolling them (Machete Island) or by putting them on the pre-installed poles (Jordan River and Airport Islands). 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 or touching the ground. 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. 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, presence of a predator (e.g., weasel) 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).

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, banding station staff visited each net and extracted all birds (Figure 12). To carry the birds, staff used holding bags with uniquely coloured and numbered clothes pegs that identified which net the bird was captured in. 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 (Figure 12). 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 datasheet.

Figure 12: **CBA technician extracting birds from a mist net at Machete Island banding station (left). Banding tent at Machete Island 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. During the survey period mist netting poles were left installed at the sites but nets were taken down after each survey (Jordan River and Airport Islands) or nets were tightly rolled, tied closed with multiple ribbons and left on the poles until the next morning (Machete Island).

2.1.3 Permitting and Safety of Captured Birds

All banding activities were conducted under a Federal Scientific Permit to Capture and Band Migratory Birds. During the entire operation, the safety of captured birds was the second highest priority (right after personal safety). Our goal was to have zero capture casualties. All Banders-in-charge monitored the operation at all times and instructed the crew members on appropriate measures to prevent or minimize any potential casualty. Prior to commencing work, all crew members were familiar with the CBA banding station protocols (CBA 2015a),which follows the North American Banding Council's mist netting and bird handling safety recommendations (Smith et al. 1999, NABC 2001).

2.2 Data Collection and Management

All field data recorded on datasheets and in field notebooks were entered into digital databases (MS Excel format) on a regular basis and were 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 datasheets and field notebooks.

Banding data were entered into Bandit 3.01 software, which the Environment Canada Bird Banding Office uses for the submission of banding data. All banding data collected by CBA in 2015 were submitted to the Migratory Bird Populations Division–Bird Banding Office in Ottawa by December 31, 2015.

2.3 Data Summary and Analysis

The purpose of this report is to review work conducted in Year 8 (2015). The following summaries are provided:

- methods employed
- survey effort
- species and number of birds captured by constant effort mist netting at Machete Island banding station
- species and number of birds captured by constant effort mist netting at Airport Islands banding station
- species and number of birds captured by constant effort mist netting at Jordan River banding station

Net-hour is a survey effort unit defined as one 12-m mist net in use for 1 hour (one 12-m long mist net in operation for one hour = one net-hour). Newly captured birds included both all newly captured and banded birds and all newly captured (for the year) recaptures from previous years. Recaptured birds were all previously captured and banded birds (within year), excluding same day recaptures. Capture rate (for newly captured birds) was calculated as the number of newly captured birds per net-hour. 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. Daily recapture rate - for each day, was the proportion of all newly captured birds that day that were recaptured later in the season (excluding same day recaptures). The daily recapture rate was not calculated for the last day of each season since no recapture was possible. 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.

Because of the large number of unidentified Traill's Flycatchers (*Empidonax alnorum/traillii*) records, for the purpose of this report we decided to pool records of Willow Flycatcher (*Empidonax traillii*), Alder Flycatcher (*Empidonax alnorum*) and Traill's Flycatcher into one taxon - Traill's Flycatcher.

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

3 RESULTS

3.1 Reservoir Operations of Arrow Lakes Reservoir in 2015

The reservoir water level peaked on July 13 and July 14 when the water reached its annual maximum of 435.5 m ASL. During the 2015 study period, water levels of the Arrow Lakes Reservoir were lower than the long-term average and the lowest observed during the CLBMON 39 study period (CLBMON 39 started in 2008). At the beginning of the fall migration survey period, the reservoir levels were at 432.0 m ASL (on August 1, 2015), and gradually descended to 429.1 m ASL by the end of the fall season (September 30; Appendix 2).

3.2 Machete Island Banding Station

3.2.1 Monitoring Effort

Constant effort mist netting monitoring was conducted at Machete Island banding station during fall migration in August and September. The first survey was conducted on August 5 and the last one on September 28. During this period, 40 surveys were conducted for a total of 2311.5 net-hours. Due to relatively low water levels in Arrow Lake Reservoir in 2015, water did not affect the operation of the banding station. Persistent rain prevented the operation of the banding station on 5 days. In addition, on 7 days, monitoring was not conducted at Machete Island due to effort at another station (Jordan River).

On the first day of surveys (Aug 5) only 4 nets were open to assure that all staff were not only familiar with the banding station protocols, but also properly trained in safe extracting and bird handling techniques. From August 6 onward, the number of nets opened daily varied from 7 to 13 (Table 2) to assure safe and prompt processing of all captured birds. In addition, on a few days some nets had to be temporary closed due to strong wind, precipitation or the presence of a predator (weasel). The average number of open nets each day was 12.1 ± 0.25 (mean ± SE) and the total number of net-hours for the whole season was 2311.5 (Table 2).

Table 2: Mist netting capture effort at Machete Island banding station in 2015.

Month	No. days nets open	Mean No. open nets (SE)	No. net-hours
August	21	11.9 (0.54)	1245.25
September	19	12.3 (0.34)	1066.25
Total	40	12.1 (0.25)	2311.50

The survey effort was distributed relatively evenly throughout the fall migration period with the highest number of net-hours in week 3 (366 net-hours) and the lowest in week 8 (230.75 net-hours; Table 3). The total number of net-hours each net was open is provided in Appendix 4.

Table 3: Weekly mist netting survey effort and number of net-hours at Machete Island banding station throughout the 2015 fall migration period.

Banding Site	Week 1 4–10 Aug	Week 2 11–17 Aug	Week 3 18–24 Aug	Week 4 25–31 Aug	Week 5 1–7 Sep	Week 6 8–14 Sep	Week 7 15–21 Sep	Week 8 22–28 Sep	Total
No. of surveys	6	4	6	5	6	5	5	3	40
Net-hours	329.50	262.00	366.00	287.75	250.50	325.50	259.50	230.75	2311.50

3.2.2 Total Number of Captured Birds

A total of 2686 birds of 60 species were captured at Machete Island banding station in 2015 with an average capture rate of 1.1620 birds per net-hour (Appendix 5, Appendix 6). The most frequently captured species was Common Yellowthroat (*Geothlypis trichas*; 30.8% of all captured birds) with a capture rate of 0.3573 birds/net-hour. Another commonly captured species was Traill's Flycatcher (both Alder and Willow Flycatchers combined) (8.7% and 0.1008 birds/net-hour), followed by American Redstart (*Setophaga ruticilla*; 7.8% and 0.0904 birds/net-hour), Yellow-rumped Warbler (*Setophaga coronata*; 7.0% and 0.0809 birds/net-hour), Orange-crowned Warbler (*Oreothlypis celata*; 5.4% and 0.0627 birds/net-hour), Song Sparrow (*Melospiza melodia*; 3.6% and 0.0415 birds/net-hour), Yellow Warbler (*Setophaga petechia*; 3.6% and 0.0415 birds/net-hour), Wilson's Warbler (*Cardellina pusilla*; 3.5% and 0.0402 birds/net-hour), Gray Catbird (*Dumetella carolinensis*; 3.3% and 0.0381 birds/net-hour), Lincoln's Sparrow (*Melospiza lincolnii*; 2.8% and 0.0320 birds/net-hour) and Least Flycatcher (*Empidonax minimus*; 2.5 % and 0.0286 birds/net-hour) (Appendix 6). The overall capture rate for each net is provided in Appendix 4.

Out of 60 species captured at Machete Island in 2015 (Appendix 6), three species have not been previously captured under CLBMON 39. These species were: European Starling (*Sturnus vulgaris*), Indigo Bunting (*Passerina cyanea*) and Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*). In 2015, 25 species were captured at Machete Island but not at Jordan River or Airport Islands. These species were: Eastern Kingbird (*Tyrannus tyrannus*), Western Wood-Pewee (*Contopus sordidulus*), Northern Waterthrush (*Parkesia noveboracensis*), Red-winged Blackbird (*Agelaius phoeniceus*), Clay-colored Sparrow (*Spizella pallida*), Pine Siskin (*Spinus pinus*), Downy Woodpecker (*Picoides pubescens*), Dusky Flycatcher (*Empidonax oberholseri*), Chipping Sparrow (*Spizella passerina*), European Starling, Purple Finch (*Haemorhous purpureus*), American Goldfinch (*Spinus tristis*), Brown-headed Cowbird (*Molothrus ater*), Black-headed Grosbeak (*Pheucticus melanocephalus*), Fox Sparrow (*Passerella iliaca*), Rufous Hummingbird (*Selasphorus rufus*), Townsend's Warbler (*Setophaga townsendi*), Varied Thrush (*Ixoreus naevius*), Indigo Bunting, Long-eared Owl (*Asio otus*), Mourning Warbler (*Geothlypis philadelphia*), Olive-sided Flycatcher (*Contopus cooperi*), Red-breasted Nuthatch (*Sitta canadensis*), Tennessee Warbler (*Oreothlypis peregrina*) and Yellow-headed Warbler.

3.2.3 Number of Newly Banded Birds

In 2015, 1977 individual birds of 57 species were newly captured and banded (Appendix 6). The most numerous newly banded bird was Common Yellowthroat with 514 individuals (26.0% of all newly banded birds), followed by Yellow-rumped Warbler (180 individuals and 9.1%), American Redstart (169 individuals and 8.5%), Traill's Flycatcher (Alder and Willow Flycatchers combined; 161 individuals and 8.1%), Orange-crowned Warbler (116 individuals and 5.9%), Yellow Warbler (84 individuals and 4.2%), Wilson's Warbler (70 individuals and 3.5%), Song Sparrow (59 individuals and 3.0%), both Lincoln's Sparrow and Least Flycatcher with 57 individuals and 2.9%, Gray Catbird (53 individuals and 2.7%) and Swainson's Thrush (*Catharus ustulatus*) with 50 individuals and 2.5% (Appendix 6).

In addition to the 57 species banded, three species (Rufous Hummingbird, Long-eared Owl and Yellow-headed Blackbird) were captured but released unbanded.

3.2.4 Migration Chronology

Migration, as measured by capture rate (number of birds captured per net-hour) varied throughout the monitoring period (Figure 13). The average daily capture rate of newly captured birds was 1.01 ± 0.134 (mean ± SE). Capture rate was high at the beginning of the season then slowed down around mid-August. The second peak in capture rate was in late August and early September with migration slowing down from mid-September onward.

Abundance of different species peaked at different times. For the four most frequently captured species, American Redstart and Traill's Flycatcher were the most abundant at the study site at the beginning of season (Figure 14). Conversely, abundance of Common Yellowthroat and Yellow-rumped Warbler peaked later in the season (Figure 14).

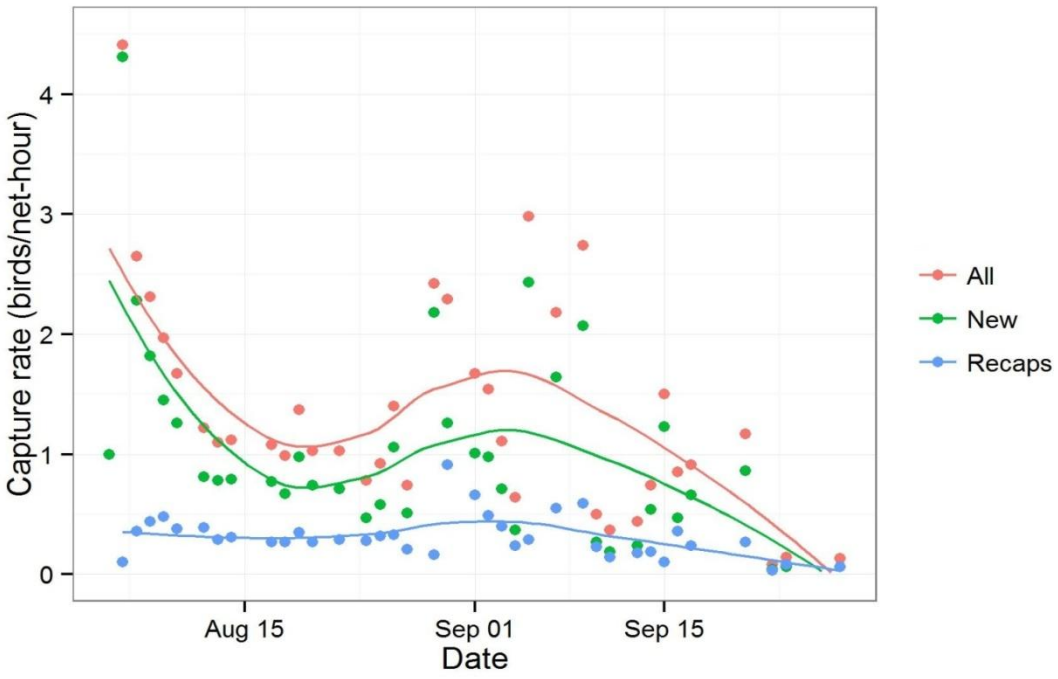

Figure 13: **Number of birds captured per net-hour at Machete Island banding station throughout the season in 2015. All = all birds captured, New = newly captured birds (including recaptures from previous years), and Recaps = Recaptures (excluding same day recaptures).**

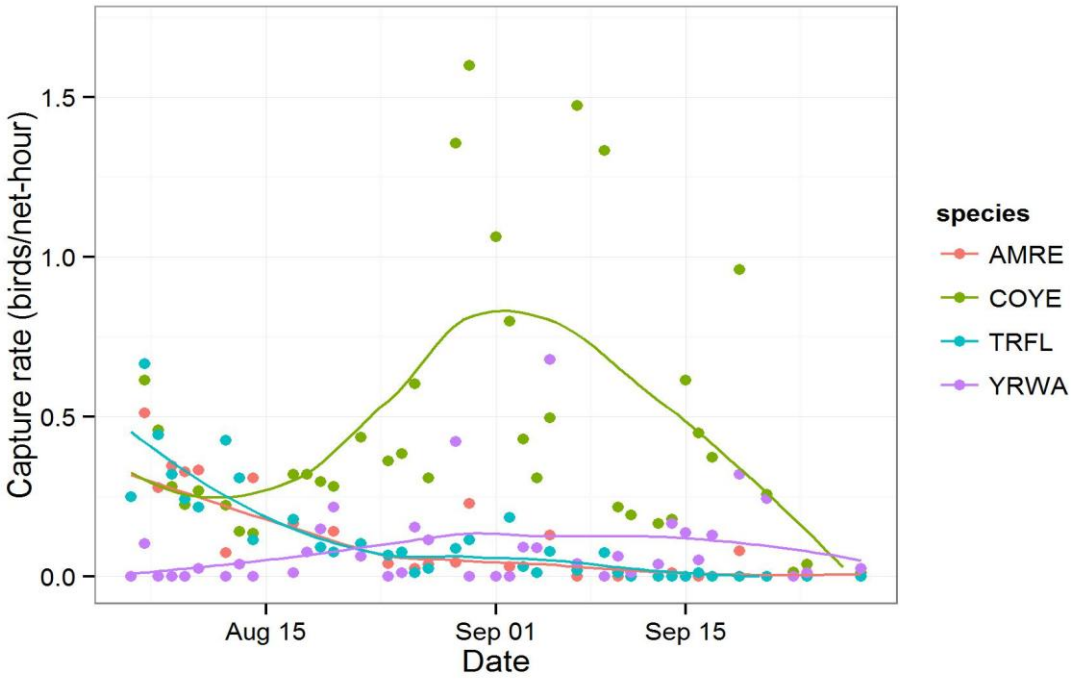

Figure 14: **Migration chronology of the four most frequently captured species at Machete Island banding station in 2015. AMRE = American Redstart, COYE = Common Yellowthroat, TRFL = Traill's Flycatcher, YRWA = Yellow-rumped Warbler.**

3.2.5 Age Ratio of Captured Birds

Of the 1971 newly-banded birds of known age (99.7% of all newly-captured birds), 1636 individuals (83.0%) were HY (juvenile birds hatched in 2015), and 335 individuals (17%) were AHY (adult birds more than one year old) (Appendix 7). HY birds outnumbered AHY birds in all weeks of the season, with the difference being more prominent in the first half of the season (Figure 15).

Of the 1015 birds that could be reliably sexed (51.3% of all newly-captured birds), 555 (54.7%) were males and 460 (45.3%) were females. Of the birds of known sex, 458 males (82.5%) and 326 females (70.9%) were HY; the remainder were AHY (Appendix 7).

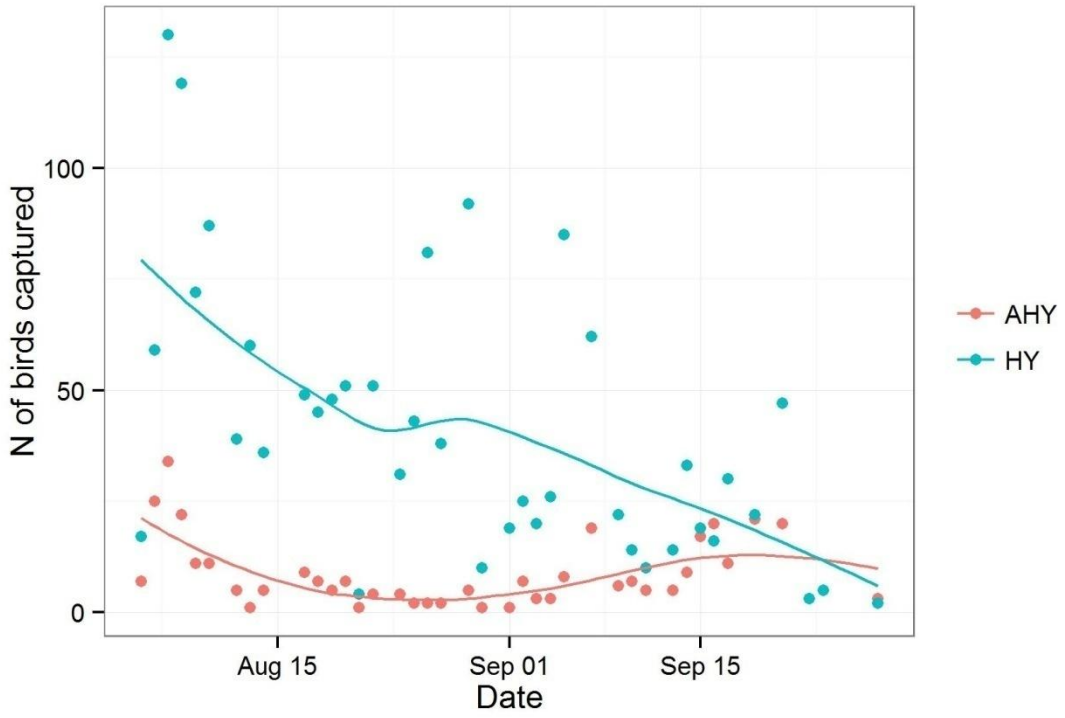

Figure 15: **Number of after hatch year (AHY) and hatch year (HY) newly captured birds at Machete Island banding station in 2015.**

3.2.6 Recaptures of Banded Birds

In 2015, 422 individuals of 31 species were recaptured at least once (641 recaptures total; Appendix 6). Of these, 295 individuals were recaptured one or more days after their initial capture. Two individuals were recaptured seven times (seven different days), three birds five times, 10 birds four times, 13 birds three times, 63 birds twice, and 204 birds only once. The overall recapture rate was 22.2%. In addition, 176 individuals were recaptured at least once in the same day as they were banded (203 recaptures total; Appendix 6) and the overall same day recapture rate was 10.3%.

The average daily recapture rate for the whole season was 0.147 ± 0.0151 (mean + SE). Daily recapture rate varied throughout the season (Figure 16). For Common Yellowthroat, the most frequently captured bird in 2015, 24.5% of newly captured individuals were recaptured at least once later in the season.

In 2015, 26 individuals banded in previous years were recaptured. All of them were previously banded at Machete Island.

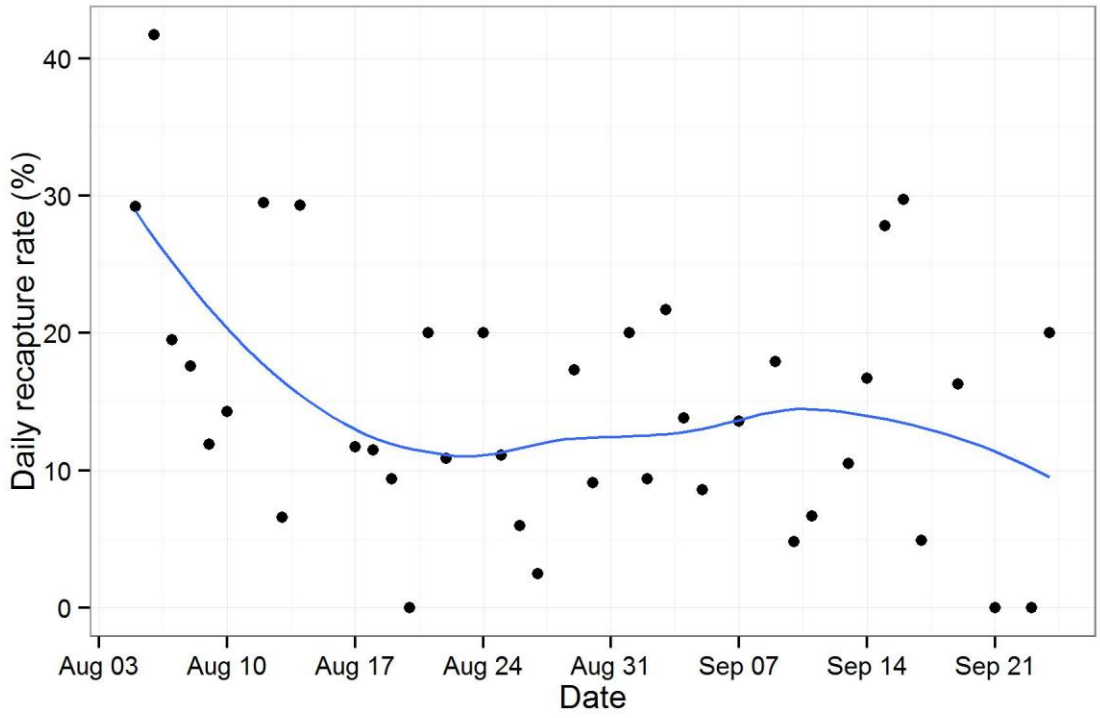

Figure 16: **Daily recapture rate at Machete Island banding station in 2015 (with Loess smoother).**

3.3 Satellite Banding Stations

3.3.1 Survey Effort

In 2015, in addition to daily surveys at Machete Island, two satellite sites were monitored for a total of 14 surveys and 548.5 net-hours (Table 4). At Airport Islands, the first survey was conducted on August 9, 2015; the last was conducted on September 24, 2015. The number of nets open varied from 7 to 9 with a mean of 8.1 ± 0.26 (mean ± SE).

At Jordan River, the first survey was conducted on August 11, 2015; the last one on September 22, 2015. Prior to the migration monitoring season, vegetation thinning occurred at a small area within the Jordan River banding station and affected shrub cover surrounding three out of our 10 permanent net lines. In 2015, these three affected net lines were not used to prevent bias in capture rate. The average number of open nets was 6.7 ± 0.18 (mean ± SE) and ranged from 6 to 7.

The variation in the number of used nets and net-hours per week reflected the fact that the number of open nets varied from day to day depending on weather and capture rate– the number of nets was always adjusted to allow for the safe processing of captured birds. The total number of net-hours for the entire season and the overall capture rate for each net is provided in Appendix 4.

Table 4: Mist netting survey effort (number of net-hours) at Airport Islands banding station and Jordan River banding station in 2015

Banding Site	No. of surveys	Week 1 4–10 Aug	Week 2 11–17 Aug	Week 3 18–24 Aug	Week 4 25–31 Aug	Week 5 1–7 Sep	Week 6 8–14 Sep	Week 7 15–21 Sep	Week 8 22–28 Sep	Grand Total
Airport Islands	7	49.50	.	48.00	48.00	60.50*	35.00	.	42.00	283.00
Jordan River	7	.	72.00*	34.50	33.00	42.00	42.00	.	42.00	265.50
Total	14	49.50	72.00	82.50	81.00	102.50	77.00	.	84.00	548.50

* two surveys during the week

3.3.2 Bird Captures and Recaptures

At Airport Islands, the overall capture rate was 0.4523 birds/net-hour. In total, 128 birds from 17 species were captured (Appendix 8). Common Yellowthroat was the most frequently captured species (0.1413 birds/net-hour), followed by Savannah Sparrow (*Passerculus sandwichensis*; 0.0707 birds/net-hour), Yellow-rumped Warbler (0.0495 birds/net-hour), Orange-crowned Warbler (0.0424 birds/net-hour), Yellow Warbler (0.0353 birds/net-hour) and Traill's Flycatcher (0.0212 birds/net-hour). The capture rate for newly captured birds was 0.3816 birds/net-hour, and the overall recapture rate was 1.9%. The recapture rate for the same-day recaptures was 13.0%.

In 2015, we captured five species that have not been previously captured at this site: American Redstart, Dark-eyed Junco (*Junco hyemalis*), Ruby-crowned Kinglet (*Regulus calendula*), Western Meadowlark (*Sturnella neglecta*) and Sora (*Porzana carolina*). Wilson's Snipe (*Gallinago delicata*), Sora and Western Meadowlark were the only species captured exclusively at this site in 2015. It was also for the first time that Western Meadowlark was captured during the CLBMON 39 study, at any site.

At Jordan River, 266 birds of 35 species were captured (Appendix 9). The overall capture rate was 1.0019 birds/net-hour, the capture rate for newly captured birds was 0.8588 birds/net-hour and the overall recapture rate was 6.1%. The most commonly captured species was Warbling Vireo (*Vireo gilvus*: 0.2373 birds/net-hour), followed by Swainson's Thrush (0.1318 birds/net-hour), American Redstart (0.0753 birds/net-hour), Black-capped Chickadee (*Poecile atricapillus*: 0.0753 birds/net-hour), Golden-crowned Kinglet (*Regulus satrapa*: 0.0603 birds/net-hour), Wilson's Warbler and Ruby-crowned Kinglet (both 0.0565 birds/net-hour), MacGillivray's Warbler (*Geothlypis tolmiei*: 0.0377 birds/net-hour), Traill's Flycatcher (0.0339 birds/net-hours), Dark-eyed Junco (0.0301 birds/net-hour), Lincoln's Sparrow, White-crowned Sparrow (*Zonotrichia leucophrys*) and Yellow Warbler (all three 0.0226 birds/net-hour). The recapture rate for same-day recaptures was 7.9%.

Three species were captured exclusively at this site: Brown Creeper (*Certhia americana*), Chestnut-sided Warbler (*Setophaga pensylvanica*) and Northern Flicker (*Colaptes auratus*).

3.4 Injuries and Casualties

At Machete Island, one bird (could not be identified) was killed in a net by an unknown predator (presumed raptor). One Song Sparrow and one Yellow Warbler showed signs of

stress during extraction and later died at the banding station. In addition, four birds suffered a minor leg injury. At Jordan River, one Black-capped Chickadee was attacked in a net by an unknown predator and died and one Western Tanager (*Piranga ludoviciana*) showed signs of a minor wing strain but was successfully released. At Airport Islands, one Dark-eyed Junco was found dead in net and three birds (two Common Yellowthroats and one Lincoln's Sparrow) were killed in net by a weasel.

3.5 Species at Risk

At Machete Island banding station, we captured one Olive-sided Flycatcher - a blue-listed species in BC (species of Special Concern in BC). This bird was captured into a mist net on August 8, 2015, banded and released.

No other species at risk was captured in 2015.

4 DISCUSSION

This section summarizes field studies completed in 2015. An overview of the management questions and approaches is presented in Appendix 1.

In 2015, three sites (Machete Island, Airport Islands and Jordan River) were surveyed by constant effort mist netting. Surveys at Machete Island were initiated as daily monitoring in 2008. However, during the 2011-2014 period, due to complexity of the scope of the CLBMON 39 project, this site was monitored with lower intensity, usually once per week (CBA 2012, 2013b, 2014, 2015b). We were able to resume daily monitoring at Machete Islands in 2015 which allowed us to expand the detailed capture-recapture dataset from 2008-2010.

Water levels in Arrow Lakes Reservoir were the lowest in 2015 that they have been during the entire CLBMON 39 study period. Water did not directly affect net lines or the surrounding habitat even at the lowest elevation site (Airport Islands).

At Machete Island, the capture rate for newly captured birds and the overall total capture rate (0.8553 and 1.1620 birds/net-hour, respectively) were lower than those from 2009 (CBA 2010b) and 2013 (CBA 2014) but higher than in any other year (MCA 2009, CBA 2011b, 2012, 2013b, 2015b). Similar to previous years, Common Yellowthroat was the most frequently captured bird at Machete Island (except for 2014 when Traill's Flycatcher was the most abundant species; CBA 2015b). For Common Yellowthroat, the capture rate for newly captured birds in 2015 was one of the highest recorded since the beginning of this project (0.2224 birds/net hour), second only to that from 2013 (0.3169 birds/net-hour; CBA 2014).

In addition, the proportion of newly captured birds that were recaptured later in the season (24.5%) was higher than in 2008 and 2010 (MCA 2009, CBA 2011b), but lower than in 2009 (2010b). In general, this supports our preliminary results which suggest a connection between the higher capture rate/relative abundance of Common Yellowthroat at Machete Island and a lower water level (CBA 2013c). In addition to Common Yellowthroat, the other frequently captured species in 2015 (e.g., Traill's Flycatcher, American Redstart, Yellow-rumped Warbler, Orange-crowned Warbler; Appendix 6) were also abundant species in previous years, though the rank varied among years (CBA 2012, 2013b, 2013c, 2014, 2015b).

Data collected during the first three years of the CLBMON 39 monitoring showed that around Revelstoke, the peak of songbird migration occurs from mid-August to early-September (CBA 2013c). The chosen monitoring period from August 1 to September 30 was therefore appropriate to monitor neotropical migrant bird migration. However, in 2015, the first survey at Machete Island was not conducted until August 5. This was due to the fact that several days were needed to properly set up the banding station to allow for safe bird banding. Relatively high capture rates right from the beginning of the 2015 survey period (Figure 13) suggest that on August 5 early migration was already underway. Therefore, in the next migration monitoring season, care will have to be taken to assure that the banding station is set up in advance and can be fully operational on August 1.

At Airport Islands banding station, the capture rate for newly captured birds and the overall (total) capture rate (0.3816 and 0.4523 birds/net-hour, respectively) were the second highest recorded since the beginning of monitoring in 2011. Only in 2011 did we record higher capture rates, almost twice as high (CBA 2012). In 2015, Common Yellowthroat was the most frequently captured species at Airport Islands, similar to previous years (CBA 2012, 2013b, 2014, 2015b), though its capture rate for newly captured birds was the second lowest recorded (only 2012 had a lower capture rate). Savannah Sparrow and Yellow-rumped Warbler were the other common species at this site, similar to previous years. Interestingly, Orange-crowned Warbler was the fourth most frequently captured species. Although this species had been previously captured at this site in 2011, 2012 and 2013, it was always in very low numbers (CBA 2012, 2013b, 2014). In addition, Western Meadowlark was captured at this site in 2015 and two individuals were banded; one was also recaptured later in the season. Although this species had been previously recorded in Revelstoke Reach during fall migration (e.g., CBA 2015b) and they also breed there (e.g., CBA 2013a), this was the first time the species was captured under CLBMON 39 at any station.

At Jordan River banding station, the capture rate for newly captured birds and the total capture rate recorded in 2015 (0.8588 and 1.0019 birds/net-hour, respectively) were the highest to date (CBA 2012, 2013b, 2014, 2015b). Warbling Vireo was the most frequently captured species, followed by Swainson's Thrush and American Redstart which were the same species as in 2014 (CBA 2015b). Since the beginning of monitoring at this site in 2011, Warbling Vireo and Swainson's Thrush remained the two most frequently captured species in all five years of monitoring (CBA 2012, 2013b, 2014, 2015b).

4.1 Management Questions

MQ1: What is the seasonal and annual variation in the abundance and species richness of neotropical migrants in Revelstoke Reach during fall migration.

In the Year 5 Interim Review report, this management question was addressed at a preliminary level (CBA 2013c). However, data from only 5 years were used for this analysis and low water conditions did not occur during those years. Since then, data from three more seasons have been added to the database. In addition, year 2015 with its low water levels allowed us to document neotropical migrant abundance and species richness during a low water year (when most of the stopover habitat in Revelstoke Reach was available as it was not flooded). Since the lack of data from low water years compared to years when the drawdown zone is flooded was identified as one of the caveats of our pilot assessment (CBA 2013c), these additional data will allow us to improve our preliminary assessment. While this management question can be answered

with the current dataset, analyzing the entire ten year study period is necessary to increase the depth and breadth of our final assessment.

MQ2: Which habitats within the drawdown zone in Revelstoke Reach are utilized by neotropical migrants and what are their characteristics?

The preliminary analysis of random plot survey data was conducted for the Year 5 Interim Review report (CBA 2013c) where the information on abundance and species richness in different habitats within the drawdown zone was presented. In general, habitat with lower vertical vegetation structure (grassland, unvegetated habitat) had significantly lower abundance and diversity of neotropical migrants compared to more complex habitat (forest or shrub habitat) (CBA 2013c). However, some localized and less common habitat types were not well represented in our random sample. Therefore, it was decided to continue random plot surveys for two additional seasons (2013 and 2014) which allowed us to focus the survey effort on sampling the habitat types for which the coverage was limited (CBA 2013c). The field sampling of random plots was completed in 2014 (CBA 2015b) and the final analysis of the combined datasets of random plot surveys is currently being conducted. This management question will be addressed in Year 9 and the summary of the final analysis will be provided in the Year 9 annual report.

MQ3: Do reservoir operations influence the species richness or abundance of neotropical migrants using habitat in the drawdown zone during fall migration? If so, how do reservoir operations influence the species richness or abundance?

Our preliminary analyses of data collected at Machete Island in 2008-2010 showed significantly higher capture and recapture rates in a year with lower water levels (2009) compared to years when the banding station was flooded (CBA 2013c). Water levels in 2015 were even lower than those in 2009 and the trend of higher capture rate in low water years, outlined in our preliminary analyses, was supported (Appendix 10). Similarly, higher capture rates of the most frequently captured species (Common Yellowthroat) linked previously to the low water level conditions (CBA 2013c), were observed in 2015. However, Common Yellowthroat is also one of the most common breeding birds in Revelstoke Reach and its abundance during the fall migration period can be, in part, explained by higher local productivity in years when nesting habitat is not flooded.

In addition to data collected at Machete Island, variation in capture rates at our low elevation riparian site (Airport Islands) suggests that the relationship between water levels and neotropical migrant abundance and species richness could be more complex. For our final analyses, we will therefore investigate the effects of different reservoir operation characteristics (e.g., maximum water level, how long the site was flooded, timing of flooding) to assess which can best explain variability in capture and recapture rates among years. Since only four years of daily monitoring at Machete Island has been completed to date, more data collected during different reservoir operations (years) will greatly improve our ability to separate normal annual variation from the effects of reservoir operations.

In addition to mist netting surveys, permanent plot sampling was conducted in Revelstoke Reach. In 2012, our preliminary analyses identified a significant effect of water depth on the presence of neotropical migrants on plot (CBA 2013c). Migrants were less likely to use grassland and shrub plots and more likely to be present on forest plots

as water depth on plot increased. The dataset used for our preliminary analyses was further enlarged by two seasons, and habitat and elevational stratification of permanent plots allowed us to obtain a large dataset of different plot flooding scenarios. This dataset is currently being analyzed, and the summary of the final permanent plot analyses will be provided in Year 9. Together with mist netting data analyses, this management question will be fully addressed in Year 10.

MQ4: Which neotropical migrants are most affected by reservoir operations?

In 2012, the preliminary analyses of mist netting and banding data from Machete Island indicated significant differences in capture rates, recapture rates and stopover length of several neotropical migrants among years (CBA 2013c). This allowed us to identify not only which species use the Revelstoke Reach during the fall migration period but also which species of neotropical migrants rely most on the habitat in Revelstoke Reach to gain energy reserves prior to their migration or during the stopover on their southward migration. Due to the complexity of the CLBMON 39 study, survey effort was focused on different components in the following years. In 2015, we were able to extend the original Machete Island dataset with another year with low water conditions. However, more than four years of capture-recapture data would be very beneficial to improve and strengthen our preliminary assessment. Combining capture-recapture data with information obtained from the random plot sampling component (habitat preferences), we will be able to address this management question in Year 10.

MQ5: Do reservoir operations affect the fattening rates of neotropical migrants using the drawdown zone during fall migration?

This management question has been already addressed (CBA 2014). We demonstrated that the reservoir operations do not affect the estimated fattening rates of migrants at riparian sites in the drawdown zone of Revelstoke Reach. Further, we found no significant variation in estimated fattening rate between sites in and outside of the drawdown zone or between two sites in the drawdown zone with different frequency of flooding. We therefore concluded that reservoir operations do not affect the fattening rates of neotropical migrants during fall migration and studies investigating this question were discontinued.

MQ6: Can operational adjustments be made to reduce impacts on neotropical migrants during fall migration or are mitigation measures required to minimize the loss of stopover habitat?

This management question has not been answered yet, but it will be addressed in full for the final comprehensive report after analyses of all components are completed.

MQ8: Are the ongoing revegetation projects effective at improving utilization of the treated habitat in the drawdown zone by neotropical migrants?

Fall monitoring of effectiveness monitoring plots (plots planted with cottonwood stakes as well as untreated control plots) were initiated in 2011 and to date 839 surveys have been conducted (CBA 2013c). In Year 7 of the CLBMON 39 study (2014) we found no clear increase in utilization of the treatment areas by neotropical migrants. While it has been documented that habitat with greater vertical vegetation structure (shrub and forest habitat) has in general higher abundance and diversity of migrants compared to grassland habitat (CBA 2013c), the revegetation areas may need more time to mature in order to become valuable stopover habitat for migrants.

No effectiveness monitoring surveys were conducted in Year 8 but we suggest these surveys are re-established in Year 9 to document any potential increase in utilization of treated areas by migrants. After the Year 9 season, the combined effectiveness monitoring dataset should be reanalyzed. Unless our analyses determine that an additional season of sampling is required, this management question should be addressed by the end of Year 9.

MQ9: Does the operation of Arrow Lakes Reservoir impact the availability or quality of stopover habitat in Revelstoke Reach for neotropical migrants?

This management question has been partially addressed in the Year 5 Interim Review report (CBA 2013c). It was demonstrated that the availability of stopover habitat was directly impacted by reservoir operations. In addition, our preliminary analyses suggested a negative link between the water levels and habitat quality, as measured by neotropical migrant abundance and diversity. This management question will be fully addressed for the final comprehensive report after the sampling of all components is completed.

4.2 Recommendations

For the 2016 season, we recommend continuing the mist netting surveys with the same effort as in 2015. During the fall migration period, Machete Island banding station should be surveyed daily while two satellite stations (Airport Islands an Jordan River) should be surveyed once a week. Mist netting surveys provide critical information to address some of the management questions (MQ3 and MQ4). To date, four years of detailed daily monitoring at Machete Island banding station have been conducted. In year 2015 we obtained data from a low water level year, which will improve our preliminary analyses of recapture rate and stopover length. Data from additional reservoir operational regimes will allow us to further improve our preliminary assessment and will allow us to address the relevant management questions with higher confidence. In addition, other components of this study will also benefit from documenting migrants' utilization of the drawdown zone by mist netting surveys during new reservoir operation regimes.

For year 2016, we also recommend resampling the set of effectiveness monitoring plots from 2014 (cottonwood revegetation treatment plots and control plots). By conducting these surveys in Year 9 (rather than in the last season) we will be able to reassess the utilization of these plots by neotropical migrants. This will allow us to address the MQ8 in Year 9 or identify if an addition season of sampling is required to fully address this management question.

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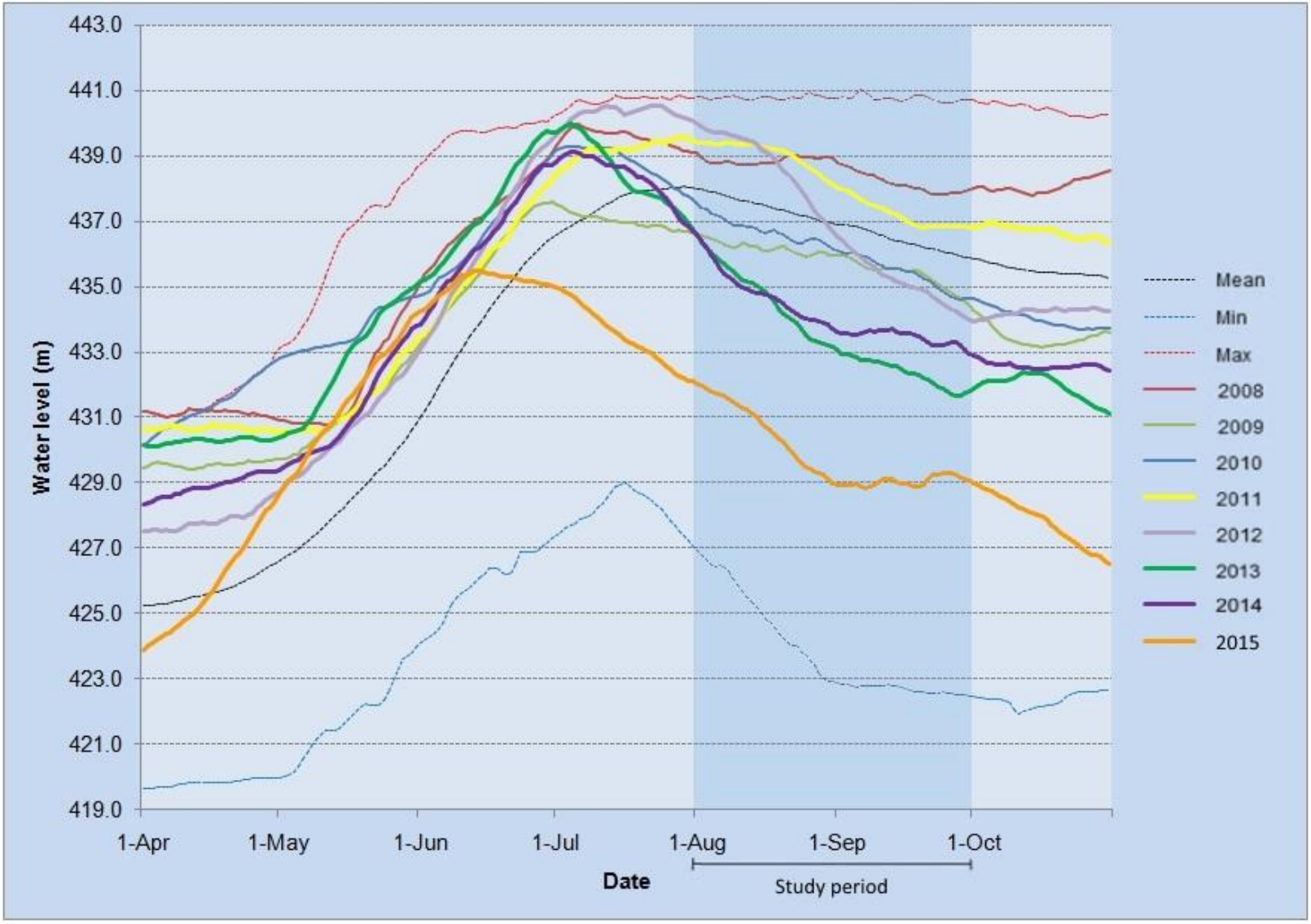
6 APPENDICES

Appendix 1: Management objectives, questions, hypotheses and approaches and status of CLBMON 39 after Year 8 (2015)

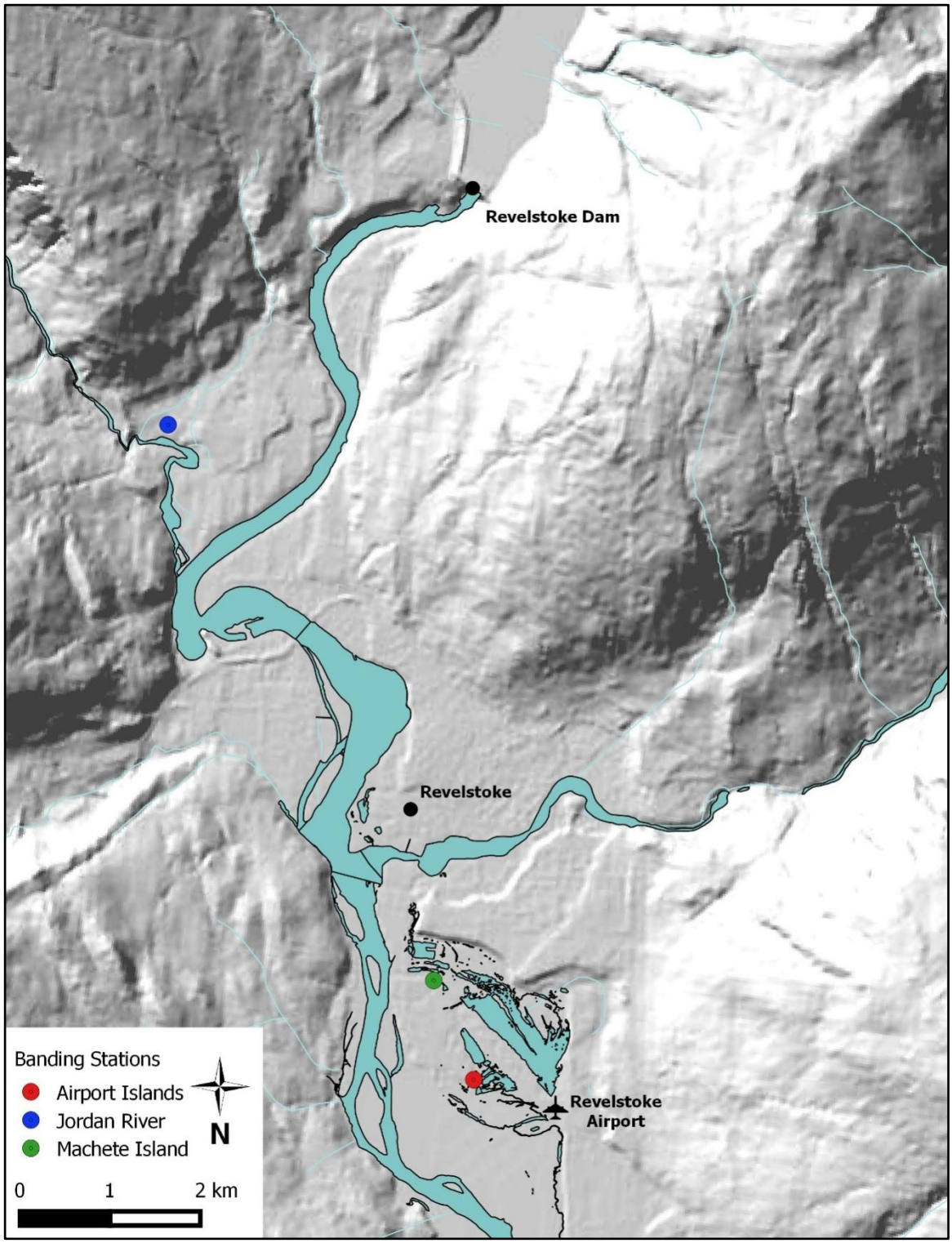
Study Objective	Management Question	Management Hypothesis	Approach	Year 8 (2015) Status
Objective 1: Determine the migration patterns of neotropicalmigrants in Revelstoke Reach over time (within season, across seasons, and across years).	**MQ1:**What is the seasonal and annual variation in the abundance and species richness of neotropical migrants in Revelstoke Reach during fall migration?		Constant effort mist netting Random plot surveys Permanent plot surveys	- Preliminary multi-year analysis was conducted for the Year 5 interim review report. - For the Year 10 final report this analysis will be updated with additional data collected in years 6-10.
Objective 2: Assess whether reservoir operations affect populations of neotropical migrants that use the area as a stopover site.	**MQ3:**Do reservoir operations influence the species richness or abundance of neotropical migrants using habitat in the drawdown zone during fall migration? If so, how do reservoir operations influence the species richness or abundance?	H1: Annual and seasonal variation in reservoir levels do not influence neotropical migrant abundance or species richness in habitats in the drawdown zone of Revelstoke Reach during fall migration.	Constant effort mist netting Permanent plot surveys	- Preliminary analysis of the constant effort mist netting and permanent plot data was conducted for the Year 5 interim review report. - Field data collection for the permanent plot survey component was finalized and the final analysis of the permanent plot data is being conducted now. - Data for the constant effort mist netting component are still being collected, and the final analysis will be conducted in Year 10.
	MQ4: Which neotropical migrants are most affected by reservoir operations?		Constant effort mist netting Permanent plot surveys Random plot surveys	- Preliminary analysis was conducted for the Year 5 interim review report. - Data for the constant effort mist netting component are still being collected. - Data from the multiple components will be used to address this question for the Year 10 final report.
	MQ5: Do reservoir operations affect the fattening rates of neotropical migrants using the drawdown zone during fall migration?	H2: Annual and seasonal variation in reservoir levels do not influence fattening rates of neotropical migrants in Revelstoke Reach during fall migration.	Physiology health monitoring	- This MQ has already been addressed.
Objective 3: 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 neotropical migrants.	**MQ6:** Can operational adjustments be made to reduce impacts on neotropical migrants during fall migration or are mitigation measures required to minimize the loss of stopover habitat?		Constant effort mist netting Permanent plot surveys Random plot	- To answer this MQ the impact of reservoir operations on stopover habitat and neotropicalmigrants needs to be addressed in full. - This MQ will be fully addressed for the Year 10 final report after answers to the other questions are finalized.

Study Objective	Management Question	Management Hypothesis	Approach	Year 8 (2015) Status
			surveys	
Objective 4: Provide information with respect to how wildlife physical works or revegetation can increase utilization of treated riparian habitat by neotropical migrants.	**MQ8:** Are the ongoing revegetation projects effective at improving utilization of the treated habitat in the drawdown zone by neotropical migrants?	H4: Revegetation does not affect utilization of the area by neotropical migrants as measured by migrant species richness or abundance.		- Preliminary analysis was conducted for the Year 5 interim review report and additional data were collected in 2013 and 2014. - In 2015, field data collection was temporarily deferred for 2 years due lack of evidence of differences in use of revegetated areas by migrants among years. - Field sampling is planned to resume in the year 10 (2017) field season. - For the Year 10 final report, our preliminary analysis will be updated with year 6-10 data.
Objective 5: 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.	**MQ2:** Which habitats within the drawdown zone in Revelstoke Reach are utilized by neotropical migrants and what are their characteristics?		Random plot surveys	- Preliminary analysis of random plot data was conducted for the Year 5 interim review report. - Field data collection for the random plot survey component was finalized and the final analysis of the random plot dataset is being conducted now.
	MQ9: Does the operation of Arrow Lakes Reservoir impact the availability or quality of stopover habitat in Revelstoke Reach for neotropical migrants?	H3: Annual and seasonal variation in reservoir levels do not influence the availability or quality of habitat for neotropical migrants.	Permanent plot surveys	- Preliminary analysis of the permanent plot data was conducted for the Year 5 interim review report. - Field data collection for the permanent plot survey component was finalized and the final analysis of the permanent plot dataset is being conducted now.

Appendix 2: Water levels (m) in Arrow Lakes Reservoir in 2015 compared with data from 2008 to 2014 and mean, minimum and maximum elevation (1968–2008)



Appendix 3: CLBMON 39 study site layout in Revelstoke Reach in 2015



Appendix 4: Survey effort and overall capture rate for each net during CLBMON 39 in 2015

Site	Net	Capture effort (net-hours)	Capture rate (birds/net-hour)
Machete Island	M1	177.5	1.138
	M2	188.8	1.144
	M3	193.5	1.018
	M4	185.5	1.542
	M5	184.0	0.832
	M6	184.0	1.185
	M7	187.3	1.987
	M8	162.3	0.789
	M9	162.3	0.807
	M10	157.3	0.776
	M12	148.8	0.592
	M14	193.5	1.917
	M3A	187.0	1.021
Airport Islands	A1	9.0	1.000
	A2	36.0	0.028
	A3	36.0	0.167
	A4	36.0	0.278
	A5	36.0	0.556
	A6	36.0	0.750
	A7	35.0	0.543
	A8	35.0	0.714
	A9	24.0	0.458
Jordan River	J3	40.3	2.087
	J4	40.3	0.174
	J5	40.3	0.845
	J7	40.3	1.565
	J9	29.8	1.244
	J10	40.3	0.522
	J11	34.5	0.609

Appendix 5: Bird species detected during CLBMON 39 in 2015

Common Name	Scientific Name	Code	Machete Island banding station		Jordan River banding station		Airport Islands banding station	
			Observed	Captured	Observed	Captured	Observed	Captured
Alder Flycatcher	*Empidonaxalnorum*	ALFL	x					
American Crow	*Corvusbrachyrhynchos*	AMCR	x				x	
American Dipper	*Cinclusmexicanus*	AMDI			x			
American Goldfinch	*Spinustristis*	AMGO	x	x	x		x	
American Pipit	*Anthusrubescens*	AMPI	x				x	
American Redstart	*Setophagaruticilla*	AMRE	x	x	x	x		x
American Robin	*Turdusmigratorius*	AMRO	x	x	x	x	x	
American Wigeon	*Anasamericana*	AMWI	x				x	
Bald Eagle	*Haliaeetusleucocephalus*	BAEA	x		x		x	
Barn Swallow	*Hirundorustica*	BARS	x					
Black-capped Chickadee	*Poecileatricapillus*	BCCH	x	x	x	x		
Belted Kingfisher	*Megacerylealcyon*	BEKI	x		x		x	
Brown-headed Cowbird	*Molothrusater*	BHCO		x				
Black-headed Grosbeak	*Pheucticusmelanocephalus*	BHGR	x	x				
Brown Creeper	*Certhiaamericana*	BRCR				x		
Canada Goose	*Brantacanadensis*	CANG	x		x		x	
Cassin's Vireo	*Vireo cassinii*	CAVI	x	x		x		
Clay-colored Sparrow	*Spizella pallida*	CCSP		x			x	x
Cedar Waxwing	*Bombycillacedrorum*	CEDW	x	x	x	x		x
Chipping Sparrow	*Spizellapasserina*	CHSP	x	x				
Cooper's Hawk	*Accipiter cooperii*	COHA			x			
Common Raven	*Corvuscorax*	CORA	x		x		x	
Common Yellowthroat	*Geothlypistrichas*	COYE	x	x	x		x	x
Chestnut-sided warbler	*Setophagapensylvanica*	CSWA				x		
Dark-eyed Junco	*Junco hyemalis*	DEJU		x	x	x		x
Downy Woodpecker	*Picoidespubescens*	DOWO	x	x	x			
Dusky Flycatcher	*Empidonaxoberholseri*	DUFL		x				
Eastern Kingbird	*Tyrannus*	EAKI	x	x				
Eurasian Collared-Dove	*Streptopeliadecaocto*	EUCD	x					
European Starling	*Sturnus vulgaris*	EUST		x				
Fox Sparrow	*Passerellailiaca*	FOSP		x				
Great Blue Heron	*Ardeaherodias*	GBHE	x				x	
Golden-crowned Kinglet	*Regulussatrapa*	GCKI		x	x	x		
Gray Catbird	*Dumetellacarolinensis*	GRCA	x	x	x	x		
Greater Yellowlegs	*Tringamelanoleuca*	GRYE	x				x	
Green-winged Teal	*Anascrecca*	GWTE	x					
Hammond's Flycatcher	*Empidonaxhammondii*	HAFL		x		x		
Hermit Thrush	*Catharusguttatus*	HETH	x	x		x		
Indigo Bunting	*Passerinacyanea*	INBU		x				
Killdeer	*Charadriusvociferus*	KILL	x					
Lapland Longspur	*Calcariuslapponicus*	LALO	x					
Lazuli Bunting	*Passerinaamoena*	LAZB		x		x		
Least Flycatcher	*Empidonaxminimus*	LEFL	x	x		x		x
Long-eared Owl	*Asiootus*	LEOW	x	x				
Lincoln's Sparrow	*Melospizalincolnii*	LISP	x	x	x	x		x

Common Name	Scientific Name	Code	Machete Island banding station		Jordan River banding station		Airport Islands banding station	
			Observed	Captured	Observed	Captured	Observed	Captured
Mallard	*Anasplatyrhynchos*	MALL	x		x		x	
Magnolia Warbler	*Setophaga magnolia*	MAWA		x		x		
Merlin	*Falco columbarius*	MERL	x				x	
MacGillivray's Warbler	*Geothlypistolmiei*	MGWA	x	x	x	x		
Mourning Warbler	*Geothlypisphiladelphia*	MOWA		x				
Nashville Warbler	*Oreothlypisruficapilla*	NAWA		x		x		
Northern Flicker	*Colaptesauratus*	NOFL	x		x	x		
Northern Harrier	*Circus cyaneus*	NOHA	x				x	
Northern Waterthrush	*Parkesianoveboracensis*	NOWA	x	x				
Northern Rough-winged Swallow	*Stelgidopteryxserripennis*	NRWS	x					
Orange-crowned Warbler	*Oreothlypiscelata*	OCWA	x	x	x	x		x
Olive-sided Flycatcher	*Contopuscooperi*	OSFL		x				
Osprey	*Pandion haliaetus*	OSPR	x		x		x	
Pacific Wren	*Troglodytes pacificus*	PAWR		x		x		
Pectoral Sandpiper	*Calidrismelanotos*	PESA	x					
Pine Siskin	*Spinuspinus*	PISI	x	x	x			
Pileated Woodpecker	*Dryocopuspileatus*	PIWO			x			
Prairie Falcon	*Falco mexicanus*	PRFA	x					
Purple Finch	*Haemorhouspurpureus*	PUFI		x				
Red-breasted Nuthatch	*Sittacanadensis*	RBNU	x	x	x			
Ruby-crowned Kinglet	*Regulus calendula*	RCKI	x	x	x	x	x	x
Red Crossbill	*Loxiacurvirostra*	RECR	x		x			
Red-eyed Vireo	*Vireo olivaceus*	REVI	x	x	x	x		
Red-tailed Hawk	*Buteojamaicensis*	RTHA	x		x			
Rufous Hummingbird	*Selasphorusrufus*	RUHU	x	x				
Red-winged Blackbird	*Agelaiusphoeniceus*	RWBL	x	x			x	
Savannah Sparrow	*Passerculussandwichensis*	SAVS	x	x	x		x	x
Semipalmated Sandpiper	*Calidrispusilla*	SESA	x					
Sora	*Porzanacarolina*	SORA						x
Song Sparrow	*Melospizamelodia*	SOSP	x	x	x	x		
Spotted Sandpiper	*Actitismacularius*	SPSA	x					
Sharp-shinned Hawk	*Accipiter striatus*	SSHA	x	x	x	x		
Steller's Jay	*Cyanocittastelleri*	STJA	x		x			
Swainson's Thrush	*Catharusustulatus*	SWTH	x	x	x	x		
Tennessee Warbler	*Oreothlypisperegrina*	TEWA		x				
Townsend's Warbler	*Setophagatownsendi*	TOWA		x				
Traill's Flycatcher	*Empidonaxalnorum/traillii*	TRFL	x	x	x	x	x	x
Turkey Vulture	*Cathartes aura*	TUVU	x		x			
Unidentified *Accipiter* Hawk	*Accipiter* (sp)	UAHA			x			
Unidentified *Calidris* sandpiper	*Calidris*(sp)	UCSA	x				x	
Unidentified *Empidonax* Flycatcher	*Empidonax*(sp)	UEFL	x					
Unidentified Blackbird		UNBL	x				x	
Unidentified Duck		UNDU	x		x		x	
Unidentified Hawk		UNHA	x					
Unidentified *Larus* Gull	*Larus*(sp)	UNLG	x		x			
Unidentified Owl		UNOW	x					

Common Name	Scientific Name	Code	Machete Island banding station		Jordan River banding station		Airport Islands banding station	
			Observed	Captured	Observed	Captured	Observed	Captured
Unidentified Sapsucker		UNSA	x					
Unidentified Shorebird		UNSH	x		x		x	
Unidentified Sparrow		UNSP	x		x			
Unidentified Swallow		UNSW	x				x	
Unidentified Teal		UNTE					x	
Unidentified Warbler		UNWA	x					
Unidentified Woodpecker		UNWO	x					
Vaux's Swift	*Chaeturavauxi*	VASW	x		x		x	
Varied Thrush	*Ixoreusnaevius*	VATH	x	x	x			
Veery	*Catharusfuscescens*	VEER	x	x		x		
Virginia Rail	*Ralluslimicola*	VIRA					x	
Warbling Vireo	*Vireo gilvus*	WAVI	x	x	x	x		
White-crowned Sparrow	*Zonotrichialeucophrys*	WCSP	x	x	x	x		
Western Meadowlark	*Sturnellaneglecta*	WEME					x	x
Western Tanager	*Pirangaludoviciana*	WETA	x	x		x		
Western Wood-Pewee	*Contopussordidulus*	WEWP	x	x				
Willow Flycatcher	*Empidonaxtraillii*	WIFL		x				
Wilson's Snipe	*Gallinagodelicata*	WISN	x				x	x
Wilson's Warbler	*Cardellinapusilla*	WIWA	x	x	x	x		x
White-throated Sparrow	*Zonotrichiaalbicollis*	WTSP		x		x		
Yellow-headed Blackbird	*Xanthocephalusxanthocephalus*	YHBL	x	x			x	
Yellow-rumped Warbler	*Setophagacoronata*	YRWA	x	x	x	x	x	x
Yellow Warbler	*Setophagapetechia*	YWAR	x	x	x	x	x	x

Appendix 6: Banding data summary from Machete Island banding station, Revelstoke Reach, 2015

Species Code*	No. of Newly Captured**	%	Capture Rate***	No. of Same-Day Recap	% New	No. of Recap	Recap Rate (% New)	Total No. Recaptures	No. of Unbanded	Total No.	Total Capture Rate***
COYE	514	26.0	0.2224	83	16.1	199	38.7	282	30	826	0.3573
TRFL	161	8.1	0.0697	28	17.4	38	23.6	66	6	233	0.1008
AMRE	169	8.5	0.0731	13	7.7	24	14.2	37	3	209	0.0904
YRWA	180	9.1	0.0779	4	2.2	.	.	4	3	187	0.0809
OCWA	116	5.9	0.0502	11	9.5	15	12.9	26	3	145	0.0627
SOSP	59	3.0	0.0255	4	6.8	32	54.2	36	1	96	0.0415
YWAR	84	4.2	0.0363	3	3.6	8	9.5	11	1	96	0.0415
WIWA	70	3.5	0.0303	13	18.6	8	11.4	21	2	93	0.0402
GRCA	53	2.7	0.0229	8	15.1	26	49.1	34	1	88	0.0381
LISP	57	2.9	0.0247	12	21.1	3	5.3	15	2	74	0.0320
LEFL	57	2.9	0.0247	2	3.5	7	12.3	9	.	66	0.0286
SWTH	50	2.5	0.0216	3	6.0	4	8.0	7	.	57	0.0247
BCCH	23	1.2	0.0100	1	4.3	28	121.7	29	2	54	0.0234
REVI	39	2.0	0.0169	3	7.7	7	17.9	10	.	49	0.0212
CEDW	39	2.0	0.0169	.	.	9	23.1	9	.	48	0.0208
VEER	27	1.4	0.0117	2	7.4	11	40.7	13	.	40	0.0173
MGWA	34	1.7	0.0147	2	5.9	1	2.9	3	2	39	0.0169
RCKI	26	1.3	0.0112	2	7.7	7	26.9	9	1	36	0.0156
WAVI	24	1.2	0.0104	1	4.2	2	8.3	3	1	28	0.0121
SAVS	21	1.1	0.0091	.	.	.	.	.	1	22	0.0095
EAKI	18	0.9	0.0078	1	5.6	.	.	1	.	19	0.0082
WEWP	16	0.8	0.0069	.	.	.	.	.	.	16	0.0069
NOWA	12	0.6	0.0052	2	16.7	.	.	2	.	14	0.0061
RWBL	13	0.7	0.0056	.	.	1	7.7	1	.	14	0.0061
CCSP	10	0.5	0.0043	.	.	2	20.0	2	1	13	0.0056
WCSP	10	0.5	0.0043	1	10.0	1	10.0	2	.	12	0.0052
WTSP	7	0.4	0.0030	1	14.3	2	28.6	3	1	11	0.0048
DEJU	8	0.4	0.0035	1	12.5	.	.	1	.	9	0.0039
HAFL	7	0.4	0.0030	.	.	.	.	.	.	7	0.0030
PISI	6	0.3	0.0026	.	.	1	14.3	1	.	7	0.0030
DOWO	6	0.3	0.0026	.	.	.	.	.	.	6	0.0026
DUFL	3	0.2	0.0013	.	.	2	33.3	2	1	6	0.0026
WETA	6	0.3	0.0026	.	.	.	.	.	.	6	0.0026
AMRO	5	0.3	0.0022	.	.	.	.	.	.	5	0.0022
CHSP	4	0.2	0.0017	1	25.0	.	.	1	.	5	0.0022
EUST	5	0.3	0.0022	.	.	.	.	.	.	5	0.0022
LAZB	5	0.3	0.0022	.	.	.	.	.	.	5	0.0022
SSHA	2	0.1	0.0009	1	50.0	.	.	1	1	4	0.0017
GCKI	3	0.2	0.0013	.	.	.	.	.	.	3	0.0013
HETH	3	0.2	0.0013	.	.	.	.	.	.	3	0.0013

Species Code*	No. of Newly Captured**	%	Capture Rate***	No. of Same-Day Recap	% New	No. of Recap	Recap Rate (% New)	Total No. Recaptures	No. of Unbanded	Total No.	Total Capture Rate***
PUFI	3	0.2	0.0013	.	.	.	.	.	.	3	0.0013
AMGO	2	0.1	0.0009	.	.	.	.	.	.	2	0.0009
BHCO	2	0.1	0.0009	.	.	.	.	.	.	2	0.0009
BHGR	2	0.1	0.0009	.	.	.	.	.	.	2	0.0009
FOSP	2	0.1	0.0009	.	.	.	.	.	.	2	0.0009
MAWA	2	0.1	0.0009	.	.	.	.	.	.	2	0.0009
PAWR	2	0.1	0.0009	.	.	.	.	.	.	2	0.0009
RUHU	.	.	.	.	.	.	.	.	2	2	0.0009
TOWA	2	0.1	0.0009	.	.	.	.	.	.	2	0.0009
VATH	1	0.1	0.0004	.	.	.	.	.	1	2	0.0009
CAVI	1	0.1	0.0004	.	.	.	.	.	.	1	0.0004
INBU	1	0.1	0.0004	.	.	.	.	.	.	1	0.0004
LEOW	.	.	.	.	.	.	.	.	1	1	0.0004
MOWA	1	0.1	0.0004	.	.	.	.	.	.	1	0.0004
NAWA	1	0.1	0.0004	.	.	.	.	.	.	1	0.0004
OSFL	1	0.1	0.0004	.	.	.	.	.	.	1	0.0004
RBNU	1	0.1	0.0004	.	.	.	.	.	.	1	0.0004
TEWA	1	0.1	0.0004	.	.	.	.	.	.	1	0.0004
YHBL	.	.	.	.	.	.	.	.	1	1	0.0004
Total	**1977**	**100.0**	**0.8553**	**203**	**10.3**	**438**	**22.2**	**641**	**68**	**2686**	**1.1620**

* Species Code: see definition in Appendix 4
** No. of Newly Captured: for CLBMON 39 in 2015 (included first recaptures of birds banded in previous year)
*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 7: Age and sex of newly banded birds captured at Machete Island banding station in 2015

Species Code*	Age			Sex							Grand Total
				Female			Male			U	
	AHY	HY	U	AHY	HY	Total	AHY	HY	Total		
COYE	70	443	1	27	112	139	43	233	276	99	514
YRWA	10	170	.	2	55	57	7	72	79	44	180
AMRE	22	146	1	16	34	50	6	57	63	56	169
TRFL	16	144	1	1		1	.	.	.	160	161
OCWA	44	72	.	20	44	64	18	28	46	6	116
YWAR	12	72	.	10	31	41	2	22	24	19	84
WIWA	24	46	.	17	23	40	7	21	28	2	70
SOSP	10	49	.	2	.	2	.	.	.	57	59
LEFL	1	56	.	.	.	.	.	.	.	57	57
LISP	5	52	.	.	.	.	.	.	.	57	57
GRCA	13	40	.	.	.	.	.	.	.	53	53
SWTH	5	45	.	1	.	1	.	.	.	49	50
CEDW	23	16	.	14	.	14	5	.	5	20	39
REVI	14	25	.	1	.	1	.	.	.	38	39
MGWA	2	32	.	2	3	5	.	5	5	24	34
VEER	6	21	.	1	.	1	.	.	.	26	27
RCKI	8	17	1	5	8	13	3	9	12	1	26
WAVI	3	21	.	3	.	3	.	.	.	21	24
BCCH	3	19	1	1	.	1	.	.	.	22	23
SAVS	4	17	.	.	.	.	.	.	.	21	21
EAKI	7	11	.	1	1	2	.	.	.	16	18
WEWP	7	9	.	.	.	.	.	.	.	16	16
RWBL	9	4	.	7	2	9	2	2	4	.	13
NOWA	.	12	.	.	.	.	.	.	.	12	12
CCSP	3	7	.	.	.	.	.	.	.	10	10
WCSP	3	7	.	.	.	.	.	.	.	10	10
DEJU	.	8	.	.	2	2	.	2	2	4	8
HAFL	.	7	.	.	.	.	.	.	.	7	7
WTSP	.	7	.	.	.	.	.	.	.	7	7
DOWO	1	4	1	1	2	3	.	2	2	1	6
PISI	4	2	.	.	.	.	.	.	.	6	6
WETA	.	6	.	.	2	2	.	1	1	3	6
AMRO	.	5	.	.	.	.	.	.	.	5	5
EUST	1	4	.	.	.	.	1	.	1	4	5
LAZB	.	5	.	.	.	.	.		.	5	5
CHSP	.	4	.	.	.	.	.	.	.	4	4
DUFL	.	3	.	.	.	.	.	.	.	3	3
GCKI	.	3	.	.	2	2	.	1	1	.	3
HETH	.	3	.	.	.	.	.	.	.	3	3
PUFI	1	2	.	.	.	.	1	.	1	2	3
AMGO	2	.	.	1	.	1	1	.	1	.	2
BHCO	.	2	.	.	2	2	.	.	.	.	2
BHGR	.	2	.	.	1	1	.	1	1	.	2
FOSP	.	2	.	.	.	.	.	.	.	2	2
MAWA	.	2	.	.	.	.	.	.	.	2	2
PAWR	.	2	.	.	.	.	.	.	.	2	2
SSHA	.	2	.	.	1	1	.	1	1	.	2
TOWA	.	2	.	.	.	.	.	1	1	1	2
CAVI	1	.	.	.	.	.	.	.	.	1	1
INBU	1	.	.	1	.	1	.	.	.	.	1
MOWA	.	1	.	.	.	.	.	.	.	1	1
NAWA	.	1	.	.	.	.	.	.	.	1	1
OSFL	.	1	.	.	.	.	.	.	.	1	1
RBNU	.	1	.	.	1	1	.	.	.	.	1
TEWA	.	1	.	.	.	.	.	.	.	1	1
VATH	.	1	.	.	.	.	.	1	1	.	1
Total	335	1636	6	134	326	460	96	458	555	962	1977

* Species Code: see definition in Appendix 4

Appendix 8: Banding data summary from Airport Islands banding station, Revelstoke Reach, 2015

Species Code*	No. of Newly Captured**	%	Capture Rate***	No. of Same-Day Recap	% New	No. of Recap	Recap Rate (% New)	Total No. Recaptures	No. of Unbanded	Total No.	Total Capture Rate***
COYE	35	32.4	0.1237	4	11.4	1	2.9	5	.	40	0.1413
SAVS	19	17.6	0.0671	1	5.3	.	.	1	.	20	0.0707
YRWA	13	12.0	0.0459	1	7.7	.	.	1	.	14	0.0495
OCWA	11	10.2	0.0389	1	9.1	.	.	1	.	12	0.0424
YWAR	7	6.5	0.0247	3	42.9	.	.	3	.	10	0.0353
TRFL	5	4.6	0.0177	1	20.0	.	.	1	.	6	0.0212
LISP	4	3.7	0.0141	.	.	.	.	.	.	4	0.0141
WEME	2	1.9	0.0071	1	50.0	.	.	1	1	4	0.0141
CCSP	3	2.8	0.0106	.	.	.	.	.	.	3	0.0106
CEDW	2	1.9	0.0071	1	50.0	.	.	1	.	3	0.0106
WIWA	3	2.8	0.0106	.	.	.	.	.	.	3	0.0106
AMRE	1	0.9	0.0035	1	100.0	.	.	1	.	2	0.0071
LEFL	1	0.9	0.0035	.	.	.	.	.	1	2	0.0071
WISN	1	0.9	0.0035	.	.	1	100.0	1	.	2	0.0071
DEJU	.	.	.	.	.	.	.	.	1	1	0.0035
RCKI	1	0.9	0.0035	.	.	.	.	.	.	1	0.0035
SORA	.	.	.	.	.	.	.	.	1	1	0.0035
Total	**108**	**100.0**	**0.3816**	**14**	**13.0**	**2**	**1.9**	**16**	**4**	**128**	**0.4523**

* Species Code: see definition in Appendix 4
** No. of Newly Captured: for CLBMON 39 in 2015 (included first recaptures of birds banded in previous year)
*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 9: Banding data summary from Jordan River banding station, Revelstoke Reach, 2015

Species Code*	No. of Newly Captured**	%	Capture Rate***	No. of Same-Day Recap	% New	No. of Recap	Recap Rate (% New)	Total No. Recaptures	No. of Unbanded	Total No.	Total Capture Rate***
WAVI	52	22.8	0.1959	5	9.6	4	7.7	9	2	63	0.2373
SWTH	35	15.4	0.1318	.	.	.	.	.	.	35	0.1318
AMRE	16	7.0	0.0603	2	12.5	2	12.5	4	.	20	0.0753
BCCH	8	3.5	0.0301	2	25.0	8	100.0	10	2	20	0.0753
GCKI	15	6.6	0.0565	.	.	.	.	.	1	16	0.0603
WIWA	14	6.1	0.0527	1	7.1	.	.	1	.	15	0.0565
RCKI	13	5.7	0.0490	2	15.4	.	.	2	.	15	0.0565
MGWA	10	4.4	0.0377	.	.	.	.	.	.	10	0.0377
TRFL	7	3.1	0.0264	2	28.6	.	.	2	.	9	0.0339
DEJU	8	3.5	0.0301	.	.	.	.	.	.	8	0.0301
LISP	5	2.2	0.0188	1	20.0	.	.	1	.	6	0.0226
WCSP	4	1.8	0.0151	2	50.0	.	.	2	.	6	0.0226
YWAR	5	2.2	0.0188	1	20.0	.	.	1	.	6	0.0226
REVI	5	2.2	0.0188	.	.	.	.	.	.	5	0.0188
GRCA	3	1.3	0.0113	.	.	.	.	.	.	3	0.0113
OCWA	3	1.3	0.0113	.	.	.	.	.	.	3	0.0113
SOSP	3	1.3	0.0113	.	.	.	.	.	.	3	0.0113
VEER	3	1.3	0.0113	.	.	.	.	.	.	3	0.0113
CEDW	2	0.9	0.0075	.	.	.	.	.	.	2	0.0075
SSHA	1	0.4	0.0038	.	.	.	.	.	1	2	0.0075
YRWA	2	0.9	0.0075	.	.	.	.	.	.	2	0.0075
AMRO	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
BRCR	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
CAVI	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
CSWA	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
HAFL	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
HETH	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
LAZB	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
LEFL	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
MAWA	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
NAWA	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
NOFL	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
PAWR	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
WETA	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
WTSP	1	0.4	0.0038	.	.	.	.	.	.	1	0.0038
Total	**228**	100.0	**0.8588**	**18**	**7.9**	**14**	**6.1**	**32**	**6**	**266**	**1.0019**

* Species Code: see definition in Appendix 4
** No. of Newly Captured: for CLBMON 39 in 2015 (included first recaptures of birds banded in previous year)
*** Capture Rate/Total Capture Rate: in birds/net-hour

Appendix 10: **Capture rate at Machete Island banding station in relation to the maximum annual reservoir level. Only years with daily monitoring are shown (2008, 2009, 2010 and 2015). Average capture rate of newly banded birds is calculated for Aug-Sep migration period.**