Columbia River Project Water Use Plan

KINBASKET AND ARROW LAKES RESERVOIRS

Reference: CLBMON 36

Kinbasket and Arrow Lakes Reservoirs: Nest Mortality of Migratory Birds Due to Reservoir Operations

Study Period: Year 5, 2012

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Cover photo : A banded juvenile Yellow Warbler (*Dendroica petechia*) tagged with a radio transmitter at Revelstoke Reach, Arrow Lakes Reservoir. The radio transmitter's antenna is visible (photo by Harry van Oort)

EXCUTIVE SUMMARY

CLBMON 36 is a 10-year monitoring program designed to determine the effects of reservoir operations on the breeding success of birds nesting in the drawdown zone of Kinbasket and Arrow Lakes Reservoirs. The study has six objectives:

1) Determine the use of riparian habitats by breeding birds in the drawdown zone and identify important breeding habitats used by migratory birds in the drawdown zones in the Kinbasket Reservoir and Revelstoke Reach.

2) Determine the effects of reservoir operations on the nest mortality, nest and site productivity and juvenile survival of birds breeding in the drawdown zones of the Kinbasket Reservoir and Revelstoke Reach.

3) Determine the effects of reservoir operations on the quality and availability of nesting habitat at the nest and landscape levels in the drawdown zones of the Kinbasket Reservoir and Revelstoke Reach.

4) Inform and evaluate the effectiveness of physical works and revegetation efforts to enhance nesting success, nest and site productivity, or juvenile survival.

5) Assess the implementation of the soft constraints[1] and any incremental impacts resulting from the addition of unit 5 at Revelstoke Dam on nesting success, nest and site productivity, or juvenile survival.

6) Refine the habitat models developed previously for birds nesting in the drawdown zone of Revelstoke Reach (AXYS Environmental Consulting 2002).

Additionally, the results from this study can be used to assess the influence of dam expansion projects (two new turbines at Mica and one new turbine at Revelstoke Dam) on nest mortality.

Two approaches are currently being employed by CLBMON 36. “Nest mortality monitoring” involves finding nests of all birds nesting within 3 m of the ground in study site polygons throughout the breeding season. This approach is used to document the communities of birds nesting in the drawdown zone, the nesting parameters for each species (especially where and when they nest), and the extent to which reservoir operations cause nest mortality. “Focal species” monitoring within and above the drawdown zone involves detailed study of four species: Willow Flycatcher (*Empidonax traillii*), Cedar Waxwing (*Bombycilla cedrorum*), Yellow Warbler (*Dendroica petechia*) and

[1] The soft constraints defined for the Arrow Lakes Reservoir for wildlife are as follows:

- Ensure that inundation of nesting bird habitat by rising reservoir water levels in early summer is no worse than that which occurred on average over recent history (1984-1999). Match operating levels to inundation statistics for elevations 434 m (1424 ft) and above over the 1984-1999 period, which were used to produce the average historic performance measure score for spring/summer nesting short-eared owl habitat.
- Ensure that availability of migratory bird habitat in the fall is as good or better than that which has been provided on average over recent history (1984-1999). Draft the reservoir quickly after full pool is reached, targeting a reservoir level of 438 m (1437 ft) or lower by 7 August.

These goals were envisioned as guidelines to follow until better knowledge is available, and are not mandatory (hard) requirements of the water licence.

Savannah Sparrow (*Passerculus sandwichensis*). During this study, the nestlings of focal species have been banded to track recruitment rates. In 2012, the nestlings of Yellow Warblers and Savannah Sparrows were tagged for radio telemetry to determine how reservoir operations affect juvenile survivorship. Focal species productivity is also monitored. Detailed data analyses will be conducted after five and 10 years of data have been collected. This report summarizes the progress and results of Year 5 (2012) of the study. The 5-year analysis will be presented in a separate report.

Three study areas were monitored in 2012: Canoe Reach and Bush Arm in Kinbasket Reservoir, and Revelstoke Reach in Arrow Lakes Reservoir. Fieldwork at Bush Arm was terminated mid-season due to road closures. At both reservoirs, water levels were higher than average during most of the 2012 breeding season. In 2012, monitoring effort was focused on monitoring nest mortality in all habitat types to ensure that the relationships between habitat type and nesting communities/productivity can be assessed by the end of Year 5.

In 2012, 2,249 person-hours of survey effort were spent in the field conducting nest searches, monitoring nests and banding birds. Considerable variability in nest density and species diversity was observed among study areas and among habitat types within study areas. In total, 359 nests of 37 species were located and monitored until young fledged or the nests failed: 36 nests (10.0%) were found in Canoe Reach (9 species), 23 nests (6.4%) were found in Bush Arm (eight species) and 300 nests (83.6%) were found in Revelstoke Reach (35 species). Nest monitoring at Bush Arm could not be completed due to road washouts.

The outcome of 284 nests was determined. Nesting success was greatest at Canoe Reach (68%), followed by Revelstoke Reach (28%). The cause of failure could not be assessed for all nests, but reservoir operations were known to destroy 53 nests in 2012 (18.7%): four from Canoe Reach (three species) and 49 in Revelstoke Reach (13 species). Predation was the most common cause of nest failure at all study areas.

To assess the productivity and survival of the four focal species, we determined the outcome of 149 nests:

- Kinbasket Reservoir: three “Traill's“ (Willow or Alder) Flycatcher, 22 Savannah Sparrow and two Cedar Waxwing nests
- Revelstoke Reach: 29 “Traill's” (Willow or Alder) Flycatcher, 32 Cedar Waxwing, 49 Yellow Warbler and 12 Savannah Sparrow nests

Survival of juvenile of Savannah Sparrow and Yellow Warbler was studied using radio telemetry. We tagged and monitored eight unrelated juvenile Savannah Sparrows, all above the drawdown zone, because there were no successful nests within the drawdown zone; seven of these juveniles were monitored successfully. Only one survived the juvenile period. Four were killed by predators, which in some cases were determined to be garter snakes (*Thamnophis sirtalis*).

Ten juvenile Yellow Warblers were tagged and monitored in the drawdown zone. All 10 tagged nestlings were raised in flooded habitats; eight of these were monitored successfully, and two survived the juvenile period (25%). At least one appeared to have died as a result of drowning. This was a distinct possibility for five other warblers that were not recovered after their transmitters were located under water.

We further documented evidence of birds shifting breeding territories as water levels rose in Revelstoke Reach. As observed in previous years, some species appeared to move to the floating bog in Montana Bay mid-season, after water levels reached 439 m ASL. In

2012, we also tracked a colour-marked female Savannah Sparrow that moved to a new territory after her former territory was flooded.

Effectiveness monitoring of wildlife physical works projects was not conducted because these projects have not yet been constructed. One nest (Chipping Sparrow [*Spizella passerina*]) was found in 2012 in a cottonwood stake that was planted during the BC Hydro revegetation programs in 2009–2010.

We provide a detailed discussion of the analytical approaches that will be applied to the data to answer the management questions associated with CLBMON 36. Our results collected to date suggest that we will be able to answer all management questions by using the current study design over the course of the 10 year study. Several management questions will likely be adequately addressed during the first 5 year analysis (in progress).

KEYWORDS

reservoir operations, nest mortality, habitat distributions, habitat suitability, habitat selection, flooding, nest monitoring, nest survivorship, juvenile survivorship, Willow Flycatcher, *Empidonax traillii*, Cedar Waxwing, *Bombycilla cedrorum*, Yellow Warbler, *Dendroica petechia*, Savannah Sparrow, *Passerculus sandwichensis*, Arrow Lakes Reservoir, Kinbasket Reservoir, BC Hydro, British Columbia

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Field studies were completed by three CBA crews. Vicky Prigmore (crew leader), James Bradley and Laura Kennedy conducted field studies in Canoe Reach. Michal Pavlik (crew leader), Devon Anderson and Russell Cannings conducted field studies in Bush Arm. Jennifer Greenwood (crew leader), Corey Bird, Peter LeCouffe, Ryan Gill, Harry van Oort and Raven Douglas conducted field studies in Arrow Lakes Reservoir. Ryan Gill provided GIS mapping and analysis. Harry van Oort planned the 2012 field study program. Suzanne Beauchesne provided overall supervision and monitoring of crews, and assisted with field studies in Arrow Lakes Reservoir. John Cooper acted as Project Manager.

CBA worked closely with Simon Fraser University throughout this study. Dr. David Green of Simon Fraser University coordinated some of the Yellow Warbler research in 2012, which was conducted by Matthew Hepp and Kyle Tonneson. Dr. David Green provided scientific guidance to CBA.

Lesley-Anne Howes and Louise Laurin (Canadian Wildlife Service Bird Banding Office) processed bird banding and capture permits. All bird handling and telemetry protocols were approved by the Simon Fraser University Animal Care Committee, and under a Science Permit issued by Environment Canada (Permit no. BC-12-0010).

Tracey Hooper provided a technical edit of the draft report.

CBA would also like to thank the communities of Valemount and Revelstoke for providing safe and enjoyable home bases for field crews during the field season.

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1 INTRODUCTION

Riparian habitats are structurally complex with a diversity of vegetation species, and they support rich communities of breeding birds (Knopf and Samson 1994), but these habitats are relatively rare landscape features (Skagen et al. 2005). In western North America, riparian habitats comprise less than 1% of terrestrial landscapes (Knopf et al. 1988). In British Columbia, about one-half of forest-dwelling terrestrial vertebrate species depend on riparian habitats for breeding and other life history requirements (Bunnell et al. 1999).

The Columbia River Basin is one of the most modified river systems in North America, and much of the natural riparian habitat has been removed or highly modified (Nilsson et al. 2005). Water storage reservoirs along the primary course of the Columbia River in British Columbia include the Kinbasket Reservoir, Lake Revelstoke and the Arrow Lakes Reservoir, which are positioned sequentially along the river's course. Natural riparian habitat has been retained in only a few intervening sections. The footprints of these reservoirs have removed most valley bottom habitat, and their substantial drawdown zones are typically comprised of steep, barren shorelines (Bonar 1979, Utzig and Schmidt 2011). In the upper elevations of the drawdown zones, the growth of riparian and wetland vegetation is possible, but such habitats are uncommon (Enns et al. 2007, Hawkes et al. 2007).

Important breeding habitats for birds remain in Revelstoke Reach in Arrow Lakes Reservoir, and in Canoe Reach and Bush Arm in Kinbasket Reservoir (Boulanger et al. 2002, Jarvis 2003, 2006, Boulanger 2005, Green and Quinlan 2007, CBA 2009, 2010). Because breeding habitats are located in reservoir drawdown zones, the operation of the reservoirs may have significant impacts on the productivity of resident bird populations that use these sites (Jarvis 2003, 2006, CBA 2009, 2010). It is possible that some nesting habitats within the reservoir act as ecological traps (Schlaepfer et al. 2002, Robertson and Hutto 2006, 2007).

During the Columbia River Water Use Planning process (BC Hydro 2007), nest mortality caused by reservoir operations was identified as a critical issue. The primary concern was that the operations of Arrow Lakes and Kinbasket Reservoirs may reduce the productivity of breeding bird communities due to flooding of active nests, reducing habitat availability and reducing habitat quality. These concerns arose from earlier studies in Revelstoke Reach that documented a high diversity of birds using drawdown habitats during the breeding season (Boulanger et al. 2002, Boulanger 2005), and studies that documented nest mortality resulting from reservoir operations (Jarvis 2003, 2006). Furthermore, the discovery of a pair of Short-eared Owls (*Asio flammeus*) nesting within the drawdown zone in 2002 (Jarvis 2003) highlighted the potential for reservoir operations to have negative effects on breeding bird species that are protected under the federal *Species at Risk Act* (SARA). Under the direction of the Columbia River Water Use Plan, BC Hydro initiated CLBMON 36, a 10-year program designed to determine the effects of reservoir operations (water level management) on breeding success of birds nesting in the drawdown zone of Kinbasket and Arrow Lakes Reservoirs, and to provide feedback and guidance on the efficacy of methods used to enhance breeding habitats for birds in reservoir drawdown zones (revegetation and wildlife physical works).

1.1 Scope and Objectives

The general scope and objectives of CLBMON 36 were outlined by BC Hydro as follows[2]:

1) Determine the use of riparian habitats by breeding birds in the drawdown zone and identify important breeding habitats used by migratory birds in the drawdown zones in the Kinbasket Reservoir and Revelstoke Reach.

2) Determine the effects of reservoir operations on the nest mortality, nest and site productivity and juvenile survival on birds breeding in the drawdown zones of the Kinbasket Reservoir and Revelstoke Reach.

3) Determine the effects of reservoir operations on the quality and availability of nesting habitat at the nest and landscape levels in the drawdown zones of the Kinbasket Reservoir and Revelstoke Reach.

4) Inform and evaluate the effectiveness of physical works and revegetation efforts to enhance nesting success, nest and site productivity, or juvenile survival.

5) Assess the implementation of the soft constraints and any incremental impacts resulting from the addition of unit 5 at Revelstoke Dam on nesting success, nest and site productivity, or juvenile survival.

6) Refine the habitat models developed previously for birds nesting in the drawdown zone of Revelstoke Reach (AXYS 2002).

1.2 Manageme nt Questions

BC Hydro provided a series of management questions related to the objectives above. These management questions (or tasks, in some cases) are as follows[1]:

a) Which bird species breed in the drawdown zones of the Kinbasket and Arrow Lakes Reservoir and where do they occur?

b) What are the seasonal patterns of habitat use by birds nesting in the drawdown zone of the Kinbasket Reservoir and Revelstoke Reach?

c) Do reservoir operations directly affect nesting success (e.g. flooding of nests)?

d) What are the various factors (e.g. reservoir levels, predation, habit availability, etc) that influence nest mortality in the drawdown zone?

e) Do reservoir operations affect nesting success by altering nesting habitat quality (e.g. vegetation characteristics, habitat configuration) of nest sites or the availability of nesting habitat at the landscape level?

f) If reservoir operations negatively affect the nesting success, what is the significance of these impacts on regional bird populations?

g) Do reservoir operations affect juvenile survival and recruitment?

h) Can the operations of the Kinbasket and Arrow Reservoirs be optimized to improve nesting success, nest productivity, site productivity, or juvenile survival?

[2] Wording and numbering are reproduced verbatim from BC Hydro RFP 771.

i) Provide recommendations for physical works projects and revegetation efforts to increase nesting success, nest and site productivity and juvenile survival in the Kinbasket Reservoir and Revelstoke Reach.

j) Evaluate the effectiveness of revegetation efforts and physical works projects implemented during the course of this monitoring program for improving nesting success, nest and site productivity, or juvenile survival.

1.3 Manageme nt Hypotheses

To augment some of the management questions, BC Hydro provided a series of management hypotheses, which are listed below[3]:

H_1: The annual and seasonal variation of water levels in Revelstoke Reach and the Kinbasket Reservoir and the implementation of soft operational constraints and potential effects of unit 5 in Arrow Lakes Reservoir do not directly affect the nesting success of migratory breeding birds.

H_{1A}: Nest mortality is no greater in the drawdown zone than above the drawdown zone.

H_{1B}: Nest mortality in the drawdown zone is not caused directly by nest inundation.

H_2: The annual and seasonal variation of water levels in Revelstoke Reach and the Kinbasket Reservoir and the implementation of soft operational constraints and potential effects of unit 5 in Arrow Lakes Reservoir do not affect juvenile survival.

H_{2A}: Juvenile mortality is no greater in the drawdown zone than above the drawdown zone.

H_3: The annual and seasonal variation of water levels in Revelstoke Reach and the Kinbasket Reservoir and the implementation of soft operational constraints and potential effects of unit 5 in Arrow Lakes Reservoir do not affect nesting or recruitment habitat required by migratory breeding birds.

H_{3A}: Reservoir operations do not result in a reduction in the quality or availability of nesting or recruitment habitat at the site and landscape level.

H_{3B}: Nest mortality, site and nest productivity, and juvenile survival are not associated with changes in habitat conditions (e.g. structure, vegetation composition and extent of habitat) or reservoir operations in the drawdown zone.

H_4: Revegetation or physical works do not increase the utilization of habitats by nesting birds in the drawdown zone.

H_{4A}: Revegetation or physical works do not increase the species diversity or abundance of birds nesting in the drawdown.

H_{4B}: Revegetation or physical works are not effective at reducing nest mortality in the drawdown zone.

H_{4B}: Revegetation or physical works do not increase nest or site productivity in the drawdown zone.

H_{4C}: Revegetation or physical works do not increase the survival of juvenile birds in the drawdown zone.

[3] Wording and numbering are reproduced verbatim from BC Hydro, RFP 771.

H_{4E}: Revegetation or physical works do not increase the amount of bird habitat in the drawdown zone.

A table showing how the management objectives, questions and hypotheses are related is provided in Appendix 6-1.

1.4 Stud y Areas

Field studies were conducted in two BC Hydro reservoirs located in southeastern British Columbia: Kinbasket Reservoir (Canoe Reach and Bush Arm) and Arrow Lakes Reservoir (Revelstoke Reach) (Figure 1-1). Details on the study areas are provided in the revised monitoring protocol report (CBA 2012a), and are briefly described below.

1.4.1 Kinbasket Reservoir

Kinbasket Reservoir is the upper-most reservoir along the main branch of the Columbia River. Kinbasket Reservoir is a 216-km long hydroelectric reservoir operated by BC Hydro for power generation (1805 MW) and flood control. It extends from Donald, 39 km northwest of Golden, down the Columbia River and north up the Canoe River to 7 km south of Valemount. The reservoir is regulated by outflow from the Mica Dam (input is unregulated), and is licensed to operate between 707.41 m and 754.38 m for storage of up to 12 MAF (BC Hydro 2007). Additional storage may be attained (to an elevation of 754.68 m) with approval from the Comptroller of Water.

1.4.1.1 Canoe Reach Study Area

Canoe Reach is the northern arm of Kinbasket Reservoir, and is situated between the Monashee and Rocky Mountains (Figure 1-1). The study area is approximately 50 km long and extends from the northern end of the reservoir south as far as Hugh Allen Creek on the east shore and Windfall Creek on the west shore. The drawdown zone of this area is comprised largely of steep, unvegetated shorelines of sand, gravel and cobble, but includes vegetated habitats near seepage sites, which are characterized by grasses and sedges (Figure 1-2). Extensive remnant peat lands occur at the north end of Canoe Reach.

Canoe Reach occurs in the Interior Cedar–Hemlock moist mild (ICHmm) biogeoclimatic subzone (Meidinger and Pojar 1991), and receives moderate precipitation, primarily from Pacific frontal systems that shed snow during the winter. The reservoir is surrounded by steep slopes with managed coniferous forests.

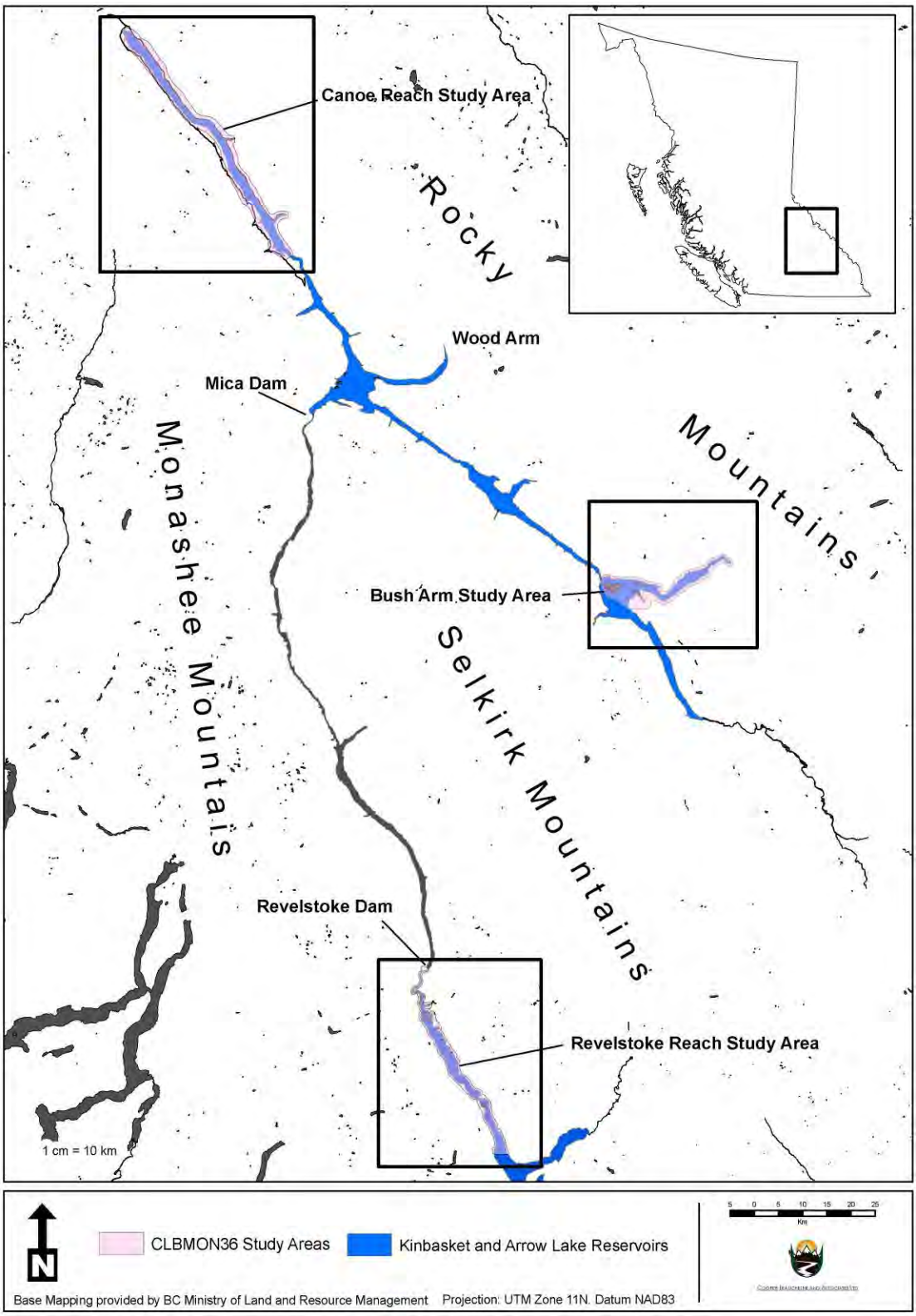

Figure 1-1: Overview map of the three study areas (lakes are shown in black)

Figure 1-2: Relatively well-vegetated drawdown habitat at Hugh Allen Bay, Canoe Reach

1.4.1.2 Bush Arm Study Area

Bush Arm is located at the southern end of the reservoir (Figure 1-1), and is formed where the Bush River flows west into the Columbia from the Rocky Mountains. The study area is about 24 km long and extends from Bear Island to the Bush River. Like most of Kinbasket Reservoir, the drawdown habitats are largely barren. The drawdown zone is rocky in places, but much of the area is comprised of unvegetated silt, and old tree stumps are a common feature (Figure 1-3). Sedge wetlands and some shrub habitat occur sporadically along the upper elevations of the drawdown zone, typically near upslope seepages or wetlands. Reed canarygrass (*Phalaris arundinacea*), common cattail (*Typha latifolia*) and willow (*Salix* spp.) are established at one location (BUSH-87). Some areas include small, rich, remnant wetland habitat (e.g., BUSH-26, BUSH-27) vegetated with willow and skunk cabbage (*Lysichiton americanus*).

Bush Arm occurs in the ICHmm (variant 1) biogeoclimatic subzone (Meidinger and Pojar 1991), and receives moderate precipitation, primarily from Pacific frontal systems that shed snow during the winter. As with Canoe Reach, the reservoir in Bush Arm is surrounded by steep slopes with managed coniferous forests.

Figure 1-3: Moderately vegetated drawdown habitat at Bush Arm

1.4.2 Arrow Lakes Reservoir

The Hugh Keenleyside Dam is located approximately 8 km north of Castlegar. The facility, completed in 1968, is capable of discharging 10,500 m^3/s (BC Hydro 2007), primarily through non-generating ports and spillways. Although the Hugh Keenleyside Dam was created primarily for flood control and water storage for downstream power generation in the U.S. (BC Hydro 2007), a 185-MW generating facility was added in 2002.

The completion of the Hugh Keenleyside Dam created the Arrow Lakes Reservoir, which extends approximately 240 km north to Revelstoke and has a licensed storage capacity of 7.1 MAF (BC Hydro 2007). The Arrow Lakes Reservoir is licensed to operate between 418.6 m and 440.1 m ASL. With approval from the Comptroller of Water Rights, the maximum allowable level is 440.75 m (BC Hydro 2007).

1.4.2.1 Revelstoke Reach Study Area

Revelstoke Reach forms the northernmost section of the Arrow Lakes Reservoir. From the Trans-Canada Highway, Revelstoke Reach extends south for about 42 km between the Monashee and Selkirk Mountain Ranges (Figure 1-1). The drawdown zone of the reservoir consists of the entire valley floor, and is comprised largely of grassy flats.

Habitats within the drawdown zone vary with topographic elevation. Grasses (e.g., *Phalaris arundinacea*), sedges (*Carex* spp.) and horsetails (*Equisetum* spp.) become well-established at 434 m; willow (*Salix* spp.*)* and cottonwood (*Poplar balsamifera*) become well-established at 438 m (Figure 1-4). Above 439 m, multi-storied mature cottonwood riparian forests have become established in some areas.

Revelstoke Reach occurs in the ICHmm (variants 2 and 3) biogeoclimatic subzone (Meidinger and Pojar 1991), and receives heavy precipitation, primarily from Pacific frontal systems that shed snow during the winter. The drawdown zone is surrounded by steep slopes with managed coniferous forests.

Figure 1-4: Shrubby drawdown habitat at Revelstoke Reach

1.5 Previous Work

A series of studies documented aspects of breeding birds in Arrow Lakes Reservoir (Revelstoke Reach) but not in Kinbasket Reservoir prior to the initiation of CLBMON 36 (Boulanger et al. 2002, Jarvis 2003, 2006, Boulanger 2005, Green and Quinlan 2007, 2008, Quinlan 2009). These studies played a role in the development of CLBMON 36. In particular, they demonstrated that a high diversity of birds occupy drawdown habitats during the breeding season (Boulanger et al. 2002, Boulanger 2005), and that there is potential[4] for nest flooding to occur (Jarvis 2003, 2006). Studies conducted by Simon Fraser University on Yellow Warbler productivity (Green and Quinlan 2007, 2008, Quinlan 2009, Rock 2011) have been integrated each year with work on CLBMON 36.

1.5.1 Year 1, 2008

CLBMON 36 was initiated in the spring of 2008 (Year 1), with nest monitoring studies being conducted at two study areas (Revelstoke Reach and Canoe Reach). The work included the study of three focal species: Willow Flycatcher (*Empidonax traillii*), Yellow Warbler (*Dendroica petechia*) and Savannah Sparrow (*Passerculus sandwichensis*) (CBA 2009).

In Year 1, the Arrow Lakes Reservoir filled rapidly, almost reached full pool (maximum water elevation reached was 439.96 m ASL), and remained relatively full into winter. All three focal species were observed at Revelstoke Reach, but Savannah Sparrows—which were chosen as a focal species because they are considered to be common in this area (Boulanger 2005)—were not observed to be nesting at the nest monitoring study sites surveyed in Year 1. Nest monitoring documented several cases of nest flooding among species that nest on the ground and in shrubs.

In Canoe Reach, the nesting community was less diverse than that documented in Revelstoke Reach. Savannah Sparrows were abundant, but no other focal species were present. Spotted Sandpiper (*Actitis macularius*) was one of the most abundant nesting species in this area. Nesting habitat was situated relatively high in the drawdown zone for all species observed, water levels did not reach those elevations until after the breeding season ended, and no nests were flooded. Nest predation rates were relatively low compared with those in Revelstoke Reach.

After Year 1, it was recommended that Cedar Waxwing (*Bombycilla cedrorum*), a shrub-nesting species, be added as a focal species because it was observed nesting in the Canoe Reach area, although only above the drawdown zone, and throughout shrub/tree habitats in Revelstoke Reach. It was postulated that this species may respond to revegetation efforts, which included attempts to increase the abundance of willow shrubs in the drawdown zone. For more information, refer to the Year 1 report (CBA 2009).

1.5.2 Year 2, 2009

In Year 2, Cedar Waxwing was included as a fourth focal species based on recommendations from Year 1.

[4] The results were not necessarily representative of all operations. The nest mortality pilot studies were conducted in years when the operations resulted in relatively high water elevations early in the year (439 m by July 3 in 2003 and by June 26 in 2006)—conditions where nest sites are more likely to be flooded during the breeding season.

In Canoe Reach, the same sites were monitored as in 2008, which produced similar results.

Operations in the Arrow Lakes Reservoir were moderate, with reservoir elevations never exceeding 437.6 m ASL; nest mortality due to reservoir operations were primarily observed among ground-nesting species, including a Red-listed species (American Avocet [*Recurvirostra americana*]). Many new nest study sites were added to improve coverage of grassland habitats, but Savannah Sparrows were still found to be uncommon.

Savannah Sparrows colonized one Revelstoke Reach study site (9 Mile) unusually late in the season, which suggested that this species may seek replacement breeding territories after being displaced by the reservoir from their initial low elevation territories. If breeding displacement does occur, it has direct relevance to management questions concerning the seasonal distribution of species among habitats (i.e., Management Question B). Recommendations for tracking Savannah Sparrows throughout the breeding season, beginning with sites that are settled early, were made in Year 2.

Reservoir operations impact breeding birds in two ways: by flooding nests/young, and by flooding habitats prior to nest initiation, thereby preventing nesting. A pilot analysis highlighted extreme variability in the potential for nesting and for nest flooding as a function of reservoir operations.

In Year 2, we indicated that monitoring juvenile survival is problematic using the approaches described for CLBMON 36 (mist netting); therefore, we recommended that radio-telemetry should be considered as an alternative. For more information, refer to the Year 2 report (CBA 2010).

1.5.3 Year 3, 2010

In Year 3, Bush Arm was introduced as a new study area in Kinbasket Reservoir, and a pilot study was conducted to locate and monitor nests. The data from 2010 suggested that drawdown habitats at Bush Arm supported a greater number of species than those at Canoe Reach.

In Year 3, we continued to monitor nest mortality and focal species productivity at the same Canoe Reach and Revelstoke Reach sites as in previous years (including some new sites at the latter area). We recorded the first documented case of reservoir flooding of nests at Kinbasket Reservoir. Nest mortalities due to reservoir operations were common at Revelstoke Reach, with both ground- and shrub-nesting species losing nests to flooding.

As in Year 2, Savannah Sparrows colonized the 9 Mile site relatively late in the season, after breeding territories had been established elsewhere in the study area, again suggesting that these birds might have been displaced from sites selected earlier in the season. Furthermore, we documented an increase in richness and abundance of nesting pairs of many species at the floating bog habitat in Montana Bay as reservoir elevations increased and other sites were flooded, which suggested that displacement also occurs among other bird species.

The previously identified need to use radio-telemetry for monitoring juvenile survival was corroborated in Year 3. That was the final year of the first contract for CLBMON 36. For more information, refer to the Year 3 report (CBA 2011).

1.5.4 New Terms of Reference and Goals for Years 4 and 5

Revised Terms of Reference were provided for a new contract to conduct CLBMON 36 in Years 4 and 5, and to complete the first multi-year (5-year) analysis of data. CBA's accepted proposal outlined an intention to use radio-telemetry to track juvenile songbirds.

1.5.5 Year 4, 2011

In Year 4, more effort was allocated in Bush Arm than in previous years, whereas monitoring efforts at Canoe Reach and Revelstoke Reach were slightly reduced. There was not enough time to organize a telemetry program in Year 4. A large focus of Year 4 monitoring was to ensure that nest mortality monitoring included a representative selection of habitat types. Habitat maps were available for Kinbasket Reservoir, but no appropriate habitat mapping was available for Revelstoke Reach. Site choice was based on professional judgement in Revelstoke Reach, and as a joint initiative between CLBMON 36 and CLBMON 40, we mapped drawdown habitats. This map was completed to a first draft stage in Year 4.

1.6 Scope of This Report

In Year 5, 2012, we followed a similar field program as that conducted in Year 4, and placed a high priority on nest mortality monitoring in habitats less well covered in previous years. We systematically selected monitoring sites in habitats where more monitoring was most needed. In Revelstoke Reach, we used the draft habitat map to select new nest mortality monitoring sites. Additionally, we conducted a pilot telemetry study on juvenile Savannah Sparrows and Yellow Warblers.

This report presents data collected in Year 5, 2012. It does not provide detailed analysis of the data: comprehensive analyses will be conducted in Years 5 and 10 of the study. The Year 1–5 analysis will be presented in a separate report.

2 METHODS

The methods used in 2012 followed those used in previous years. A detailed description of methods is provided in the revised monitoring protocol report for CLBMON 36 (CBA 2012a). A brief description of the data collection methods and relevant analytical methods is presented below to provide context for the reader.

2.1 Approaches and Site Selection

Two approaches were used to monitor bird populations: "nest mortality monitoring" and the "focal species approach".

2.1.1 Nest Mortality Monitoring

Nest mortality monitoring was used to study productivity and diversity of nesting communities, and to associate those data with habitat type. Effort was focused on monitoring multiple sites in all available habitat types.

Within the study sites, we attempted to find all nests of all bird species. Nests located within 3 m of the ground were monitored. Nests were considered to be successful if at least one young fledged. Failed nests were assessed for causes of failure, whenever possible. Nest mortality monitoring data will be used to determine how nesting

communities, their productivity and nest mortality rates vary with habitat type and reservoir operations.

Site selection for nest mortality monitoring followed a systematic sampling design. Annually, sites were systematically selected from each of the available habitat types (strata). Site accessibility and habitat patch size/configuration were considered during site selection, but we did not have or use prior knowledge of the site's suitability for nesting when delineating the sites (CBA 2012a). Sites were monitored for at least one breeding season.

Habitat stratification could not be based on standard ecological classification systems (e.g., Meidinger and Pojar 1991) because drawdown zone habitats are not equivalent to natural ecosystems (Baxter 1977), and habitat mapping usually identifies only one habitat type for drawdown zone habitats (water). In Kinbasket Reservoir, we stratified the drawdown habitats by the vegetation communities identified by CLBMON 10 (Hawkes et al. 2010). In Revelstoke Reach, we stratified the drawdown zone by vegetation communities identified by a habitat map developed by CBA (CBA 2012c). Habitat categories for both reservoirs are described in Appendix 6-2. All sites monitored in 2012 are described and mapped in Appendix 6-3, Appendix 6-4, Appendix 6-5 and Appendix 6-6.

2.1.2 Focal Species Approach

Nest mortality monitoring was complemented with focal species monitoring in order to gain a more complete understanding of the factors affecting populations. The focal species approach was used to evaluate productivity, juvenile survivorship and recruitment of four focal species: Savannah Sparrow, Cedar Waxwing, Yellow Warbler and Traill's Flycatcher. (For this study, we grouped Willow and Alder Flycatchers because the two species cannot always be separated in the field.) Focal species were banded as nestlings and adults, and were used for mark-recapture analysis. The bird banding component was conducted at Canoe Reach (Savannah Sparrows and Cedar Waxwings) and Revelstoke Reach (all focal species), but not at Bush Arm.

Prior to the initiation of CLBMON 36, Simon Fraser University had begun a long-term study on Yellow Warblers in Revelstoke Reach, and had established three nest monitoring sites in the most extensive patches of suitable habitat for that species (Green and Quinlan 2007). Those three sites continue to be monitored annually. Other permanent sites were chosen by CBA for monitoring the other focal species. Where possible, focal species were monitored at permanent sites above the drawdown zone to provide context.

2.1.3 Modified Monitoring Approaches

The nest mortality monitoring and focal species approaches had to be modified for the following research initiatives:

2.1.3.1 Physical Works Projects

Monitoring has been conducted repeatedly at permanent plots where Wildlife Physical Works (WPW) or Revegetation Physical Works (RPW) projects are planned or have been implemented (Golder Associates 2009, Keefer and Moody 2010). Aside from using permanent plots, physical works were monitored the same as the nest mortality plots.

2.1.3.2 Airport Marsh

We have monitored a site in the Airport Marsh (REV-15) annually because the marsh is an important wetland for breeding birds, and it exhibits considerable (unexplained) annual variability in water levels and bird populations.

2.1.3.3 Breeding Displacement

Evidence from Years 2–4 suggested that habitat selection in drawdown zones is dynamic due to breeding displacement caused by reservoir operations. To study this process, we adapted methods from both the focal species (mark-recapture of Savannah Sparrows) and nest mortality approaches by:

- identifying and monitoring early season nesting areas of Savannah Sparrows,
- attempting to capture and mark Savannah Sparrows at their early season nesting habitats to track their dispersal movements,
- monitoring the 9 Mile site where Savannah Sparrows are known to settle relatively late in the season, and
- continuing to monitor nesting at Montana Bay (REV-24)—a floating bog that appears to be used by displaced birds.

Nest mortality monitoring at Montana Bay was used to track how the breeding community (density and diversity) changes within season and among years in order to determine if usage of this site is related to annual variations in reservoir operations.

2.2 Field Procedures

2.2.1 Nest Searching

Sites were surveyed by walking slowly and systematically while looking for nests or signs of nesting activity. Birds exhibiting nesting behaviour (e.g., giving warning calls; carrying nest material, fecal sacs or food) were watched for clues of nest locations (Martin and Geupel 1993). In grassland habitats, rope dragging was used to flush birds from nests (CBA 2012a).

2.2.2 Nest Monitoring

Standard nest data were collected at all nests. Active nests were monitored every three or four days until young fledged or the nest failed. Evidence of nest outcome was documented for each nest. A nest was considered to be successful if it fledged one or more young. Nest failure was categorized as being caused by nest predators (Figure 2-1) or reservoir operations (Figure 2-2), or as failed for unknown reasons. Nest outcomes were designated as “unknown” if it was unclear whether the nest had been successful or had failed. Nests that had well-developed young late in the nestling phase were deemed to be successful if the last observation of the active nest was after the minimum number of days recorded for fledging by that species. Information about fledging periods was obtained from *The Birds of North America* species accounts (Poole 2010).

2.2.3 Focal Species Capture

Targeted mist netting with call-playback was undertaken in areas with focal species. In 2012, efforts to capture adults focused on Savannah Sparrows and Yellow Warblers. Mist nets were set up near territorial males, and an audio recording of the species’

territorial song was played to lure the focal species into the nets. Once captured, all focal species were banded with a metal Canadian Wildlife Service (CWS) leg band inscribed with a unique number. Additionally, unique combinations of coloured plastic leg bands were applied to individuals of three of the focal species (Savannah Sparrow, Cedar Waxwing and Yellow Warbler) to allow field biologists to identify and track individual birds. Nestlings of these species were also colour banded. Only metal CWS number bands were placed on Traill's Flycatchers due to restrictions imposed by Environment Canada, which were based on concerns about leg injuries (Sedgwick and Klus 1997).

In 2012, we attempted to capture all territorial male Savannah Sparrows in the drawdown zone of Revelstoke Reach early in the breeding season in order to document habitat selection and dispersal within the drawdown zone later in the season.

2.2.4 Juvenile Survivorship and Recruitment

In 2012, we continued to record observations of previously colour-banded individuals to determine if any banded juveniles return to the study area. In 2012, we also introduced a pilot telemetry study to assist in determining survivorship within the study area after juveniles had left the nest. In this report, we calculate the percentage of birds that survived the juvenile period (survivorship analyses and a full account of recruitment will be addressed in the multi-year analysis report).

2.2.5 Habitat Monitoring

2.2.5.1 Field Sampling

In 2012, high reservoir elevations prevented sufficient habitat sampling from being conducted around nest sites; therefore, effort was redirected towards revising the habitat map for Revelstoke Reach in preparation of the Year 5 analysis.

2.3 Data Summary and Analysis

Nest density was calculated for each nest monitoring plot by dividing the total number of nests found by the plot’s area. Nesting success rate was calculated as the number of successful nests divided by the total number of nests with known outcomes. Predation rates were calculated as the number of confirmed predated nests divided by the number of nests with a known outcome. Productivity (average reproductive output) was estimated as the average number of nestlings fledged per nest, including both successful and unsuccessful nests. Site productivity was calculated as the nest success rate multiplied by nest density for each site.

Daily rates of nest finding (calculated as the number of nests found per every person-hour spent at the site) were compared with the reservoir elevations over time. Spatial variability in nesting communities and productivity related to habitat was analyzed by associating nesting variables with the vegetation communities mapped by CLBMON 10, and on the Revelstoke Reach habitat map.

Figure 2-1: Examples of evidence of predation: a garter snake (*Thamnophis sirtalis*) consuming a Chipping Sparrow nestling (left); Common Yellowthroat eggs destroyed by a nest predator (right)

Figure 2-2: A Willow Flycatcher nest flooded by reservoir operations

Date of nest initiation was calculated as the date when the first egg was laid. This was estimated by combining observations of egg-laying and estimated nestling ages with published information on typical incubation periods (Poole 2010), and by making the following assumptions:

- one egg was laid per day,
- Brown-headed Cowbirds (*Molothrus ater*) removed one egg for every egg they laid in parasitized nests, and
- females began incubating on the day when the penultimate egg was laid.

Results are reported for all species from the pooled nest records.

All data manipulation, statistical computing and graphing was performed using R (R Development Core Team 2006). Graphs were produced using the ggplot2 package (Wickham 2009). Overplotting (where data overlap) in scatterplots was dealt with by setting the transparency of the points (the “alpha” setting). When “transparency = 1/2", two or more points overlapping are 100% opaque; when “transparency = 1/5”, five or more points are required to make a point 100% opaque. We also occasionally used the “jitter” function to wiggle points slightly if they were overplotted (Wickham 2009).

No statistical analyses are reported in this report because a multi-year (2008-2012) analysis will be conducted and reported in 2013.

3 RESULT S

3.1 Reservoir Operations in 2012

In the Kinbasket Reservoir, water elevation was ~ 724 m ASL in early May, which was near the lower historic quartile, but filled quickly over the course of the season to relatively high levels, and was near full pool elevation by mid-July (Figure 3-1). Throughout August, the elevation was near or above normal full pool elevations (754.38 m ASL), and the highest elevation was reached at the end of the month (754.67 m ASL on August 28—the last record obtained at the time of report writing).

Relatively high water elevations occurred in the Arrow Lakes Reservoir in 2012, more so as the spring advanced (Figure 3-1). By early July, the reservoir was above the normal full pool (440.10 m ASL). The maximum average daily elevation in 2012 occurred on July 7, at 440.52 m ASL. By late August the water elevation began to decrease rapidly.

3.2 Other Annual Conditions in 2012

Higher than average rainfall was recorded at Revelstoke airport in April and June, 2012 compared to the previous four years of monitoring (Figure 3-2). Similar weather occurred at the Kinbasket study areas. This caused many road washouts, which had an impact on our survey effort (see Section 3.3).

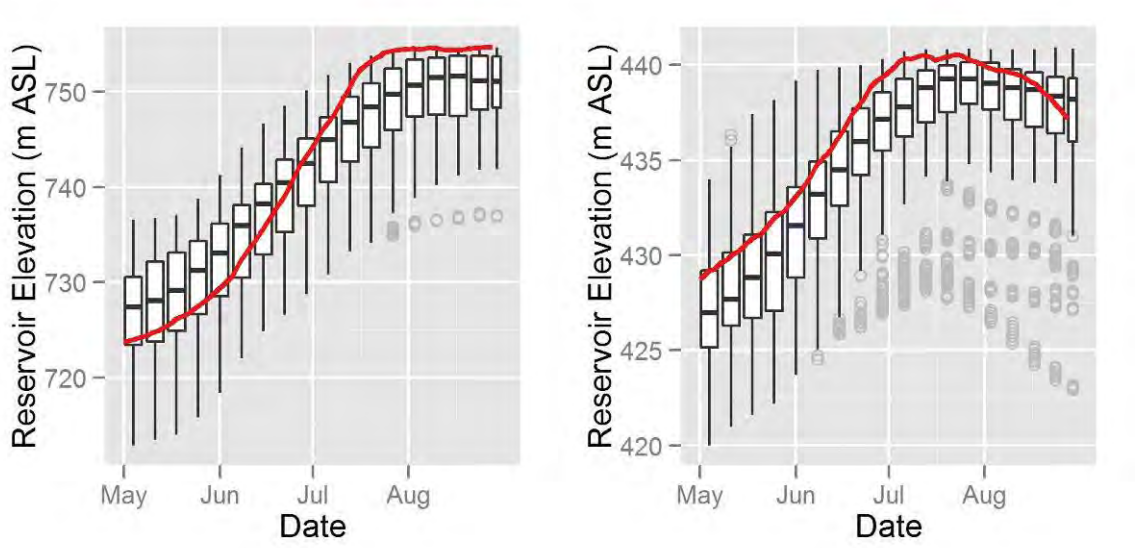

Figure 3-1: **Reservoir elevations at Kinbasket Reservoir (left) and Arrow Lakes Reservoir (right) plotted as weekly boxplots of historical data (1968 to present), with the 2012 elevations plotted in red**

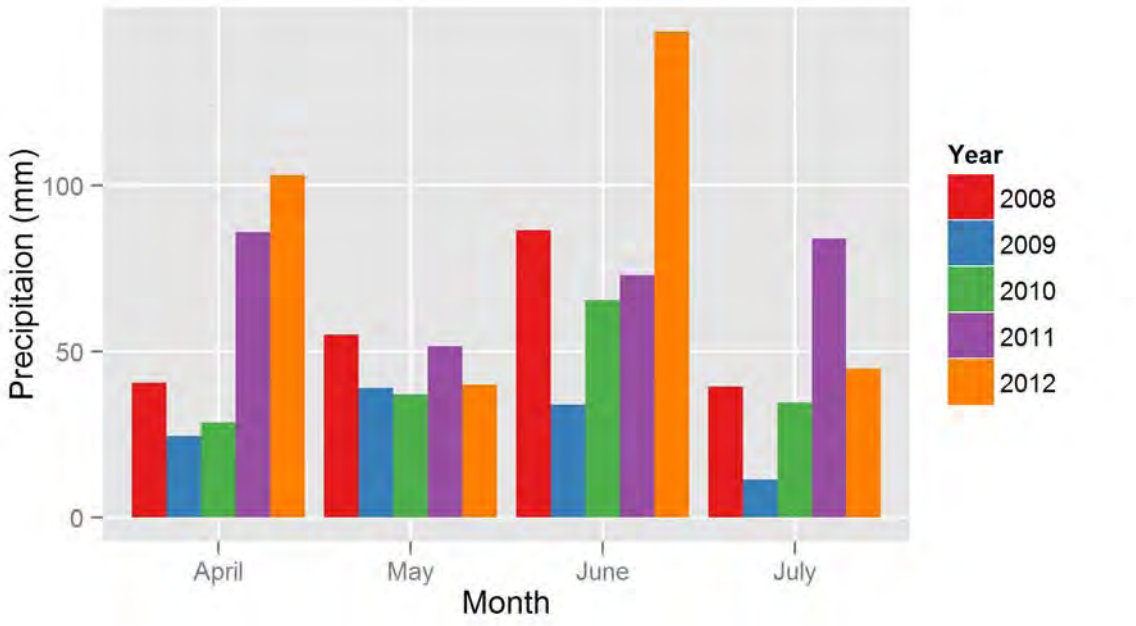

Figure 3-2: **Precipitation measured at the Revelstoke airport weather station over the course of five summers of CLBMON monitoring**

The high reservoir elevations in 2012 appeared to have had impacts to drawdown habitats in the Arrow Lakes Reservoir, partly through the disruption to wetlands, and partly through increased erosion.

During the full pool period, parts of the Airport Marsh appeared to be disrupted, particularly the mats of common cattail (*Typha latifolia*) that float on the surface of the marsh. Some of these mats had flipped upside down; some sections of other mats had broken loose and floated away. One piece floated away as far as 9 Mile. Also, large sections of the floating bog at Montana Bay, complete with shrubs, had calved off, floated away and became marooned on shore elsewhere. Sections of sedge that likely came loose from Montana Bay or Airport Marsh were deposited on the shoreline at 12 Mile. As such, high water levels were seemingly detrimental to the wetlands in Revelstoke Reach, and limited the availability of these habitats for nesting birds.

The high water levels likely introduced wave action, which caused considerable erosion of habitats that are normally protected. For example, numerous trees fell over as the banks collapsed (Figure 3-3). This was commonly seen along all shorelines in Revelstoke Reach following the full pool period in 2012.

Figure 3-3: Increased shoreline erosion was an obvious consequence of the high water levels in the Arrow Lakes Reservoir in 2012. Drawdown wetlands were also impacted. The photo was taken in September, 2012

3.3 Survey Effort

In all three study areas, crew schedules were coordinated so that surveys were conducted almost daily, but this was not always possible in Bush Arm due to its remote setting.

In Canoe Reach, field sampling was conducted from May 16 to July 28, 2012. During this period, we monitored 33 nest mortality monitoring sites.

In Bush Arm, field sampling was conducted from May 25 to July 18, 2012. We set out to monitor 22 nest mortality study sites, but the field season was shortened prematurely due to road washouts (Figure 3-4) which then precluded access. Site productivity cannot be calculated unless monitoring spans the entire season. Four nest mortality sites were monitored sufficiently enough to report site productivity data simply because there were no birds; repeated surveys at these sites had shown conclusively that no birds were attempting to breed on site. We report data on the nests we found in Bush Arm, but we do not include data from the incompletely monitored sites when reporting productivity data.

In Revelstoke Reach, field sampling was conducted from May 8 to August 30, 2012. During this period, 38 nest mortality study sites were monitored. We also monitored five sites with focal species.

In 2012, we recorded 2,249 person-hours of field effort, 70% of which was spent searching for nests, and 17% was spent monitoring nests. The remaining 13% was spent conducting mist netting, habitat sampling and other sampling activities (Table 3-1).

Figure 3-4: **Example of a road washout in June (Prattle/Chatter Creek area), photographed as the road was eroding. This extended rain event caused many washouts in B.C. and a premature ending to nest monitoring in that study area in Bush Arm in 2012 (photo Jen Greenwood).**

Table 3-1: **Approximate nest monitoring field survey effort (number of hours) summarized by study area and activity, 2012**

Monitoring Task	Bush Arm	Canoe Reach	Revelstoke Reach	Total
Person-hours	137.00	401.00	1,711.25	2,249.25
Searching for nests	127.58	335.38	1,116.55	1,579.50
Monitoring nests	8.55	60.08	313.73	382.35
Mist netting	0.00	0.00	186.28	186.28
Field habitat sampling	0.00	0.00	10.70	10.70
Other	0.88	5.55	84.00	90.43

3.4 Nest Mortality Monitoring

In 2012, 359 nests from 37 species were located and monitored until young fledged or the nest failed (Table 3-2). Nest locations are mapped in Appendix 6-4, Appendix 6-5 and Appendix 6-6. Revelstoke Reach supported higher species richness and density of breeding birds than either of the Kinbasket Reservoir study areas (Table 3-2). In 2012, we recorded one nest in a cottonwood stake that was planted as part of the CLBMWORKS 2 revegetation efforts (Revelstoke Reach). This nest was built by a Chipping Sparrow (Figure 3-5), but was unsuccessful as a result of nest predation.

Figure 3-5: Chipping Sparrow nest in a cottonwood stake planted by CLBWORKS 2, Revelstoke Reach, 2012

3.4.1 Kinbasket Reservoir Nest Records

3.4.1.1 Breeding Bird Community in Canoe Reach

In Canoe Reach, 36 nests from nine species were found, which accounted for 10% of the total nest records (Table 3-2). Thirty-four of these nests (eight species) were located in the drawdown zone; two nests were found above the drawdown zone (Vesper Sparrow and Savannah Sparrow). The most abundant species found nesting in the drawdown zone was Savannah Sparrow (*n* = 20), followed by Traill's Flycatcher (*n* = 3) and Spotted Sandpiper (*n* = 3). All species found nesting at Canoe Reach had been recorded previously in Years 1–4.

Table 3-2: Bird species and number of nests found in Canoe Reach and Bush Arm (Kinbasket Reservoir), and in Revelstoke Reach (Arrow Lakes Reservoir) in 2012

		Above Drawdown Zone			Within Drawdown Zone			
Common Name	Scientific Name	Bush Arm	Canoe Reach	Revelstoke Reach	Bush Arm	Canoe Reach	Revelstoke Reach	Total
Pied-billed Grebe	*Podilymbus podiceps*						6	6
Canada Goose	*Branta canadensis*				1		1	2
American Wigeon	*Anas americana*						5	5
Mallard	*Anas platyrhynchos*						8	8
Cinnamon Teal	*Anas cyanoptera*						2	2
Unidentified Teal	*Anas* spp.						1	1
Green-winged Teal	*Anas crecca*						1	1
Bald Eagle	*Haliaeetus leucocephalus*	1						1
Virginia Rail	*Rallus limicola*						3	3
Sora	*Porzana carolina*						6	6
Killdeer	*Charadrius vociferus*				6	2	3	11
Spotted Sandpiper	*Actitis macularius*				3	3		6
Wilson's Snipe	*Gallinago delicata*				1		5	6
Common Nighthawk	*Chordeiles minor*			1				1
Northern Flicker	*Colaptes auratus*						1	1
Traill's Flycatcher	*Empidonax alnorum/traillii*					3	31	34
Least Flycatcher	*Empidonax minimus*						1	1
Dusky Flycatcher	*Empidonax oberholseri*			1			1	2
Unidentified Flycatcher	*Tyrannidae* spp.						2	2
Warbling Vireo	*Vireo gilvus*						1	1
Red-eyed Vireo	*Vireo olivaceus*						1	1
Marsh Wren	*Cistothorus palustris*						5	5
Mountain Bluebird	*Sialia currucoides*				2			2
Veery	*Catharus fuscescens*						2	2
American Robin	*Turdus migratorius*			1			1	2
Gray Catbird	*Dumetella carolinensis*						9	9
Cedar Waxwing	*Bombycilla cedrorum*					2	40	42
Yellow Warbler	*Dendroica petechia*						52	52
American Redstart	*Setophaga ruticilla*						3	3
MacGillivray's Warbler	*Oporornis tolmiei*						1	1

Continued.....		Above Drawdown Zone			Within Drawdown Zone			
Common Name	Scientific Name	Bush Arm	Canoe Reach	Revelstoke Reach	Bush Arm	Canoe Reach	Revelstoke Reach	Total
Common Yellowthroat	*Geothlypis trichas*					1	18	19
Chipping Sparrow	*Spizella passerina*					1	3	4
Vesper Sparrow	*Pooecetes gramineus*		1					1
Savannah Sparrow	*Passerculus sandwichensis*		1	14	8	20	1	44
Song Sparrow	*Melospiza melodia*						24	24
Lincoln's Sparrow	*Melospiza lincolnii*				1	2		3
Lazuli Bunting	*Passerina amoena*			2				2
Red-winged Blackbird	*Agelaius phoeniceus*			1			23	24
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*						14	14
Unidentified Bird							5	5
Total		1	2	20	22	34	280	359

3.4.1.2 Breeding Bird Community in Bush Arm

At Bush Arm, 23 nests from eight species were located, which accounted for 6.4% of the total nest records (Table 3-2). Seven species were found nesting in the drawdown zone (22 nests). Savannah Sparrow nests were the most numerous (*n* = 8), followed by those of Killdeer (*n* = 6). Only one nest was found above the drawdown zone (Bald Eagle).

3.4.1.3 Distribution of Nests by Elevation and Site at Kinbasket Reservoir

In Canoe Reach, nests were located between 744.8 m and 756.9 m ASL, but most nests were found at high elevations in the drawdown zone (between 751 m and 755 m ASL). (Figure 3-6). In Bush Arm, nests were located a little lower in the drawdown zone. Nests were found between 739.3 m and 757 m ASL, but most nests were concentrated between 747 m and 753 m ASL (Figure 3-6).

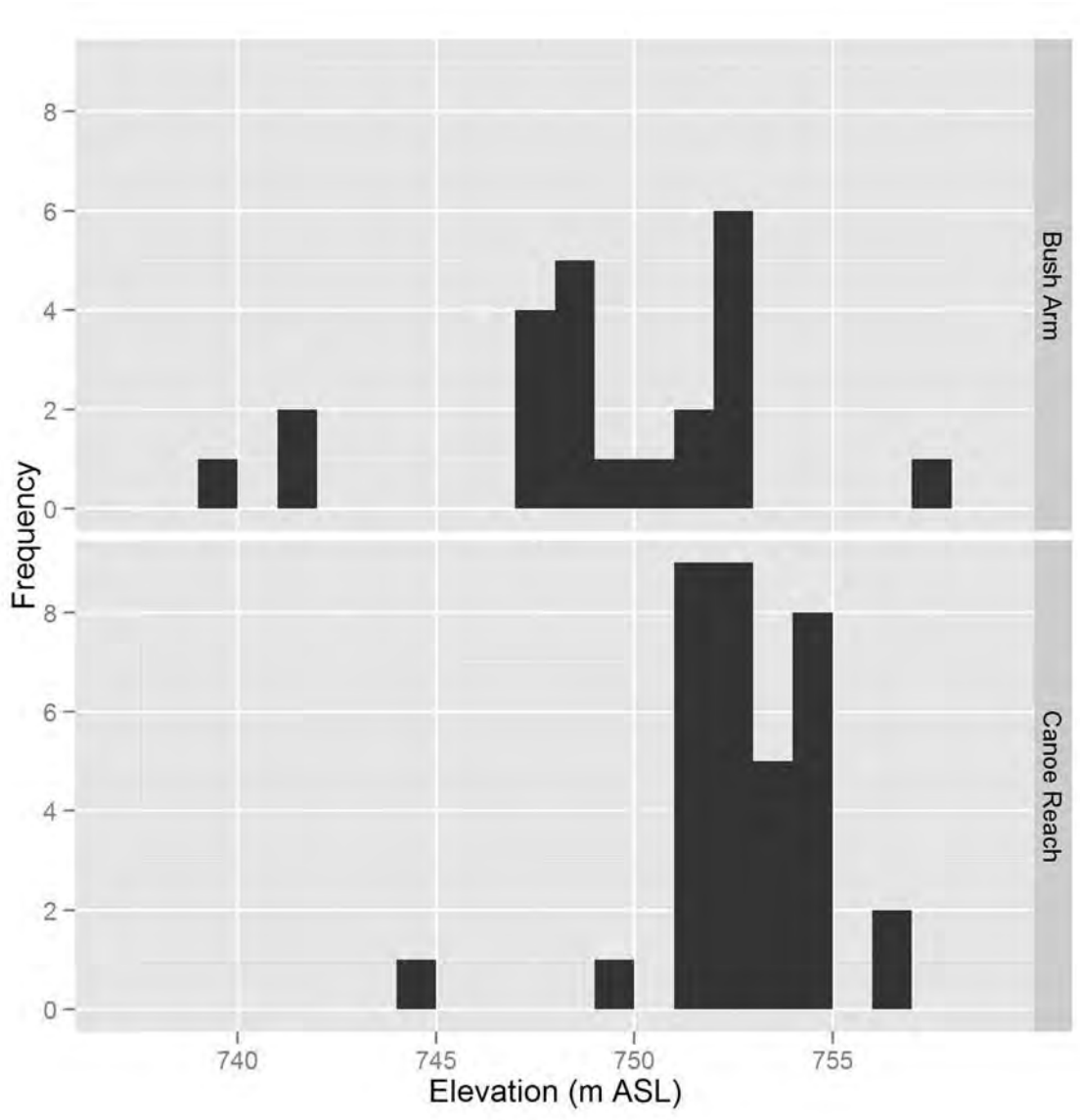

Figure 3-6: Nest site elevations at Bush Arm and Canoe Reach in Kinbasket Reservoir, 2012

3.4.1.4 Distribution of Nests among Nest Mortality Study Sites in Kinbasket Reservoir

In Kinbasket Reservoir, nest density averaged 0.25 nests/ha and ranged up to 4.57 nests/ha. Maximum density was recorded at KIN-90 in Canoe Reach, where nest density was much greater than at all other sites in Kinbasket Reservoir (Figure 3-7).

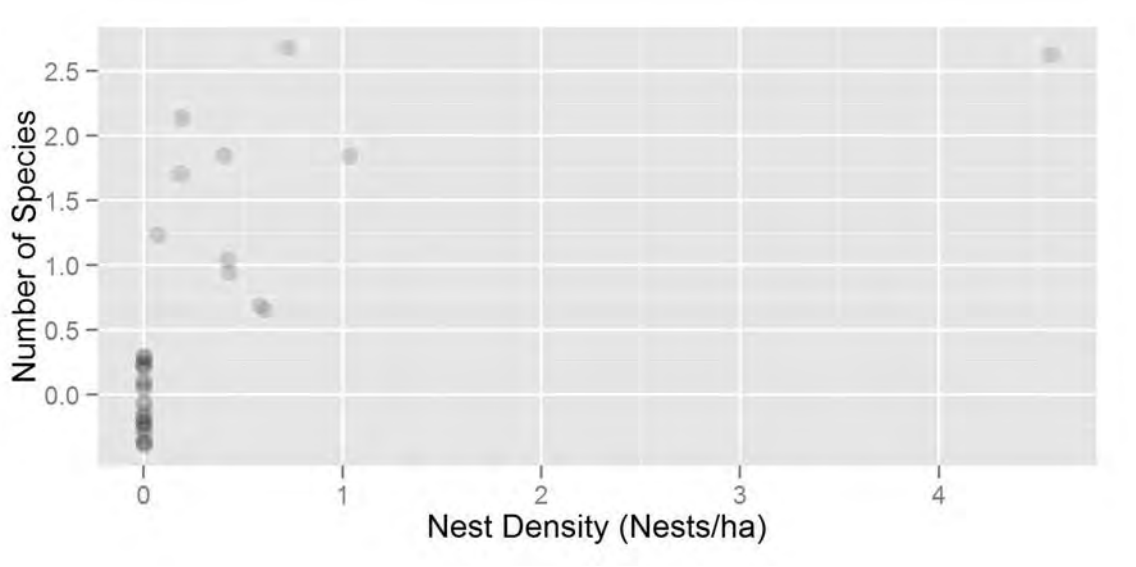

Figure 3-7: Nest density and number of species recorded among nest mortality study sites in Kinbasket Reservoir (points are jittered in the Y axis; transparency = 1/8)

3.4.1.5 Distribution of Nests among Habitat Types in Kinbasket Reservoir

Fifteen vegetation community types (Hawkes et al 2010) were mapped within the study sites monitored in Kinbasket Reservoir in 2012. Nest densities in different habitats ranged from 0.0 to 0.71 nests/ha. The greatest nest densities were found in the Willow Sedge (WS) vegetation community, followed by Driftwood (DR; Figure 3-8).

The number of nesting species was greatest in Driftwood (DR; three species), followed by three habitats with two species found in each: Clover-Oxeye Daisy (CO), Kellogg's Sedge (KS) and Swamp Horsetail (SH; Figure 3-8).

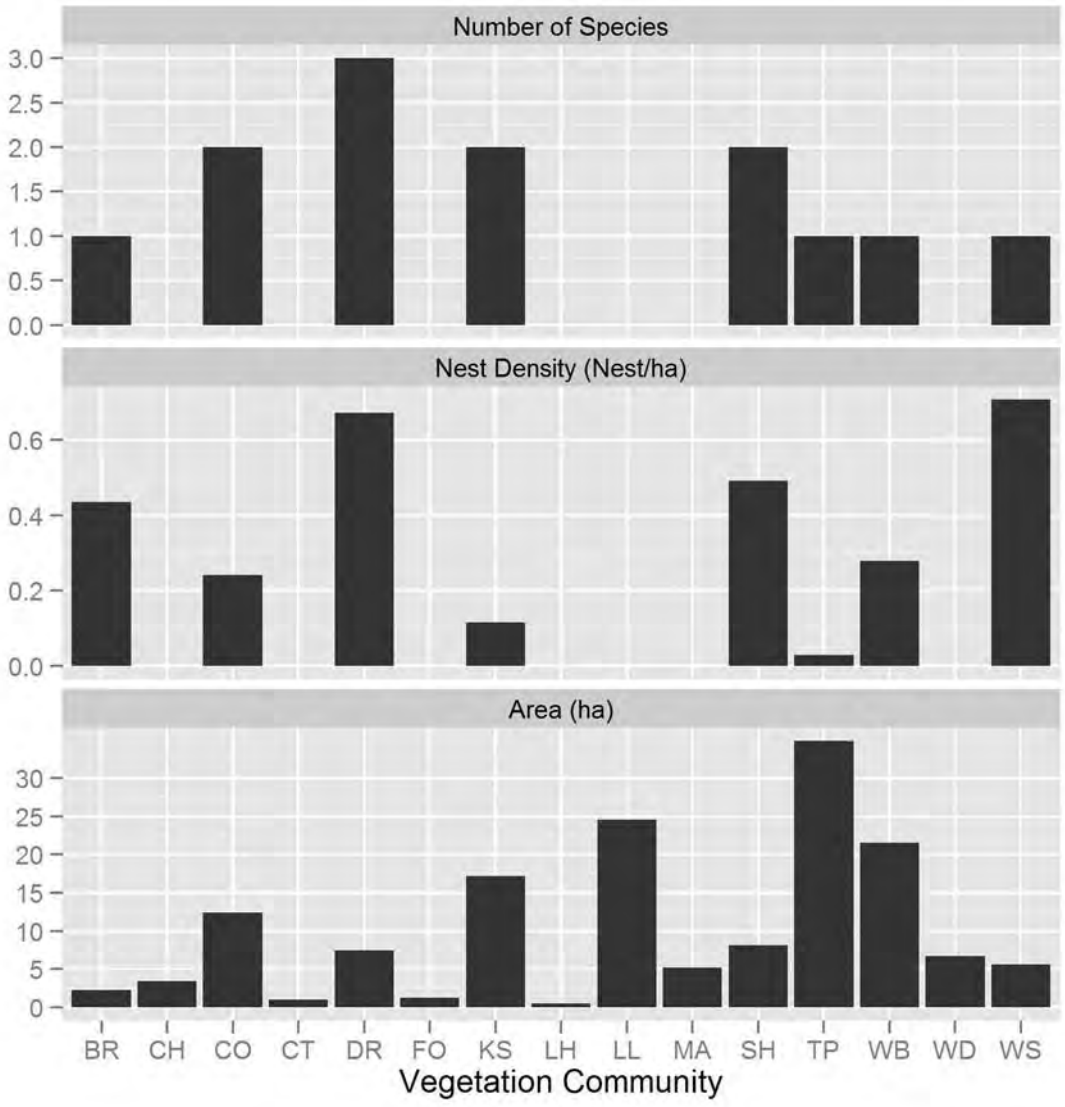

Figure 3-8: **Vegetation community types and total number of species found nesting (top), nest density (middle) and total area of habitat monitored (bottom) in Kinbasket Reservoir, 2012**

3.4.1.6 Nest Site Substrates in Kinbasket Reservoir

Substrates for 52 nests in Kinbasket Reservoir were recorded in 2012. Among the shrub-nesting species, most nests were found in alders (two species, four nests [8%]); however, 42 nests (81%) were located on the ground, primarily within sedge or grass tussocks (Appendix 6-7).

3.4.1.7 Species at Risk in Kinbasket Reservoir

No species at risk were found breeding in the Kinbasket Reservoir in 2012. Barn Swallows (*Hirundo rustica*) were observed flying over the drawdown zone in both Kinbasket study areas, but no nests were located on monitoring plots.

3.4.2 Revelstoke Reach Nest Records

3.4.2.1 Breeding Bird Community in Revelstoke Reach

With 300 nests from 35 species, Revelstoke Reach accounted for most nests (84%) found in 2012. Cinnamon Teal was the only species that was found breeding for the first time in 2012. In the drawdown zone, 280 nests from 33 species were found; 20 nests from six species were found above the drawdown zone.

Results from nest mortality sites indicated that the most abundant nests in the drawdown zone were those of Cedar Waxwing (*n* = 33), followed by Traill's Flycatcher (*n* = 22) and Song Sparrow (*n* = 22).

3.4.2.2 Distribution of Nests by Elevation and Site at Revelstoke Reach

In 2012, nest site elevations in the Revelstoke Reach drawdown zone ranged from 433.9 m to 440.4 m ASL (Figure 3-9). An unusually large number of nests were located at approximately 436 m, which was due almost entirely to nests found on the naturally floating bog habitat at Montana Bay (Figure 3-9). The number of species nesting in the monitoring sites in Revelstoke Reach ranged from 0 to 11 and increased with nest density (Figure 3-10).

3.4.2.3 Distribution of Nests among Habitat Types in Revelstoke Reach

In Revelstoke Reach, 23 vegetation community types were mapped within the nest mortality study sites monitored in 2012. Nest densities in different habitats ranged from 0.0 to 19.6 nests/ha. The greatest nest density was found in Floating Bog (BF) habitat, followed by Cattail habitat (CT; 12.6 nests/ha) and Shrub Wetland Complex (CW; 9.4 nests/ha) (Figure 3-11). The greatest number of species nested in the Shrub Savannah habitat (SH; 12 species), followed by the Floating Bog (BF; 11 species) and Shrub Wetland Complex (CW; 10 species) (Figure 3-11).

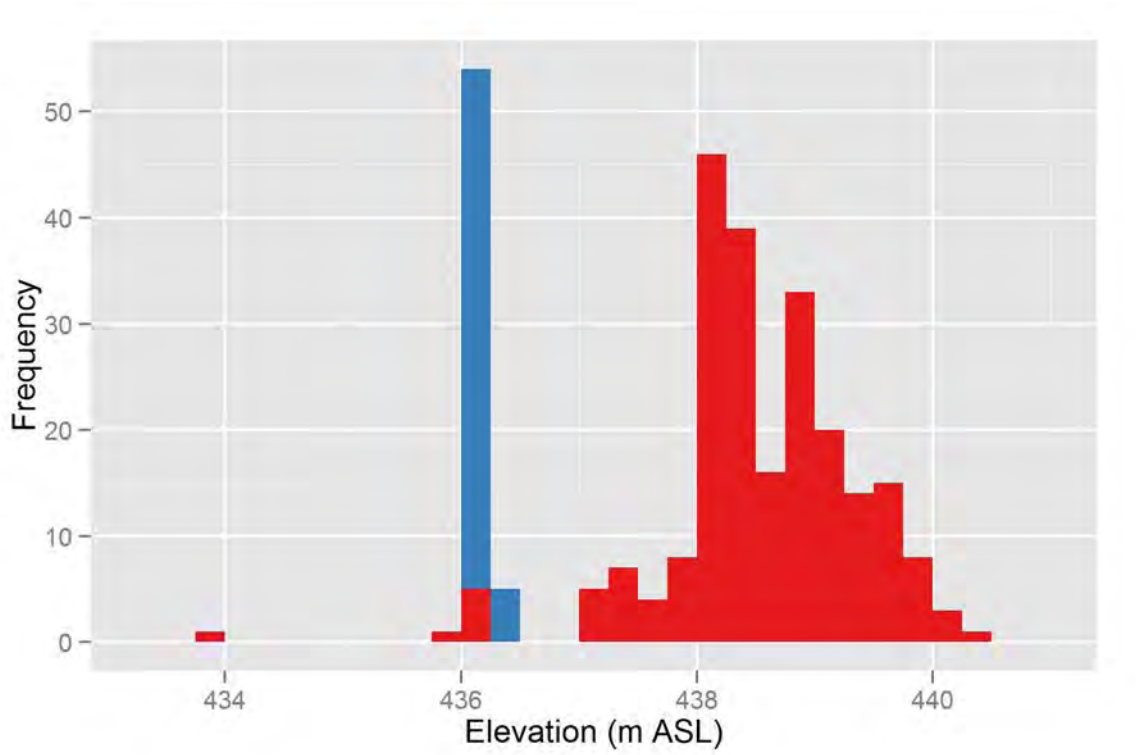

Figure 3-9: **Nest site elevations in or near the drawdown zone of Revelstoke Reach (blue = Montana Bay [REV-24] nests; red = nests from all other sites)**

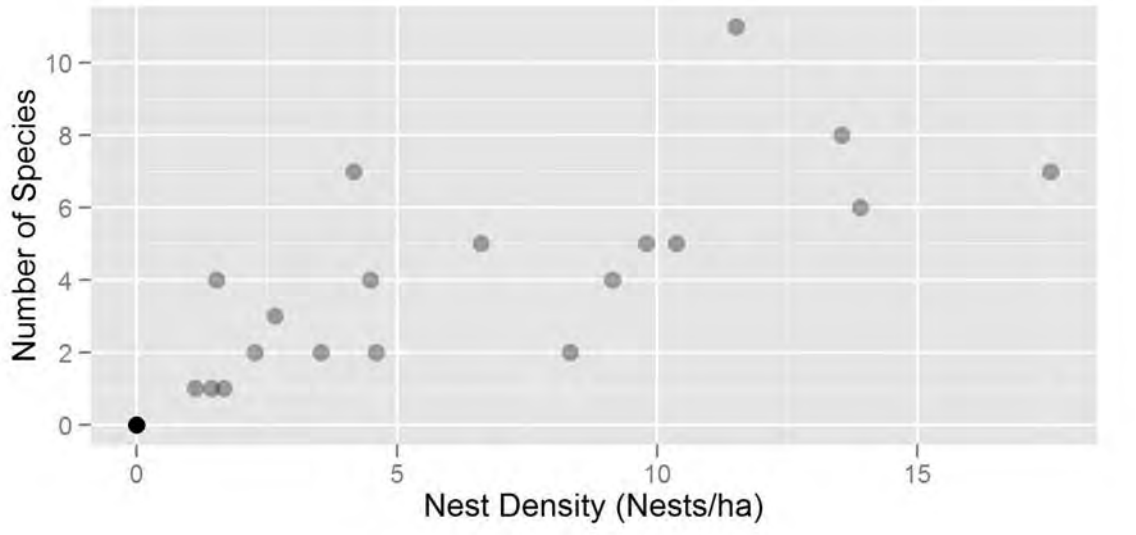

Figure 3-10: **Nest density and number of species among nest mortality study sites in Revelstoke Reach, 2012 (transparency = 1/3)**

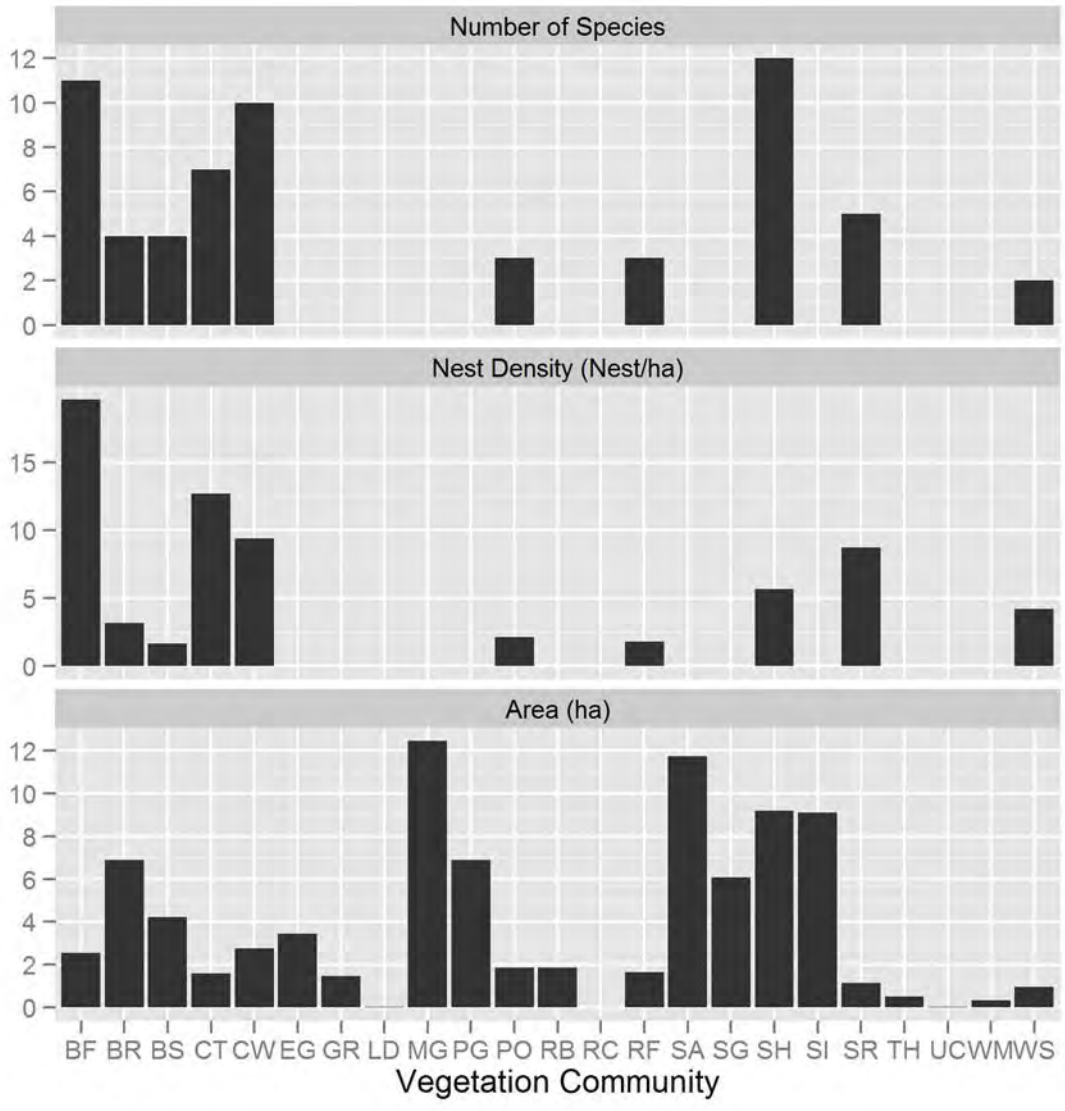

Figure 3-11: **Vegetation community types and total number of species found nesting (top), nest density (middle) and total area (ha) of habitat monitored (bottom) for all mapped parts of the nest mortality study sites monitored in 2012 in Revelstoke Reach**

3.4.2.4 Nest Site Substrates in Revelstoke Reach

Substrates for 267 nests were recorded in the Revelstoke Reach study area in 2012 (Appendix 6-7). Willows were used extensively for nesting (11 species; 38% of nests; *n* = 102). Nests located directly on the ground accounted for 18% of all nests found (*n* = 48); nests located in emergent vegetation (bulrush or cattail) accounted for 21% (*n* = 55).

3.4.2.5 Species at Risk in Revelstoke Reach

Common Nighthawks (*Chordeiles minor*) and Barn Swallows were occasionally seen flying overhead in the Revelstoke area in 2012 but were not observed landing or nesting in the drawdown zone. One Common Nighthawk nest was located above the drawdown zone.

3.4.3 Breeding Displacement

To date, breeding displacement caused by reservoirs has not been recorded at Kinbasket Reservoir, but it has been documented at Revelstoke Reach.

3.4.3.1 Tracking Savannah Sparrows in Revelstoke Reach

There were very few Savannah Sparrows to monitor in 2012. Between May 28 and July 25, 2012, we captured nine adult Savannah Sparrows in mist nets in the Revelstoke Reach drawdown zone. Eight of these were captured before June 8, when the reservoir flooded the grasslands. One of the birds was a recapture of a bird banded in a previous year. In addition, we re-sighted one colour-banded bird that had been banded in a previous year. Therefore, in total, there were 10 known banded sparrows in the drawdown zone in 2012. They were found in the following areas:

Two banded males were found just south of 9 Mile (REV-43). One was mated to a banded female, but the other did not appear to have a mate.

One banded male was found along the old rail bed south of Cartier Bay.

Three males were found at Montana Bay: two males were in the floating bog habitat (at least one of these was paired and bred with a banded female), and a banded pair was further out by the rail bed.

South of Machete Island (at REV-47 and REV-48), we were aware of three males of unknown breeding status, but the Savannah Sparrows were challenging to track because there were very few of them and they travelled over long distances, could not regularly be found at the same sites and were singing very little. They did not appear to be well established. Two of these males were banded; there was at least one more male but we were unable to confirm if he was banded.

Finally, there was a banded male north of Machete Island, near the Osprey nest platform south of the Illecillewaet River.

At 9 Mile (REV-1), a single pair attempted to establish a breeding territory after the reservoir flooded the lower grasslands. There had been no sparrows at the site up to and including June 18. On June 21 the pair was spotted, but the site was already mostly flooded. The female was banded and had moved about 0.9 km from the south where she had originally been banded (REV-43). At this time, she appeared to be paired with an un-banded male. A pair of Savannah Sparrows was observed from a distance flying among the remaining non-flooded land just north of the site on June 26, prior to complete inundation of the area.

3.4.3.2 Nesting at Montana Bay, Revelstoke Reach

The discovery of new nests did not peak rapidly as the reservoir inundated the drawdown zone, but there was a sustained high rate of nest finding at this site over the field season (Figure 3-12). Four species that typically nest early were discovered nesting mid-season:

Sora, Wilson's Snipe, American Wigeon and Mallard (Appendix 6-8). They may have moved to the site after they experienced nest failures in habitats that flooded earlier.

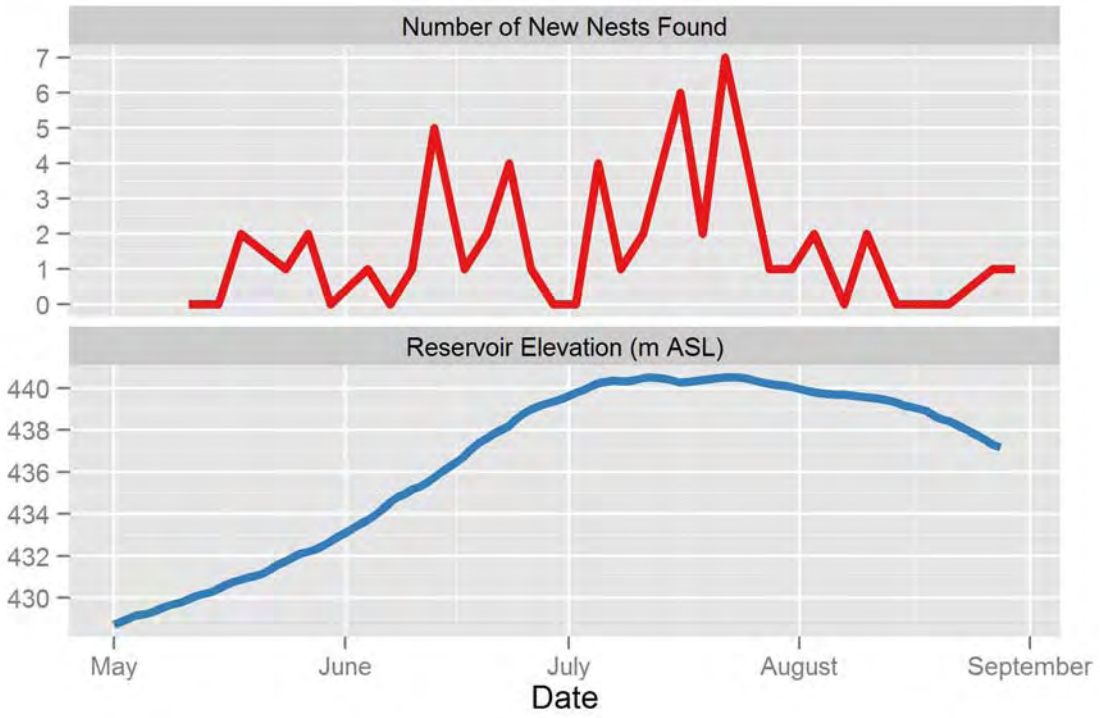

Figure 3-12: Reservoir elevations and the number of new nests found during surveys at Montana Bay (REV-24) in 2012

3.4.4 Nesting Phenology

The date when the first egg was laid was calculated for 196 nests monitored in 2012 (Figure 3-13). The 2012 data showed a large variability in nest initiation among and within species. Some of the earlier nesting species included Killdeer, Song Sparrow and Red-winged Blackbird. Other species, like Cedar Waxwing and Willow Flycatcher, did not begin nesting until late in the season.

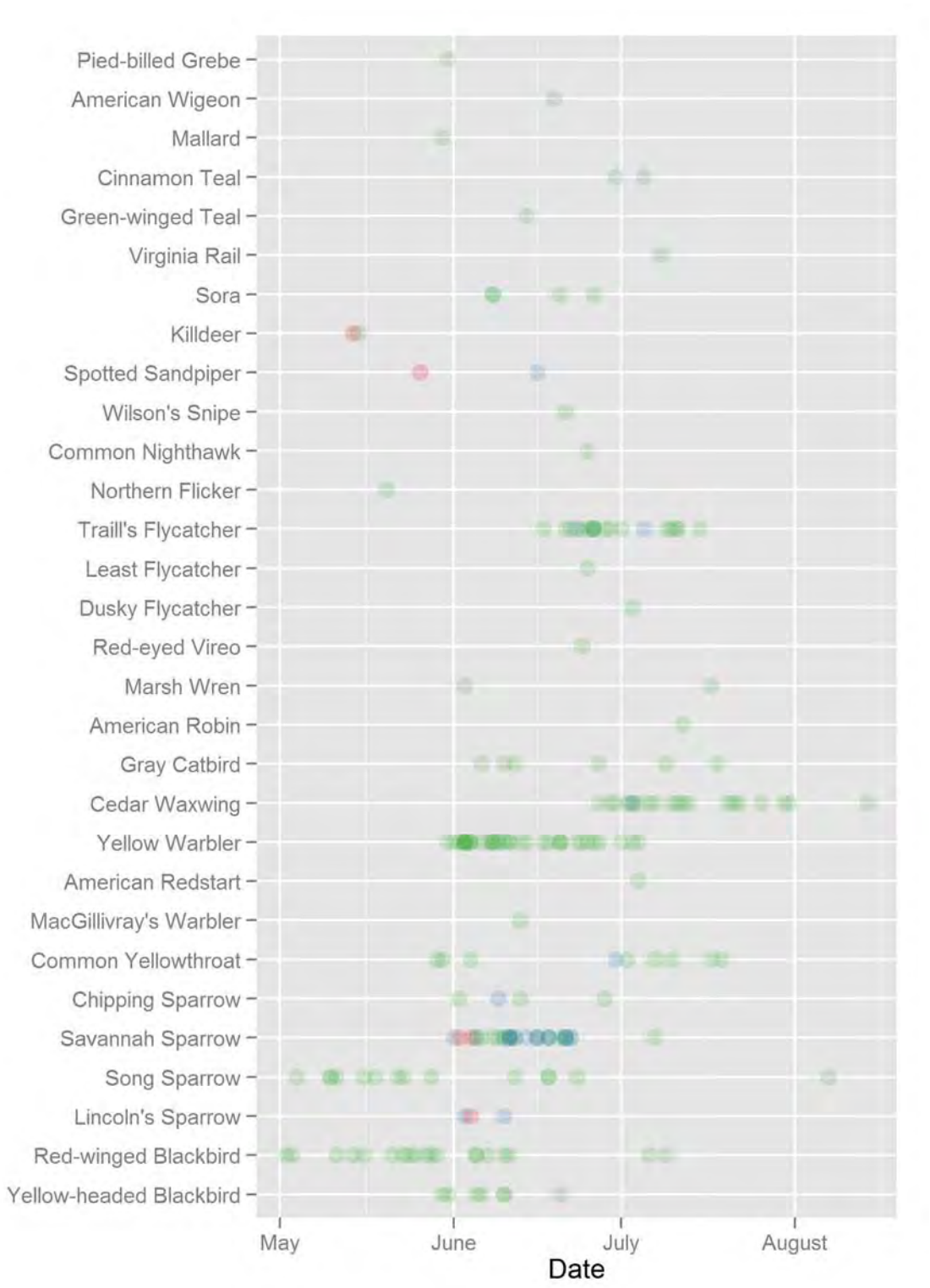

Figure 3-13: Back-calculated da tes fo r first egg laid for 196 nests in Ca noe Re ach (blue), Bush Arm (red) and Revelstoke Reach (green) in 2012 (transparency = 1/5)

3.4.5 Nest Monitoring Results

Of the nests for which outcomes were determined (*n* = 284, 84% of all nests), 100 (35%) were successful (Appendix 6-9). Of the 184 documented nest failures (65% of nest outcomes), 67 (36%) failed due to predation, and 53 (29%) failed as a result of reservoir operations (Appendix 6-9).

Within the drawdown zones, nest success rate was highest in Canoe Reach (68%); Revelstoke Reach had considerably lower nest success rate (28%). Predation rates within the drawdown zones were 18% at Canoe Reach and 24% at Revelstoke Reach (Appendix 6-9).

3.4.5.1 Productivity among Habitat Types

Nest success was relatively high in the Kinbasket Reservoir study areas in 2012, but nest outcomes differed among the vegetation communities (Figure 3-14). A relatively large proportion of nests in the Wool-grass-Pennsylvania Buttercup (WB) and Driftwood (DR) habitats were successful (Figure 3-14). When the area monitored was controlled for, Driftwood (DR) was the most productive habitat, whereas no productivity was recorded in the Lady's Thumb-Lamb's Quarter (LL), Marsh Cudweed-Annual Hairgrass (MA) and Wood Debris (WD) habitats despite considerable monitoring (Figure 3-15).

In Revelstoke Reach, there was notable variability in the outcomes of nests among habitats in 2012 (Figure 3-16). A relatively high proportion of nests were successful in Shrub Wetland Complex (CW) and Submerged Buoyant Bog (BS) habitats (Figure 3-16). Most nest failures due to reservoir operations were recorded in the Shrub Savannah habitat (SH), followed by the Bulrush (BR) habitat. When the area monitored was controlled for, Floating Bog (BF), Cattail (CT) and Shrub Wetland Complex (CW) were the most productive of the monitored habitats, whereas Mixed Grassland (MG), Sand (SA), Silt (SI), Sedge Grassland (SG) and Sparse Grassland (PG) habitats (all low-elevation grasslands or non-vegetated flats) were clearly unproductive (Figure 3-17).

3.4.5.2 Mortality Due to Reservoir Operations

Reservoir operations directly flooded 53 monitored nests in the two fully monitored study areas in 2012 (Appendix 6-10; Figure 3-18). None of these were nests of species at risk.

Four nests were flooded by rising water in the Kinbasket Reservoir drawdown zone (all in Canoe Reach). Two (50%) of these were ground nests (mean elevation = 752 m ASL), one was near the ground in the shrub/grass interface, and the other was in a shrub. It was unknown how many nests were flooded in Bush Arm in 2012.

Forty-nine active nests were flooded by rising water in the Revelstoke Reach drawdown zone. Three (6%) of these were ground nests, 20 were near the ground in the shrub/grass interface or were in emergent vegetation (41%), and 26 nests were located in shrubs (53%).

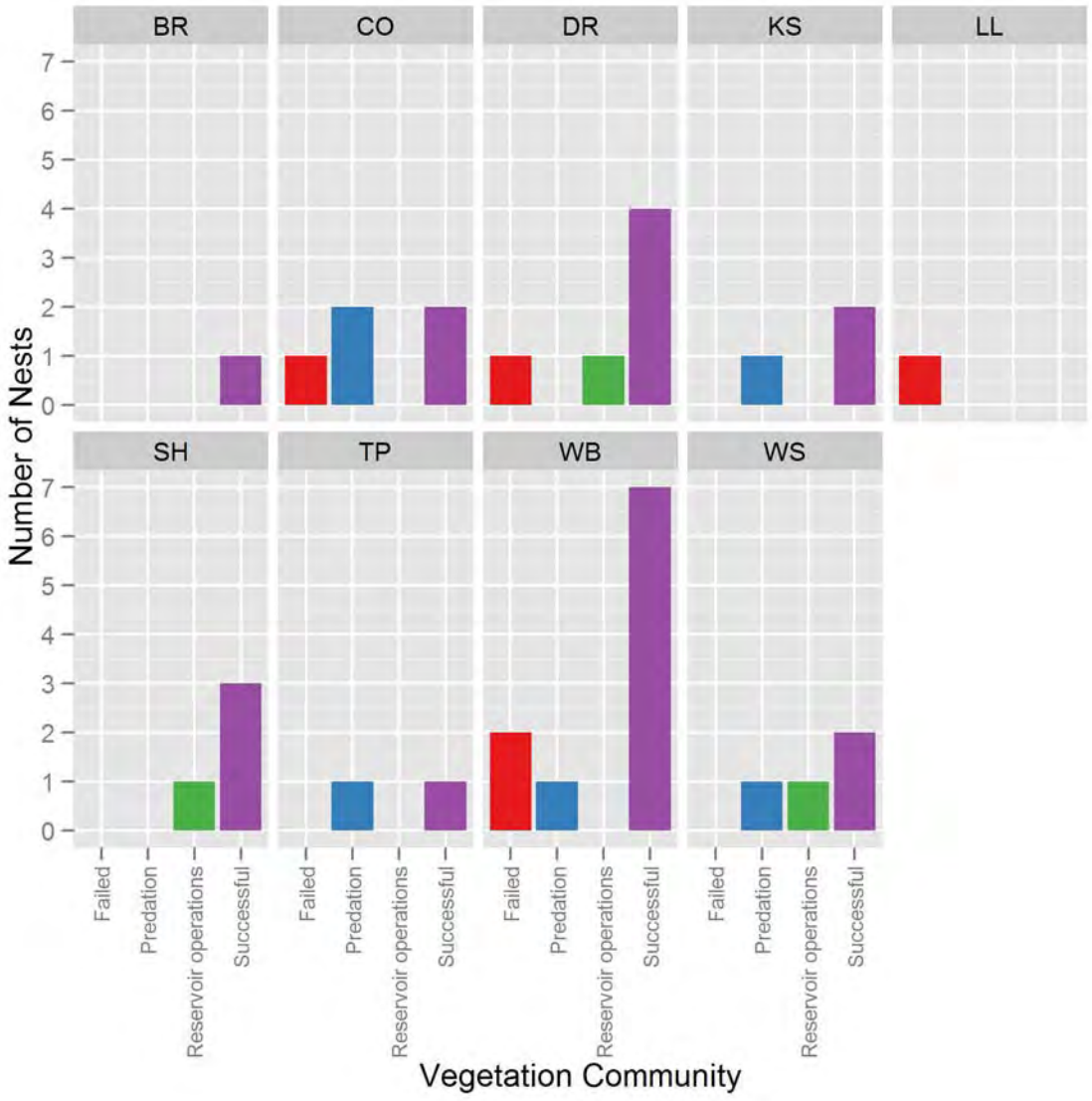

Figure 3-14: Outcomes of nests in Kinbasket Reservoir by vegetation community type (Hawkes et al. 2010)

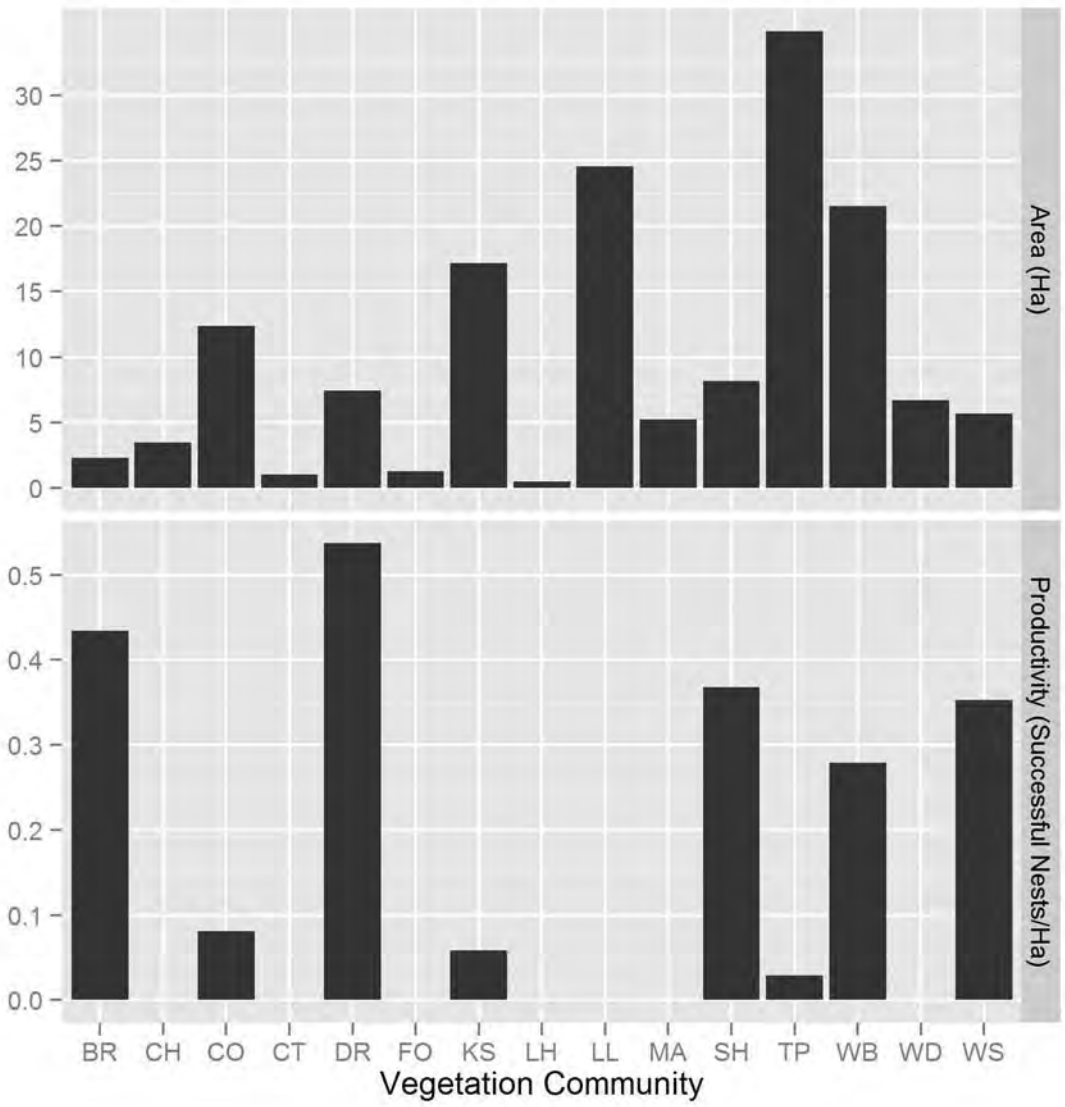

Figure 3-15: Area monitored and site productivity in Kinbasket Reservoir by mapped vegetation community type

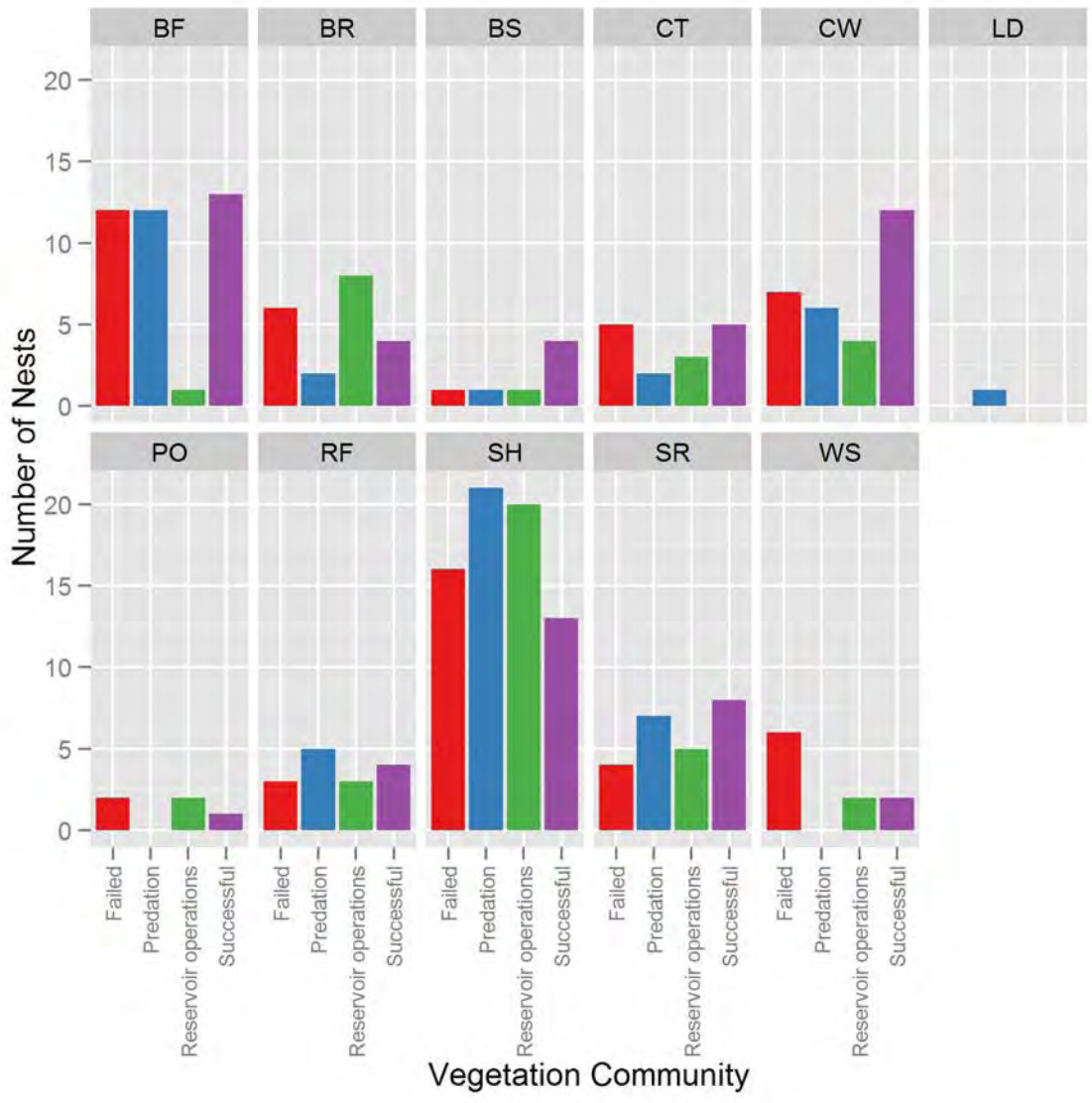

Figure 3-16: Number of failed nests in Revelstoke Reach by vegetation community type

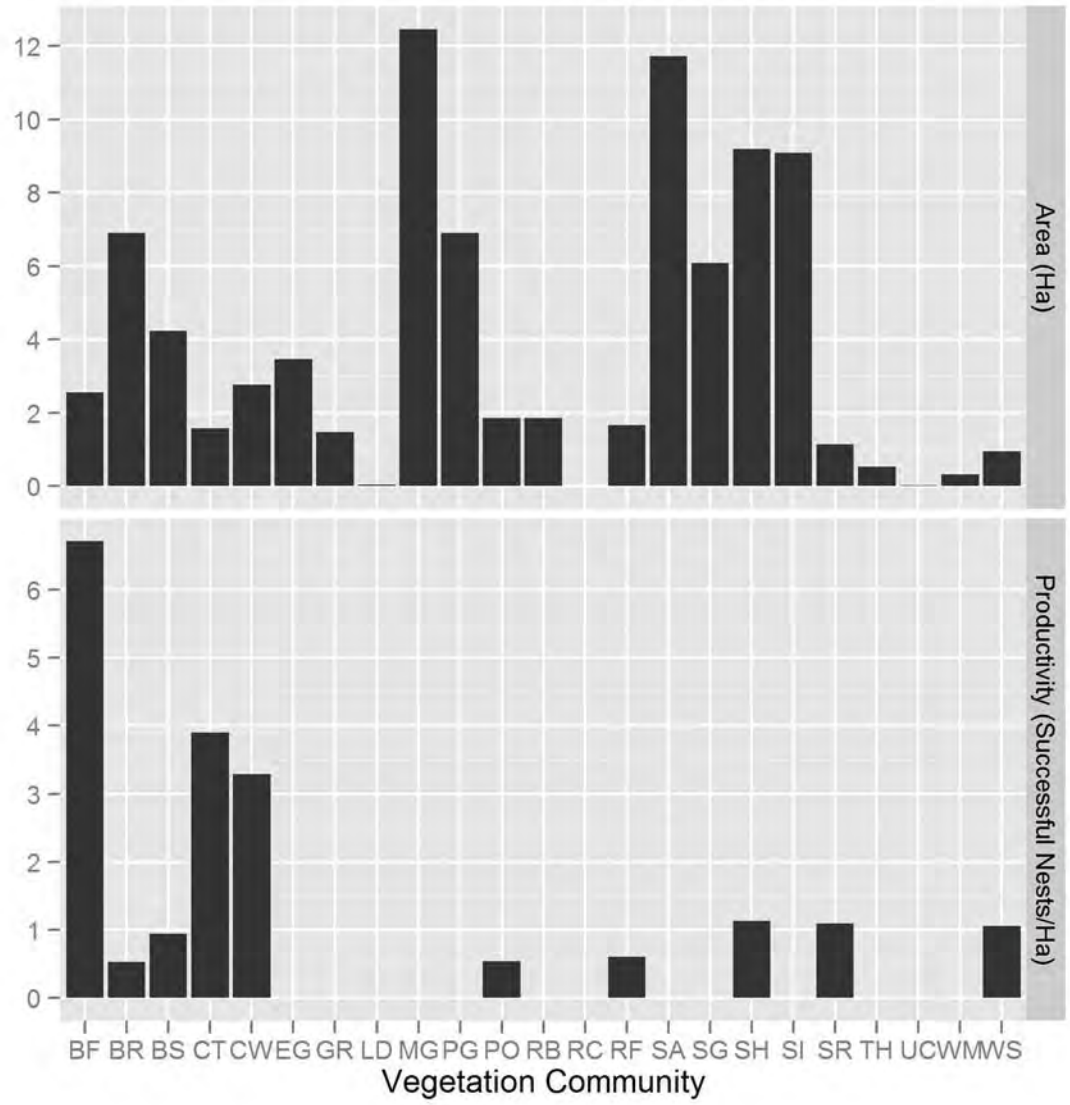

Figure 3-17: Area monitored and site productivity in Revelstoke Reach by mapped vegetation community type

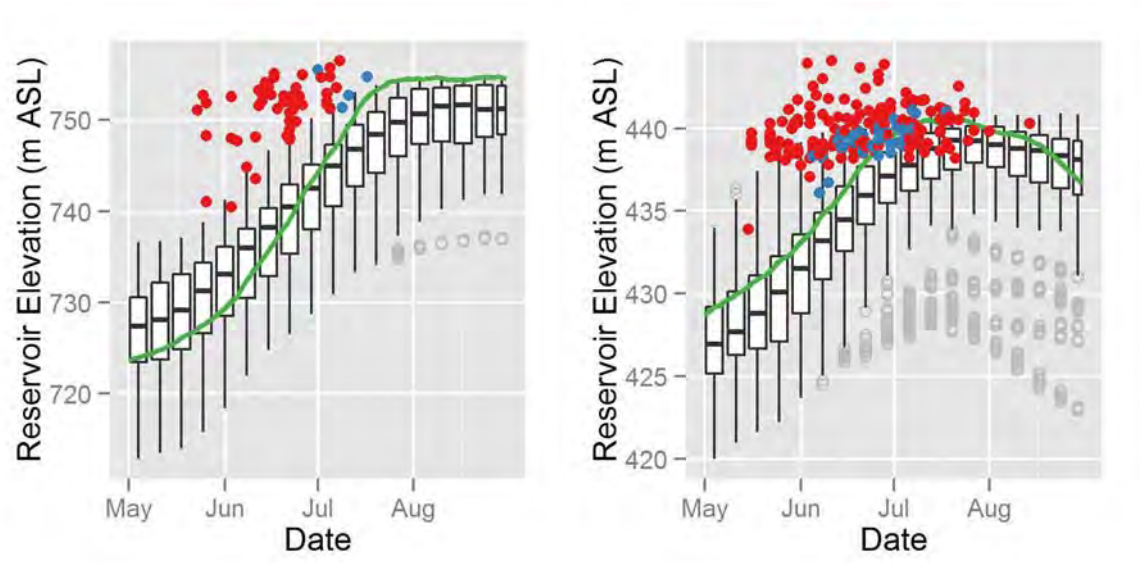

Figure 3-18: **The reservoir elevations (green lines) observed in 2012 are plotted for Kinbasket (left) and Arrow Lakes Reservoirs (right) against historic elevations (boxplots). The calculated nest elevation and date of nest discovery is plotted as points; blue points are those that were observed to have been flooded. In the right graph, nests that appear below the water elevation are those that were positioned in unidentified floating substrates (cattails), or were missing nest height data.**

3.5 Productivity, Juvenile Survival and Recruitment

3.5.1 Productivity of Focal Species

Productivity data from focal species nests with known nest outcomes are provided in Table 3-3. Nesting success was high for Savannah Sparrows in Kinbasket Reservoir and above the drawdown zone in Arrow Lakes Reservoir, which resulted in relatively high productivity for that species in 2012.

Table 3-3: **Productivity of focal species, and their nest locations in the drawdown zone (DDZ) in Arrow Lakes Reservoir (ALR) and Kinbasket Reservoir (KIN) in 2012. SD = standard deviation of productivity**

Reservoir	Location	Species	No. of Nests	Nesting Success	Productivity	SD
ALR	Above DDZ	Savannah Sparrow	11	0.73	1.5	1.58
ALR	Below DDZ	Cedar Waxwing	32	0.19	0.47	1.08
ALR	Below DDZ	Savannah Sparrow	1	0.00	0.00	NA
ALR	Below DDZ	Traill's Flycatcher	29	0.28	0.66	1.17
ALR	Below DDZ	Yellow Warbler	49	0.35	1.04	1.62
KIN	Above DDZ	Savannah Sparrow	1	1.00	4.00	NA
KIN	Below DDZ	Cedar Waxwing	2	0.00	0.00	0.00
KIN	Below DDZ	Savannah Sparrow	21	0.62	2.29	1.95
KIN	Below DDZ	Traill's Flycatcher	3	0.67	2.33	2.08

3.5.2 Juvenile Survival

We placed radio transmitters on eight nestling Savannah Sparrows in 2012. All of these individuals were from nests above the drawdown zone because there were no viable nests in the drawdown zone. One transmitter failed prior to the juvenile fledging. Of the seven remaining tagged sparrows, one survived (14%) and was followed until it was 28 days old. Four tagged sparrows were killed by predators, which included snakes (*Thamnophis sirtalis*), and two died of unknown causes (Appendix 6-11). Two out of the eight remaining juveniles survived (25%) and were followed until they were 25 and 26 days old. The remaining six birds likely died. One was found in the water and had presumably drowned. The remaining five also likely died (drowning or predation) but it is also possible that they dropped their transmitter; the transmitters of these five birds were located under water.

The surviving tagged birds fledged between eight and 11 days of age. The juvenile birds made longer flights as they matured (Figure 3-19). Savannah Sparrows tended to have a move further from the nest compared with Yellow Warblers as they increased their independence (Figure 3-20).

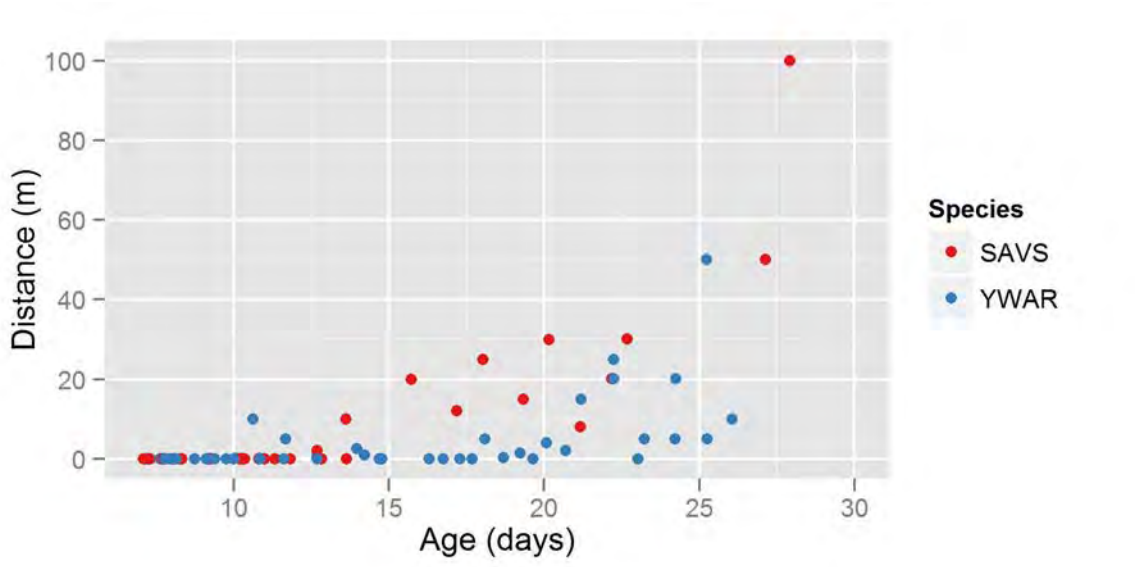

Figure 3-19: Estimated length of the furthest flights of tagged juvenile birds on each observation occasion, plotted against the birds' age

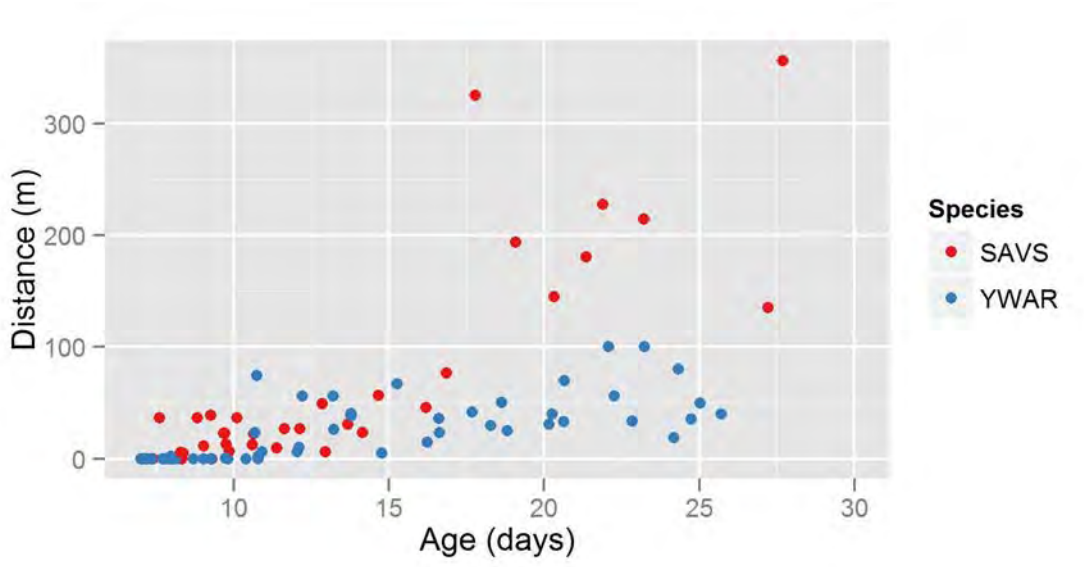

Figure 3-20: Estimated distance from nest of tagged juvenile birds on each observation occasion, plotted against the birds' age

4 DISCUSSION

We have not yet performed any detailed analyses of the CLBMON 36 data set, and this report does not try to answer any research questions; rather, it summarizes progress made in Year 5. The focus of this discussion is to explain how and if the management questions (MQs) will be answered using the approaches that were initially prescribed for this project.

4.1 Management Questions

4.1.1 Reservoir Operations and Nest Mortality

4.1.1.1 MQ-A: Which bird species breed in the drawdown zones of the Kinbasket and Arrow Lakes Reservoirs and where do they occur?

Results from nest searching are being used to build a database of breeding bird occurrence within a full range of habitat types. By Year 10, these data will be used to provide an answer to this management question.

In Year 5, we did not document any species nesting at Canoe Reach that were not recorded in Years 1 through 4, which suggests that our knowledge of typical species compositions in the monitored habitats of this study area is nearly complete.

In two previous years of study at Bush Arm, we found a relatively high number of species compared with numbers at Canoe Reach. To date, 22 species have been found nesting at Bush Arm. Monitoring in Year 5 was terminated prematurely due to road washouts, and Bush Arm was not surveyed until Year 3. Because there has been less effort at Bush Arm compared with Canoe Reach, the list of species nesting in the Bush Arm drawdown zone is likely to be less complete; nonetheless, we have likely identified a large proportion of the regular breeding species at this study area.

In Revelstoke Reach, the number of species and abundance of nesting birds is considerably greater than that of either Kinbasket Reservoir study area. At Revelstoke Reach in 2012, we recorded nests of one species that we had previously documented but had not found nesting—Cinnamon Teal. Earlier studies documented other species breeding in this area, including Northern Harrier, Common Merganser, Gadwall, Belted Kingfisher, Bank Swallow and Vesper Sparrow (Jarvis 2003, 2006). We have observed all of these species using the drawdown zone but have not yet found them nesting in our nest monitoring sites.

We expect to uncover new species breeding at all study areas over the next five years, but these species will be those breeding at low densities, or in specialized habitats; we expect that the number of new species will be small.

To date, we have not yet partitioned which species are found in each of the different drawdown habitats. In Kinbasket Reservoir, we classify habitats using the CLBMON 10 vegetation community codes, which we have found to be meaningful for avian nesting communities. In previous years, nest mortality monitoring data were compared among the relatively simplistic habitat classifications from the CLBMON 33 project (Enns et al. 2007). Such comparisons were limited because the mapping layer was incomplete. Nonetheless, the data clearly indicated that nest density and species richness were relatively high in the shrubby habitat (PA) and low in the grassland (PC) habitats (CBA 2012b). In this report, we introduced a new habitat classification scheme that was mapped for the entire Revelstoke Reach study area. Using this habitat map, we achieved some similar results: high nest density and species diversity was recorded in Shrub Savannah (SH) habitats, and no nesting was recorded in the grassland habitats (MG, SG, PG, EG). Other habitat types that supported a large nesting community in 2012 included the Floating Bog (BF) habitat at Montana Bay and the Cattail (CT) and Shrub Wetland Complex (CW) habitats.

The diversity and density of species varied among habitat types in both reservoirs, with considerable consistency among years. Variation is expected among years and sites; moreover, it is likely that variability in nesting communities also differs among habitats. Future monitoring should include additional new monitoring sites as a means of improving our ability to estimate natural variation in habitat use. A complete breakdown of which species are found in each habitat will be provided in the multi-year analyses reports.

4.1.1.2 MQ-C: Do reservoir operations directly affect nesting success (e.g. flooding of nests)?

CLBMON 36 has annually documented many cases of nest mortality caused directly by reservoir operations, primarily in the Arrow Lakes Reservoir but also in Kinbasket Reservoir. As such, this question has been addressed. Over time, the list of species affected will undoubtedly grow as we continue to document these events.

In Year 5, the number of occurrences of nest flooding in Revelstoke Reach was more than double those recorded in previous years due to the early, rapid, high filling of the Arrow Lakes Reservoir in what was an exceptionally wet season. The nests that were flooded in 2012 tended to be those of shrub-nesting species, and were most common in shrub savannah and wetland habitats. This contrasts with 2009, when the reservoir was not filled close to its capacity. In that year, it appeared that ground-nesting species were more at risk of being flooded, and shrub-nesting species were well protected from the

water. However, caution should be used when comparing data from different years, given that different sites are monitored annually. The multi-year analysis will control for differences in monitoring effort, and will provide a more accurate assessment of how reservoir operations are linked to nest flooding. Furthermore, by modelling nest mortality, we will be able to estimate nest mortality for the full range of reservoir operations (not just the operations that we observed).

4.1.1.3 MQ-D: What are the various factors (e.g. reservoir levels, predation, habit availability, etc) that influence nest mortality in the drawdown zone?

We have been documenting causes of nest failure within the drawdown zone and comparing their relative impacts (e.g., reservoir levels, predation). Data accumulated over the course of this study should allow us to assess the relative importance of each of these factors.

The relative importance of various nest mortality factors is likely to change annually. In 2012 there was a wet spring, and operations in both reservoirs were relatively extreme: water levels rose rapidly and were above the normal full pool elevation early in the year. In most years, there is considerable potential for birds to nest successfully prior to being impacted by the reservoir, especially in Kinbasket Reservoir; therefore, it follows that earlier, more aggressive filling regimes have greater potential for negative impacts on birds nesting in the drawdown zone, and the relative importance of reservoir operations in causing nest mortality will increase in years like 2012. For example, reservoir operations accounted for a much larger proportion of the nest fates in 2012 than in previous years. In Canoe Reach, four monitored nests failed as a result of flooding, whereas in previous years, the maximum number of nests flooded was two (CBA 2009, 2010a, 2011b, 2012b). In Revelstoke Reach, 49 monitored nests failed as a result of flooding in 2012, whereas in the previous years, between seven and 29 monitored nests flooded annually (CBA 2009, 2010, 2011, 2012b).

Weather may also affect nest mortality, and will vary among years. Likewise, predation rates appear to fluctuate among years in both study areas. As such, it is important that many years of monitoring be conducted before the relative importance of these factors can be properly estimated.

4.1.1.4 MQ-H: Can the operations of the Kinbasket and Arrow Lakes Reservoirs be optimized to improve nesting success, nest productivity, site productivity, or juvenile survival?

Reservoir operations are constrained by the Columbia River Treaty (among other factors), but some minor adjustments could possibly be made to improve nesting success. We will be able to provide precise guidelines for modifying reservoir operations to improve nesting success once nest density and mortality have been modelled as a function of date and reservoir elevation.

Results from the telemetry studies of juvenile survival could also be used to estimate the age at which juvenile songbirds are safe from being impacted by water levels in the reservoir. It is too early to draw any conclusions, but the data from 2012 suggest that flooded habitat may present a mortality factor for Yellow Warblers. Our telemetry monitoring also provides indications of when the juveniles are able to fly well enough to escape the water—something that would be particularly important for grassland species. These data can then be used to modify the nest-flooding model so that the vulnerable time period for juvenile birds is also taken into account during reservoir operations.

4.1.1.5 MQ-F: If reservoir operations negatively affect th e nesting success, what is the significance of these impacts on regional bird populations?

Nest failure due to reservoir operations will continue to be documented for the duration of this project. A list of species affected will be compiled for each of the study areas/reservoirs, and the impact of reservoir operations on the local population (i.e., within drawdown zone) will be assessed. Specifically, we will calculate and model the proportion of nests that failed due to reservoir operations for all species nesting in the drawdown zones. These analyses will allow the relative impact of reservoir operations to be ranked among populations in the drawdown zone.

The impacts of reservoir operations on nesting success in local drawdown populations will then be considered at a regional scale, for example, by considering the distribution of populations above the drawdown zone. For species that are widespread habitat generalists, the effects of reservoir operations will be diminished at the regional scale. For species that have limited ranges or are habitat specialists with preferred habitats available predominantly within the reservoir, the regional effects will be larger. Species range and habitat requirements will be determined through literature reviews and professional experience.

Many species found nesting in the drawdown zones seemingly have low vulnerability to nest flooding, but other species suffer nest flooding on a regular basis, especially in Revelstoke Reach; one such species in Revelstoke Reach is the Savannah Sparrow. Very few Savannah Sparrow nests have been located within the drawdown zone, yet this species has one of the highest proportions of flooded nests, and there is evidence that the local population has been declining. Prior to CLBMON 36, point count studies that were conducted when the reservoir elevation remained relatively low indicated that Savannah Sparrows were one of the most abundant species in the drawdown zone grasslands (Boulanger et al. 2002, Boulanger 2005). By 2008, the reservoir had been filling to near full pool for several years, and this species was no longer abundant. During our study, the number of Savannah Sparrow territories found at 9 Mile (REV-1) declined (8–9 territories in 2009, ~5 territories in 2010, 3 territories in 2011 and 1 in 2012). In addition, the number of Savannah Sparrow territories at REV-43 declined from eight in 2010, to five in 2011, to three in 2012. Regionally, there are very few sites above the drawdown zone where Savannah Sparrows breed. Although it is too early to draw conclusions, these data are consistent with the hypothesis that reservoir operations can significantly impact regional population of Savannah Sparrows.

4.1.2 Reservoir Operations, Juvenile Survival and Recruitment

4.1.2.1 MQ-G: Do reservoir operations affect juvenile survival and recruitment?

Juvenile survivorship is important to study because most altricial bird species have weak flying ability and rely heavily on parental care post fledging; a brood that fledges prior to the reservoir flooding the nest site is not necessarily safe from drowning or from the loss of foraging opportunities close to the nest site. Some altricial bird species may be better able than others to deal with encroaching water levels during the juvenile period. For example, juvenile Yellow Warblers may be able to climb branches as water levels rise. Grassland species, such as Savannah Sparrows, may be just as vulnerable to mortality from reservoir flooding when they are fledglings as they are as nestlings. Savannah Sparrows cannot fly well shortly after fledgling, and long flights may be required to find escape terrain as water levels rise. Although this is an important question, it is a

challenging question to address due to the difficulty of monitoring juvenile birds, and initial methods specified for CLBMON 36 were inadequate.

Telemetry is the most direct way to study juvenile survivorship (CBA 2011b). In 2012, we deployed the first transmitters on juvenile birds to study their survivorship. The primary purpose in this initial year of conducting telemetry was to assess its potential, identify issues and refine the methodology, if necessary. However, there was additional value in monitoring above the drawdown zone because data from non-drawdown environments can be used to assess whether survivorship is different in drawdown zones after the effects of habitat flooding are accounted for.

Through the use of telemetry, juvenile birds can be found easily on a daily basis. Known fate models can then be used to make inferences about daily survival rates (White and Burnham 1999), which is the primary reason for using this method. Our pilot data show promise in addressing MQ-G. The Yellow Warbler component is particularly promising, given that it can directly measure differences in survivorship as a function of habitat inundation. However, the Yellow Warbler data for 2012 did not provide contrasts between inundated and dry territories because most territories were flooded. In a typical year, inundation levels will be considerably lower than those in 2012; therefore, we expect the telemetry component will produce the type of data required to answer MQ-G. The Savannah Sparrow component should probably be conducted primarily in Kinbasket Reservoir in the future, where the timing of the reservoir operation is more likely to have impacts on juvenile sparrows rather than on nesting success. In Revelstoke Reach, we conducted all pilot monitoring on Savannah Sparrows nesting above the drawdown zone because this species is now uncommon and appears to have very low nesting success in the drawdown zone.

The 2012 telemetry data also gave insights on juvenile survivorship aside from those provided by the survivorship modeling framework. For example, the Yellow Warblers were subjected to habitat inundation, due primarily to natural flooding along the banks of the Illecillewaet River. This species has evolved in riparian floodplain habitats, and may be partially adapted to habitat inundation. The telemetry study allowed us to observe how Yellow Warbler juveniles cope when newly fledged in flooded habitats. The juveniles were relatively tenacious at grabbing branches, and were sometimes found close to the water surface (Figure 4-1). When newly fledged, however, they cannot fly, so are vulnerable to accidently landing in water. Six of eight transmitters (75%) successfully deployed on juvenile Yellow Warblers ended up under water. In one of these cases, we recovered the transmitter, which was attached to a drowned bird that had just fledged. In all other cases, we could not recover the transmitter; therefore, we could not ascertain whether the fledgling had drowned, dropped the transmitter or been predated. The confirmed case of juvenile drowning in 2012 suggests that rising water levels can impact juvenile survivorship; however, the degree of impact can be determined only by conducting survivorship analyses on a much larger data set.

Figure 4-1: **A newly fledged juvenile Yellow Warbler (below red arrow) clinging to vegetation just above the surface of 2 to 3 m of water. In this case, the young birds fledged a day or two early when their nest became flooded. The tagged juvenile survived a couple of days after this picture was taken, then the transmitter was signalling from under the water, and the adults were no longer observed at the shrub patch.**

Habitat flooding was not a factor at the site where we monitored tagged Savannah Sparrows. During the monitoring, we noted at what age the juveniles were able to sustain longer flights—something that is directly relevant to their ability to escape water in grassland drawdown habitats. Based on these initial observations, it appeared that these birds have limited flying ability until they are approximately 15 days old, which is about five days after fledging. We were also able to determine the fate of seven tagged juveniles, and in some cases, the type of predator involved. Two of the tagged juveniles were predated by snakes (*Thamnophis sirtalis*), which was determined when the signal was found coming from within the snake (Figure 4-2). Garter snakes are commonly seen in our nest monitoring plots, and they are the only predator that we observe depredating nests. When Savannah Sparrows fledge, they are very easy to capture at first, but they immediately begin to hop away from the nest and their siblings. Our 2012 data suggest that they are still susceptible to being found and eaten by snakes when they are as old as 15 days.

Figure 4-2: ***Thamnophis sirtalis*** **located using telemetr y while tracking a ju venile Savannah Sparrow. The transmitter was recovered from the snake's feces a day later.**

4.1.3 Habitat

4.1.3.1 MQ-B: What are the seasonal patterns of habitat use b y bi rds nestin g in the drawdown zone of the Kinbasket Reservoir and Revelstoke Reach?

In 2012, our field effort focused largely on ensuring that all available habitat types were being monitored. We used a new habitat map of Revelstoke Reach (CBA 2012c), which enhanced our ability to address this MQ. We also continued to monitor new representative sites in order to maximize spatial replication so that a statistically robust

analysis of how breeding communities are associated with habitat types can be performed.

To date, results have shown considerable variability in the number of species and density of nests found in each habitat type. For most species, individual birds breed in one type of habitat throughout their breeding season; therefore, identifying the seasonal pattern of habitat use will require determining which habitats each species uses, and the timing and length of the nesting season for each species. However, reservoir operations can affect seasonal patterns of habitat use. We have documented evidence that birds sometimes relocate to new breeding grounds following the flooding of their nest sites. Since 2009, we have observed Savannah Sparrows settling at 9 Mile (Revelstoke Reach) late in the breeding season (CBA 2010). The elevation of 9 Mile is higher than that of the grassland habitats in which this species attempts to breed at the beginning of the breeding season. The late arrivals at 9 Mile appear to be birds that have relocated to a new breeding location after being displaced by flooding of their initial territories. Through the use of mark-recapture, we documented one male Savannah Sparrow relocating territories in 2011: he moved 0.5 km to establish a new territory at 9 Mile after his first territory was flooded. In 2012, we recorded a banded female behaving similarly, moving a distance of approximately 0.9 km.

Since 2010, we have also found that nest density at Montana Bay has increased midway through the nesting season. We believe that this may also be due to birds relocating following territory inundation. In 2012, the nest finding rate did not spike dramatically like it did in previous years, but we did document a number of early nesting species that only started nesting at this site mid-season. In the future, it will be possible to examine how the nesting community at Montana Bay changes seasonally and as function of reservoir operations. It will also be possible to make inferences about breeding displacement by comparing nest finding rates at this site with those at other sites, and to determine how the rate changes seasonally and as a function of reservoir operations.

4.1.3.2 MQ-E: Do reservoir operations affect nesting success by altering nesting habitat quality (e.g. vegetation characteristics, habitat configuration) of nest sites or the availability of nesting habitat at the landscape level?

Addressing this question requires information on how habitats are modified by reservoir operations, and how nesting success varies across habitat types.

Some reservoirs are not filled annually, and may undergo net increases or decreases in the amount of water stored in the basin over several years, depending on inter-annual climate variability. In such reservoirs water levels can differ greatly among years, allowing dramatic colonization by plants in years when water levels are low, and destruction of vegetation in their drawdown zones in years of high water. This in turn impacts populations that depend on those habitats for nesting (Ellis et al. 2009, Hatten et al. 2010). Kinbasket and Arrow Lakes Reservoirs are operated to store and draft water annually, reaching near full-pool capacity in most years, and the plant communities are generally stabilized and strongly associated with topographic elevation in the drawdown zones, which reflects a tolerance to the average reservoir operations over time. Still, annual variations in reservoir operations likely affect the plant communities in these drawdown zones to some degree, especially at the upper and lower elevations where the plant communities occur. For example, willows positioned lower in the drawdown zone may suffer greater mortality than those growing at higher elevations in the drawdown zone during years when water storage levels are higher than average; it is thought that this occurred in 2008 in the Arrow Lakes Reservoir (CBA 2010). Changes in reservoir

operations (e.g., with the adoption of a new water use plan) could, therefore, cause a shift in the positions of the vegetation bands (Korman 2002), which could lead to changes in the availability of drawdown zone habitat types.

The effects of reservoir operations on vegetation are being monitored by CLBMON 33 and CLBMON 35 in Arrow Lakes Reservoir, and by CLBMON 9 and CLBMON 10 in Kinbasket Reservoir. Results from these and other studies (Korman 2002) will provide an account of how reservoir operations affect the distribution of habitat types in the drawdown zones.

Nesting success and nest density are being monitored using the nest mortality approach, and can be linked to habitat type and configuration. In the Year 4 report, we showed a positive association between shrub density and nest density (CBA 2012b). Shrub density is also likely associated with species diversity, and may be associated with nesting success and productivity. We have also demonstrated a strong association between vegetation communities and the species diversity and density of the nesting community. Models relating habitat variables such as shrub density and vegetation community to nesting success and nesting density can be applied to results from the vegetation monitoring studies mentioned above.

In 2008 we witnessed what appeared to be a direct impact of reservoir operations on habitat when low-elevation willow shrubs died back following an extended fall storage event. In 2012 we observed a different type of impact of reservoir operations on habitat availability: the loss of considerable amounts of emergent vegetation in the drawdown wetlands in Revelstoke Reach, and the loss of trees due to bank erosion. These observations suggest that unusually high reservoir elevations are destructive to some of the more important wildlife habitats in the drawdown zone.

4.1.3.3 MQ-J: Evaluate the effectiveness of revegetation efforts and ph ysical works projects implemented during the course of this monitoring program for improving nesting success, nest and site productivity, or juvenile survival.

The establishment of breeding bird communities in the Kinbasket Reservoir drawdown zone is likely limited by habitat availability, given the lack of vegetation. As such, we expect that bird communities will respond positively to a large measurable change in vegetation cover if the CLBWORKS 1 project objectives (revegetation) are realized, which will result in increases in both nest density and diversity of breeding bird species.

CLBWORKS 1 revegetation efforts have been ongoing during the course of the CLBMON 36 study. The treatments include planting sedge plugs, willow stakes and cottonwood stakes; however, these revegetation efforts are generally regarded as having been unsuccessful in meeting their objectives due to plant mortality (Fenneman and Hawkes 2012). We have monitored a variety of the treated sites but have not detected any influence to nesting birds so far.

In Revelstoke Reach, the CLBWORKS 2 project included similar treatments to those applied by CLBWORKS 1, which achieved variable levels of early success (Enns et al. 2010). The planting of cottonwood stakes may have been successful in some sites: some plants are now going into their third winter. To date, one nest has been located in the cottonwood stake treatment plots. The Yellow Warbler nests in cottonwoods, and may benefit from this treatment. Graduate students working with Dr. David Green at Simon Fraser University have been monitoring Yellow Warblers at 12 Mile since 2004—a location where an extensive cottonwood treatment was administered. In 2012, the nesting distribution of Yellow Warblers at 12 Mile showed very little overlap with the

young cottonwood plantation. Over time, Yellow Warbler nesting territories may expand into this planted area. This will be an important case study of the effectiveness of this treatment.

WPW projects have not yet been implemented in any of the study areas.

To date, we have located only one nest in a habitat modified by revegetation physical works projects. We expect that we will find more nests making use of physical works projects over time. A data set that includes many nests located in physical works sites would allow us to compare nesting success and productivity in physical works substrates against nests in un-manipulated substrates. We will also be able to predict the potential for nest flooding over a normal range of reservoir operations and nest initiation dates, which will allow us to determine the performance of the modified habitats. Results from the modified habitats will be compared with results from unmodified habitats.

It is unclear how impacts of physical works projects on juvenile survival should be determined. This requires a focal species to be using the habitats, which cannot be guaranteed or expected. In the best case scenario, a population of a focal species would establish in an extensive physical works site, and then juvenile survival could be compared with that of other populations. It is unlikely that the impacts of WPW or RPW projects can be assessed empirically.

4.1.3.4 MQ-I: Provide recommendations for physical works projects and revegetation efforts to increase nesting success, nest and site productivity and juvenile survival in the Kinbasket Reservoir and Revelstoke Reach

To date, none of the physical works or revegetation projects have been specifically designed to increase nest success, overall productivity or juvenile survival. Recommendations will take time to develop because detailed analyses have yet to be performed.

Results to date have illustrated differences in nest densities among habitat types. Combining knowledge of habitat occupancy with modelled results for nest mortality caused by reservoir operations and predation rates will allow us to identify which habitat types can sustain the greatest density and diversity of breeding birds while minimizing nest mortality due to reservoir operations or predation. Such knowledge could be used to design a scientifically backed physical works prescription for increasing nesting productivity in drawdown habitats, but this cannot be done until detailed analyses have been performed. However, during the course of this project, other physical works ideas have been generated directly from field observations.

In 2010 we noted that successful RPW projects in Kinbasket Reservoir would be beneficial since nesting success is high in that reservoir, habitat is limiting and reservoir flooding of nests is uncommon (CBA 2011b). We still support this idea, and note that WPW projects may be required to provide adequate stability to the substrates before RPW projects can be successful.

We also previously noted that nest boxes could be a cost-effective WPW project for Kinbasket Reservoir (CBA 2011b). In 2011, we observed two additional species nesting in stumps—Northern Flicker and American Robin—and we noted that one of the nests flooded by the reservoir was located in a stump. Nest boxes could be used by several species, especially Mountain Bluebirds, and could ensure that the birds are safe from reservoir operations.

In Year 3 we also discussed how Machete Island provides a model of how habitat can be restored in the Revelstoke Reach drawdown zone (CBA 2011b). We still believe that these ideas, which are detailed in the Year 3 report (CBA 2011b), are suitable for directing physical works projects towards enhancing avian productivity.

In Year 4 we discussed the idea of creating floating habitat islands, and pointed out that while this idea holds great merit, the benefits to nesting birds will be limited by the territoriality of most bird species and the scale at which the project is undertaken. Species that nest in small colonies could probably benefit greatly from the installation of floating habitat islands. For example, Caspian Terns are known to respond very well to constructed floating nesting habitat (Collis et al. 2002). There are no truly colonial species nesting in Revelstoke Reach, but there are species that can tolerate nesting in dense groups (e.g., Wilson's Snipe, Cedar Waxwing). Such a project should not focus on creating habitat for any one species, but rather a whole community of species.

4.2 Annual Effects in 2012

An exceptionally wet June occurred in the Columbia Mountains and elsewhere in B.C. in 2012, which caused an intense spring freshet and contributed to unusual reservoir operations. The Revelstoke Dam spilled (Figure 4-3), and there were many road washouts, which greatly limited access to some of the more remote monitoring sites in Bush Arm. These weather conditions may have had a direct impact on nesting success, but such an effect was probably minor relative to the increase in nest flooding that occurred. It should be noted, however, that flooding and washouts occurred throughout the province, and many unregulated rivers produced unusually high discharge, which likely flooded many nests naturally.

In the previous year (2011), we noted several differences in the nesting community, particularly at Revelstoke Reach, including a greatly diminished Marsh Wren population and a pattern of habitat selection by Yellow Warblers which differed from previous years (CBA 2012b). In 2012, the Marsh Wren population appeared to have recovered somewhat, but it was our impression that the population was still diminished compared with pre-2011 levels. In 2012, the Yellow Warblers were distributed as they were in 2011, with a high concentration at the Illecillewaet area and very few birds nesting at Machete Island. We have no explanation for these observations.

Figure 4-3: The Revelstoke Dam spilling (June 17, 2012)

4.3 Recommendations

4.3.1 Telemetry

The use of telemetry in 2012 proved to be a viable approach for studying juvenile survivorship. We recommend that the telemetry study of Savannah Sparrow juvenile survivorship be conducted primarily in Kinbasket Reservoir, where there are well-established populations. These populations suffer very few nest losses due to flooding. The water levels likely reach the nesting territories shortly after the juveniles have fledged and may have a larger impact on juveniles compared with nests. In Revelstoke Reach, the population is all but extirpated, and it appears that the reservoir typically fills during the nesting period (for the few remaining sparrows), destroys the nests, leaving no juveniles to monitor in the drawdown zone.

4.4 Conclusions

We have not made any research conclusions at this stage of CLBMON 36. In Year 6, a comprehensive report will provide an overall synthesis of results from Years 1-5, which will likely allow conclusions to be made about some of the management questions.

5 ADDITIONAL REPORTING REQUIREMENTS

5.1 Banded Birds

Birds were banded in accordance with national permit regulations. Only focal species were targeted, although incidental captures of a few non-focal species did occur, so these birds were also banded. All data were entered into Bandit 2.01 software and were submitted to the Bird Banding Office of the Canadian Wildlife Service. No mortalities or injuries occurred during banding in 2012. Banded birds are summarized in Appendix 6-12.

5.2 Provincially- and SARA-listed Species

One SARA-listed species was found nesting in 2012 (Common Nighthawk). This nest was located above the drawdown zone in the fields near the Revelstoke Dam.

5.3 Species with Provincial Jurisdiction

All nest records were reported to the Ministry of Environment following the Wildlife Species Inventory standards.

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Appendix 6-1: Status of management objectives, questions and hypotheses

STATUS OF OBJECTIVES, MANAGEMENT QUESTIONS AND HYPOTHESES

Objectives*	Management Questions*	Management Hypotheses*	Approaches	Year 5 (2012) Status
1) Determine the use of riparian habitats by breeding birds in the drawdown zone and identify important breeding habitats used by migratory birds in the drawdown zones in the Kinbasket Reservoir and Revelstoke Reach.	a) Which bird species breed in the drawdown zones of the Kinbasket and Arrow Lakes Reservoir and where do they occur?	None applicable	Nest Mortality	Will be adequately addressed by study completion using current methods
	b) What are the seasonal patterns of habitat use by birds nesting in the drawdown zone of the Kinbasket Reservoir and Revelstoke Reach?			
2) Determine the effects of reservoir operations on the nest mortality, nest and site productivity and juvenile survival on birds breeding in the drawdown zones of the Kinbasket Reservoir and Revelstoke Reach.	c) Do reservoir operations directly affect nesting success (e.g. flooding of nests)?	H_{1B}: Nest mortality in the drawdown zone is not caused directly by nest inundation.	Nest Mortality	Concluded
	d) What are the various factors (e.g. reservoir levels, predation, habit availability, etc) that influence nest mortality in the drawdown zone?	None applicable		Will be adequately addressed by study completion using current methods
	f) If reservoir operations negatively affect the nesting success, what is the significance of these impacts on regional bird populations?	H_{1A}: Nest mortality is no greater in the drawdown zone than above the drawdown zone.	Focal Species	In progress. More sites above the drawdown zone would be beneficial.
	g) Do reservoir operations affect juvenile survival and recruitment?	H_{2A}: Juvenile mortality is no greater in the drawdown zone than above the drawdown zone.		Telemetry work starting in Year 5 will allow this question to be addressed.
	h) Can the operations of the Kinbasket and Arrow Reservoirs be optimized to improve nesting success, nest productivity, site productivity, or juvenile survival?	None applicable	Nest Mortality	Will be adequately addressed by study completion using current methods
3) Determine the effects of reservoir operations on the quality and availability of nesting habitat at the nest and landscape levels in the drawdown zones of the Kinbasket Reservoir and Revelstoke Reach.	e) Do reservoir operations affect nesting success by altering nesting habitat quality (e.g. vegetation characteristics, habitat configuration) of nest sites or the availability of nesting habitat at the landscape level?	H_{3A}: Reservoir operations do not result in a reduction in the quality or availability of nesting or recruitment habitat at the site and landscape level.	Nest Mortality	Will be adequately addressed by study completion using current methods
		H_{3B}: Nest mortality, site and net productivity, and juvenile survival are not associated with changes in habitat conditions (e.g. structure, vegetation composition and extent of habitat) or reservoir operations in the drawdown zone.		
4) Inform and evaluate the effectiveness of physical works and revegetation efforts to enhance nesting success, nest and site productivity, or juvenile survival.	i) Provide recommendations for physical works projects and revegetation efforts to increase nesting success, nest and site productivity and juvenile survival in the Kinbasket Reservoir and Revelstoke Reach.	None applicable	Nest Mortality	Will be adequately addressed by study completion using current methods
	j) Evaluate the effectiveness of revegetation efforts and physical works projects implemented during the course of this monitoring program for improving	H_{4A}: Revegetation or physical works do not increase the species diversity or abundance of birds nesting in the drawdown.	Nest Mortality	Using both direct and indirect inference, most of these will be adequately addressed by study

4) Continued.	nesting success, nest and site productivity, or juvenile survival.	H_{4B}: Revegetation or physical works are not effective at reducing nest mortality in the drawdown zone.**		completion using current methods. The exception is H_{4C}, which is probably not testable using empirical methods. This can be addressed using professional opinion.
		H_{4B}: Revegetation or physical works do not increase nest or site productivity in the drawdown zone.**		
		H_{4C}: Revegetation or physical works do not increase the survival of juvenile birds in the drawdown zone.	Focal Species	
		H_{4E}: Revegetation or physical works do not increase the amount of bird habitat in the drawdown zone.	Nest Mortality	
5) Assess the implementation of the soft constraints and any incremental impacts resulting from the addition of unit 5 at Revelstoke Dam on nesting success, nest and site productivity, or juvenile survival.	None applicable	None applicable	Nest Mortality	Will be adequately addressed by study completion using current methods
6) Refine the habitat models developed previously for birds nesting in the drawdown zone of Revelstoke Reach (Axys Environmental Consulting 2002).***	None applicable	None applicable	Nest Mortality	Will be adequately addressed by study completion using current methods

*Some of the objectives, management questions and hypotheses were updated for Years 4 and 5.

**The duplicate yet different H_{4B} were stated this way by BCH in the Terms of Reference.

*** The applicable soft constraint is to “Ensure that inundation of nesting bird habitat by rising reservoir water levels in early summer is no worse than that which occurred on average over recent history (1984 to 1999). Match operating levels to inundation statistics for elevations 434 m (1424 ft) and above over the 1984 to 1999 period, which were used to produce the average historic performance measure score for spring/summer nesting short-eared owl habitat.”

Appendix 6-2: Habitat classes (vegetation communities) within the Kinbasket Reservoir drawdown zone mapped by CLBMON 10 (Hawkes et al. 2010), and within Revelstoke Reach

Vegetation communities within the Kinbasket Reservoir drawdown zone mapped by CLBMON 10 (Hawkes et al. 2010)

Code	Vegetation Community	Description
BR	Bluejoint Reedgrass	Above CH, often above KS
BS	Buckbean–Slender Sedge	Very poorly drained, wetland association
CH	Common Horsetail	Well drained, above LL or lower elevation on sandy, well-drained soil
CO	Clover–Oxeye Daisy	Well drained, typical just below shrub line and above KS
CT	Cottonwood – Trifolium	Imperfectly to well drained, above CO, below MC and LH
DR	Driftwood	Long, linear bands of driftwood, very little vegetation
FO	Forest	Any forested community
KS	Kellogg's Sedge	Imperfectly to moderately well drained, above CH
LH	Lodgepole Pine–Annual Hawksbeard	Well drained, above CT along forest edge, very dry site
LL	Lady's Thumb–Lamb's Quarter	Imperfectly to moderately well drained; the lowest vegetated elevations
MA	Marsh Cudweed–Annual Hairgrass	Imperfectly to moderately well drained; common in the Bush Arm area
MC	Mixed Conifer	Well drained, above CT along forest edge
RC	Reed Canarygrass	Imperfectly to moderately well drained; similar elevation to CO community
RD	Common Reed	*Phragmites australis*
SH	Swamp Horsetail	Poorly drained, wetland association
TP	Toad Rush–Pond Water-starwort	Imperfectly drained, above LL, wet sites
WB	Wool-grass–Pennsylvania Buttercup	Poorly drained, wetland association
WD	Wood Debris	Thick layers of wood debris, no vegetation
WS	Willow–Sedge wetland	Very poorly drained, wetland association

Vegetation communities within the Revelstoke Reach drawdown zone

Code	Category	Description
RF	Riparian forest	Riparian forest with cottonwoods and shrubs, with variable conifer component
UC	Upland conifer	Conifer-dominated upland forest
UM	Upland mixed	Upland forests typically containing high amounts of birch and white pine
EG	Equisetum grassland	Horsetail-dominated grassland
MG	Mixed grassland	Grasslands with variable mixture of graminoids
PG	Sparse grassland	Grasslands with sparse/low graminoid cover
RC	Reed canarygrass	Grasslands dominated by well-developed reed canarygrass cover
SG	Sedge grassland	Sedge-dominated grassland
SH	Shrub savannah	Shrub-savannah
SR	Riparian shrub	Riparian shrub
BE	Steep bedrock	Bluffy steep banks comprised of bedrock slabs or cliffs. Variable vegetation and coarse woody debris
RB	Rocky bank	Steep banks comprised of boulders, talus, and loose rocks. Variable vegetation and coarse woody debris
SB	Sand bank	Sand banks - usually failing. Variable vegetation and coarse woody debris
TH	Thaliweg	Columbia River channel
CR	Coarse rocks	Coarse rocks, cobbles, boulders, etc.
GR	Gravel	Gravel, pebbles, etc.
SA	Sand	Sand
SI	Silt	Silt
UR	Urban	Residential, industrial, etc.
BF	Floating bog	Floating peat bog that provides island habitat
BR	Bulrush	Pond habitat with large stands or patches of bulrush
BS	Submerged buoyant bog	Peat bog that rises with water but becomes flooded
CK	Creek	Gravel/rocky creek channel or estuary
CT	Cattail	Cattail-dominated wetland
CW	Shrub wetland complex	Transitional, containing a mixture of wetland components, often with shrubs
LD	Low elevation draw	Muddy/clay depression or channel
PO	Pond	Open water pond habitat with variable amounts of submergent vegetation
SW	Swamp	High in the drawdown zone. Beaver ponds, skunk cabbage, alders, etc.
WM	Wet meadow	Sedge, grass, seasonally flooded area with depressions
WS	Water Sedge	Sedge-dominated marsh of fen

Appendix 6-3: Details of the CLBMON 36 nest mortality study sites

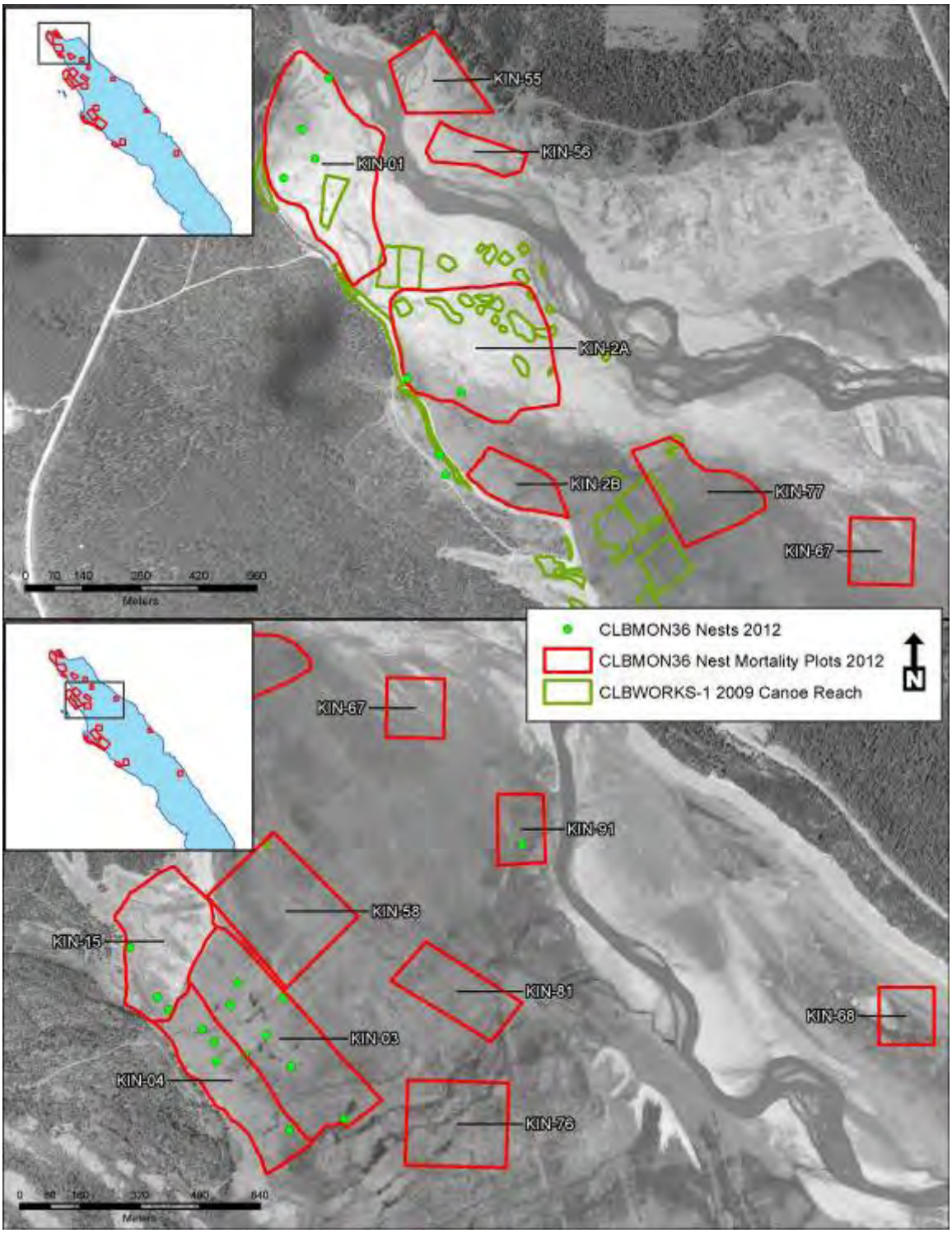
Plot ID	Reservoir*	Study Area	Area (ha)	No. of Nests	No. of Species	Nest Density
REV-15	ALR	Revelstoke Reach	8.4	35	7	4.16
REV-24	ALR	Revelstoke Reach	4.6	53	11	11.51
REV-25	ALR	Revelstoke Reach	3.9	6	4	1.54
REV-73	ALR	Revelstoke Reach	1.7	11	5	6.61
REV-74	ALR	Revelstoke Reach	0.2	2	2	8.32
REV-75	ALR	Revelstoke Reach	1.4	0	0	0
REV-76	ALR	Revelstoke Reach	5.4	0	0	0
REV-77	ALR	Revelstoke Reach	0.6	0	0	0
REV-78	ALR	Revelstoke Reach	0.8	0	0	0
REV-79	ALR	Revelstoke Reach	1.1	15	8	13.54
REV-80	ALR	Revelstoke Reach	0.7	13	7	17.56
REV-81	ALR	Revelstoke Reach	0.6	2	2	3.54
REV-82	ALR	Revelstoke Reach	0.9	2	2	2.27
REV-83	ALR	Revelstoke Reach	1.7	0	0	0
REV-84	ALR	Revelstoke Reach	7.9	0	0	0
REV-85	ALR	Revelstoke Reach	3.7	0	0	0
REV-86	ALR	Revelstoke Reach	1.0	10	5	9.79
REV-87	ALR	Revelstoke Reach	0.7	0	0	0
REV-88	ALR	Revelstoke Reach	0.6	9	6	13.90
REV-89	ALR	Revelstoke Reach	3.4	0	0	0
REV-90	ALR	Revelstoke Reach	3.0	0	0	0
REV-91	ALR	Revelstoke Reach	7.4	0	0	0
REV-92	ALR	Revelstoke Reach	1.1	5	4	4.49
REV-93	ALR	Revelstoke Reach	1.5	4	3	2.65
REV-94	ALR	Revelstoke Reach	1.5	16	5	10.36
REV-95	ALR	Revelstoke Reach	0.7	1	1	1.44
REV-96	ALR	Revelstoke Reach	3.2	0	0	0
REV-97	ALR	Revelstoke Reach	1.0	0	0	0
REV-98	ALR	Revelstoke Reach	0.8	7	4	9.13
REV-99	ALR	Revelstoke Reach	0.9	1	1	1.13
REV-100	ALR	Revelstoke Reach	1.1	5	2	4.60
REV-101	ALR	Revelstoke Reach	1.1	0	0	0
REV-102	ALR	Revelstoke Reach	1.2	2	1	1.67

Plot ID	Reservoir*	Study Area	Area (ha)	No. of Nests	No. of Species	Nest Density
REV-103	ALR	Revelstoke Reach	1.7	0	0	0
REV-104	ALR	Revelstoke Reach	2.2	0	0	0
REV-105	ALR	Revelstoke Reach	2.8	0	0	0
REV-106	ALR	Revelstoke Reach	2.9	0	0	0
REV-107	ALR	Revelstoke Reach	3.4	0	0	0
KIN-52	KIN	Bush Arm	5.2	0	0	0
KIN-65	KIN	Bush Arm	1.0	0	0	0
KIN-66	KIN	Bush Arm	3.1	0	0	0
BUSH-98	KIN	Bush Arm	1.2	0	0	0
KIN-01	KIN	Canoe Reach	9.9	4	2	0.40
KIN-2A	KIN	Canoe Reach	10.5	2	2	0.19
KIN-2B	KIN	Canoe Reach	2.1	0	0	0
KIN-03	KIN	Canoe Reach	11.6	7	1	0.61
KIN-04	KIN	Canoe Reach	6.9	4	1	0.58
KIN-15	KIN	Canoe Reach	7.1	3	1	0.42
KIN-44	KIN	Canoe Reach	1.9	2	2	1.03
KIN-45	KIN	Canoe Reach	4.1	3	3	0.72
KIN-46	KIN	Canoe Reach	2.4	0	0	0
KIN-47	KIN	Canoe Reach	5.6	0	0	0
KIN-48	KIN	Canoe Reach	2.4	0	0	0
KIN-49	KIN	Canoe Reach	5.5	0	0	0
KIN-53	KIN	Canoe Reach	1.2	0	0	0
KIN-55	KIN	Canoe Reach	2.9	0	0	0
KIN-56	KIN	Canoe Reach	1.7	0	0	0
KIN-57	KIN	Canoe Reach	10.8	2	2	0.19
KIN-58	KIN	Canoe Reach	8.3	0	0	0
KIN-59	KIN	Canoe Reach	13.6	1	1	0.07
KIN-67	KIN	Canoe Reach	2.5	0	0	0
KIN-68	KIN	Canoe Reach	2.2	0	0	0
KIN-74	KIN	Canoe Reach	5.0	0	0	0
KIN-75	KIN	Canoe Reach	1.4	0	0	0
KIN-76	KIN	Canoe Reach	6.1	0	0	0
KIN-77	KIN	Canoe Reach	4.3	0	0	0

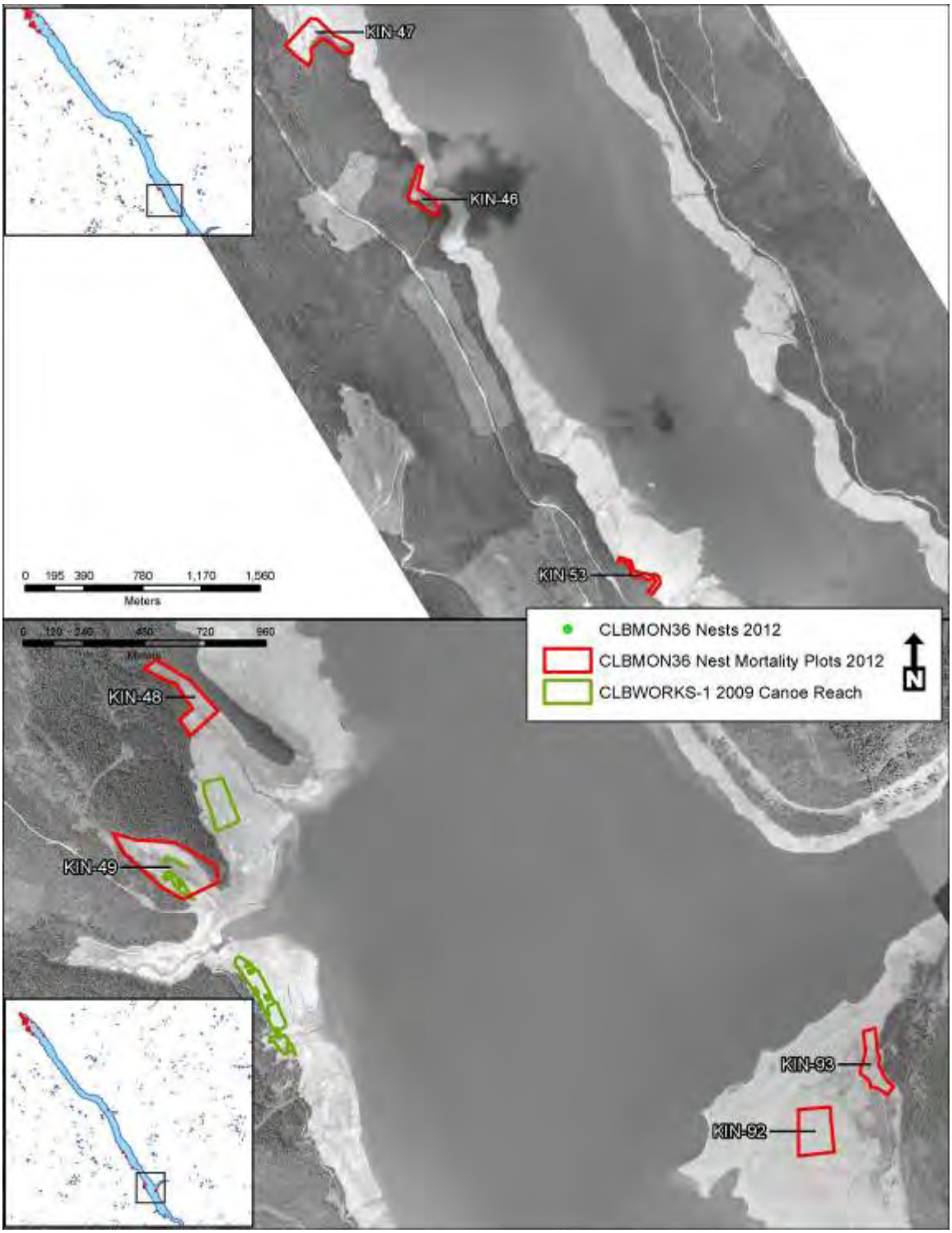
Plot ID	Reservoir*	Study Area	Area (ha)	No. of Nests	No. of Species	Nest Density
KIN-78	KIN	Canoe Reach	5.1	0	0	0
KIN-81	KIN	Canoe Reach	4.2	0	0	0
KIN-82	KIN	Canoe Reach	3.7	0	0	0
KIN-84	KIN	Canoe Reach	3.6	0	0	0
KIN-86	KIN	Canoe Reach	2.1	0	0	0
KIN-90	KIN	Canoe Reach	0.9	4	3	4.57
KIN-91	KIN	Canoe Reach	2.3	1	1	0.43
KIN-92	KIN	Canoe Reach	2.4	0	0	0
KIN-93	KIN	Canoe Reach	1.5	0	0	0

* ALR = Arrow Lakes Reservoir; KIN = Kinbasket Reservoir

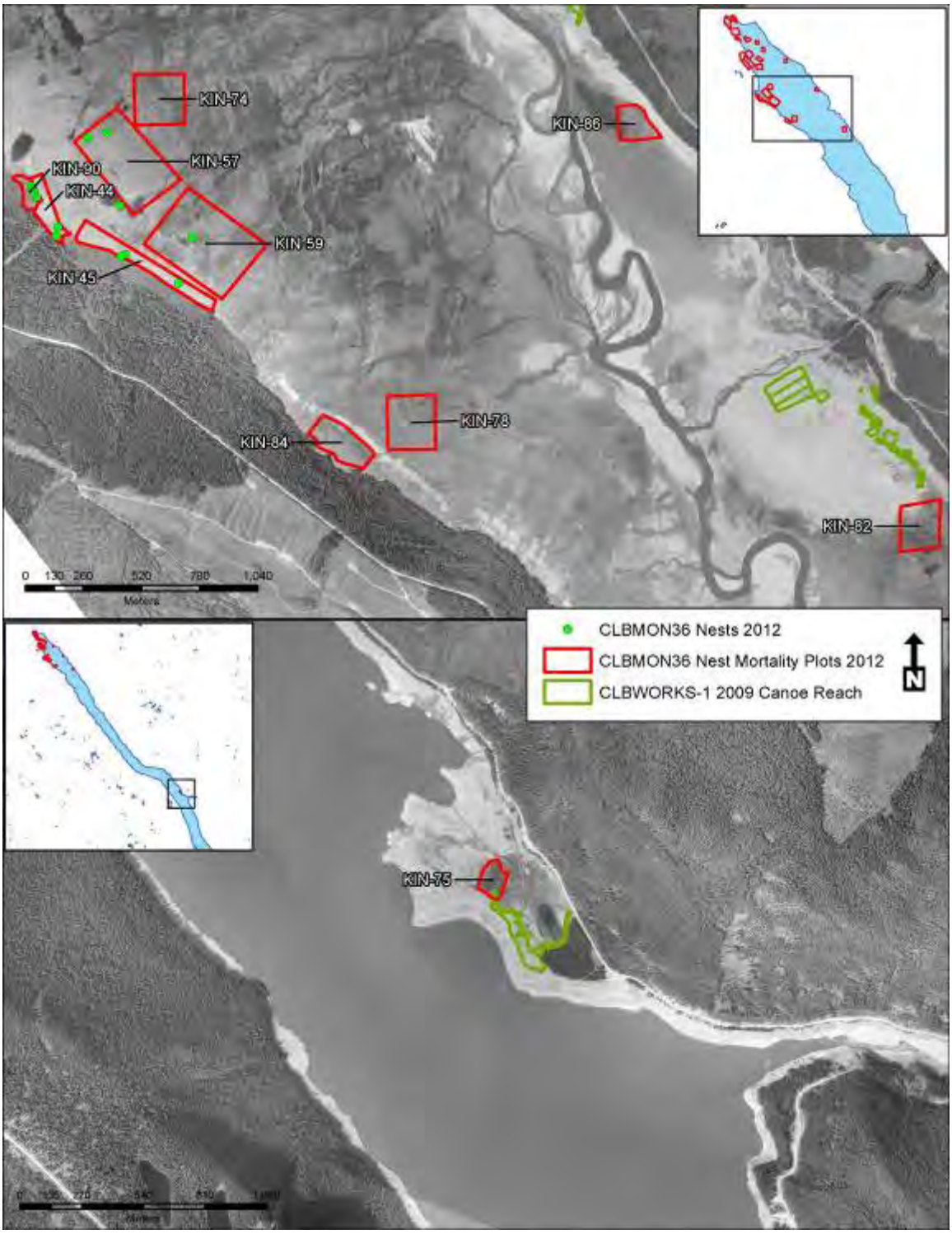
Appendix 6-4: Locations of study sites and nests at Canoe Reach



Northern Canoe Reach

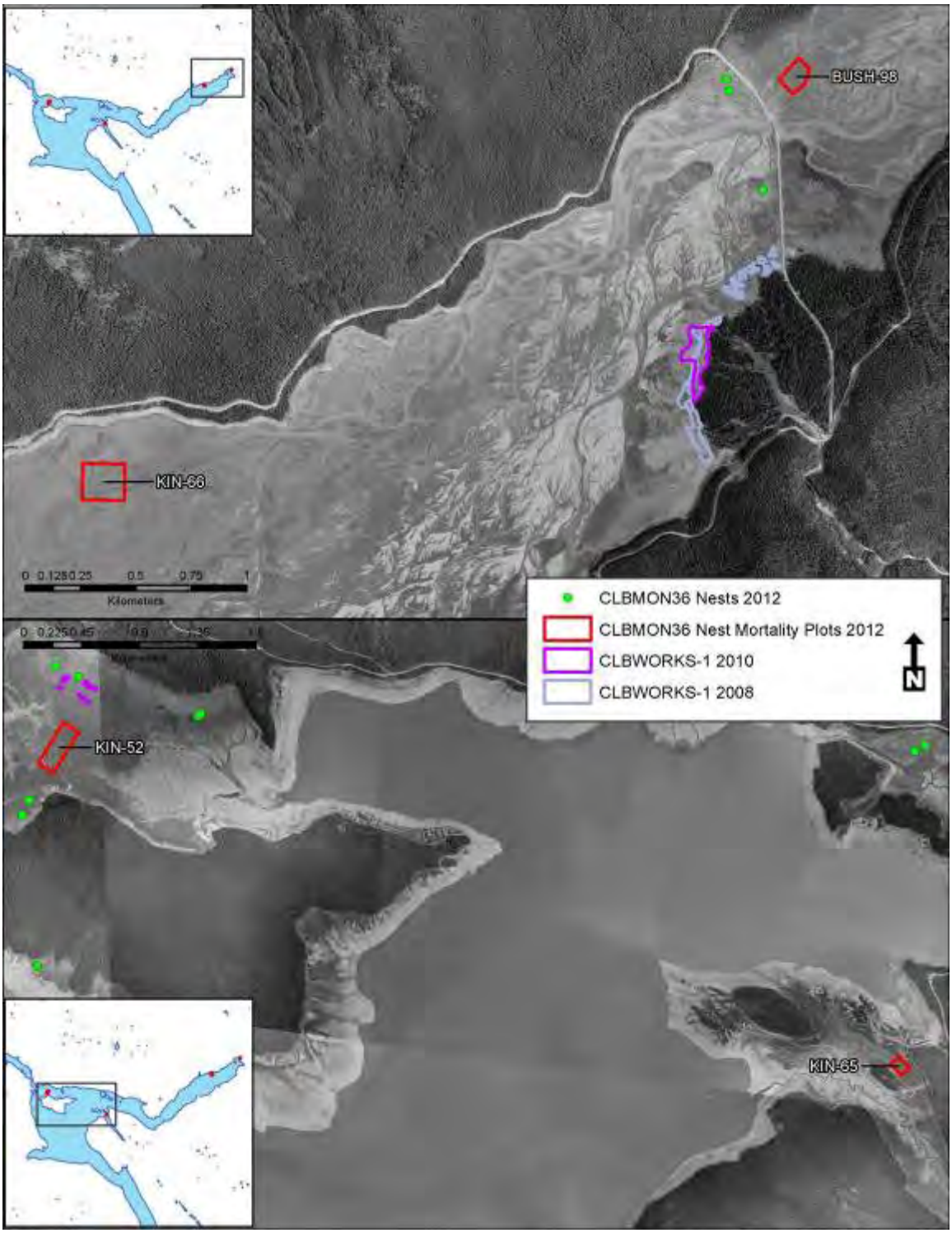


Southern Canoe Reach



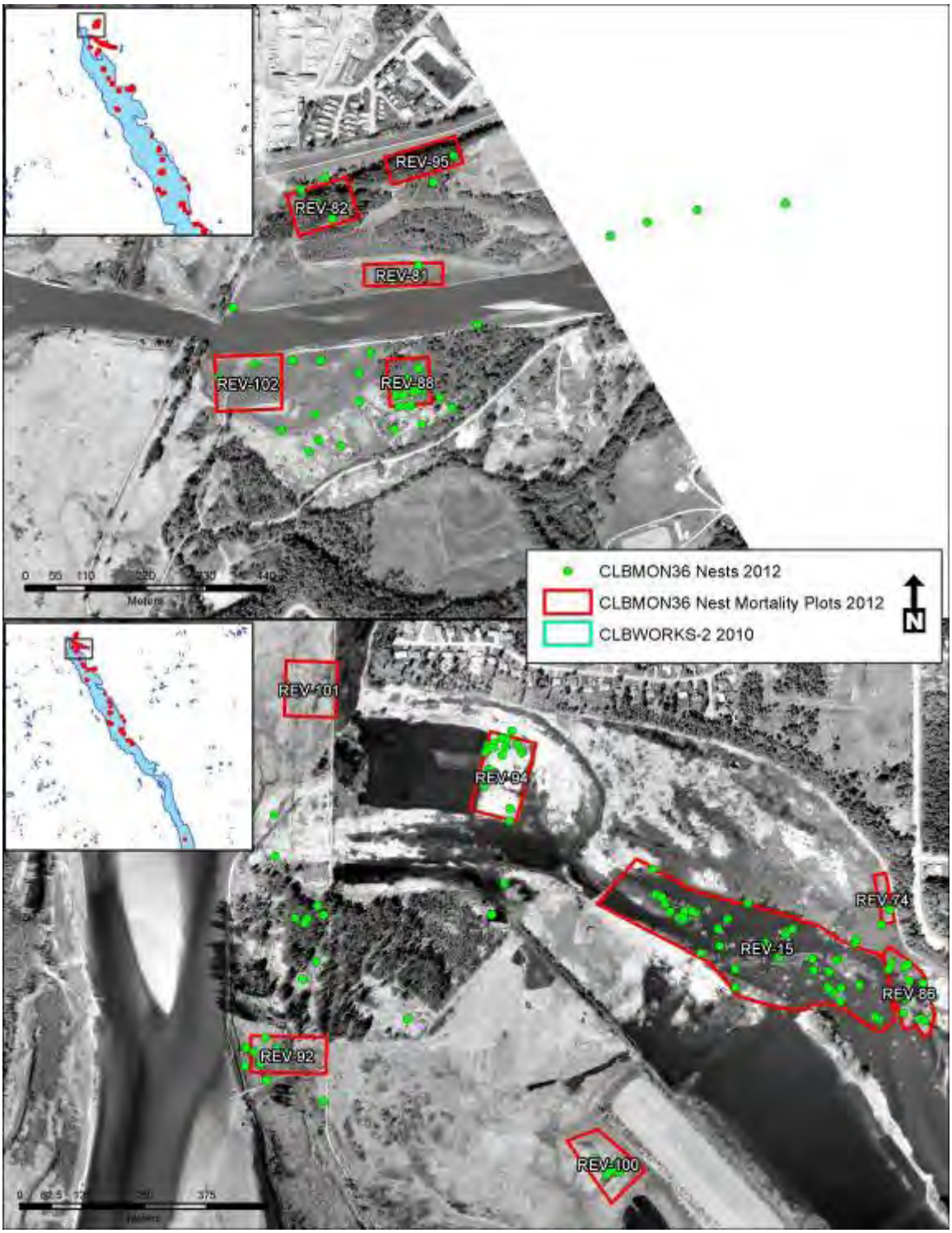
Northern Canoe Reach (top); south-eastern Canoe Reach Bottom

Appendix 6-5: Locations of study sites and nests at Bush Arm

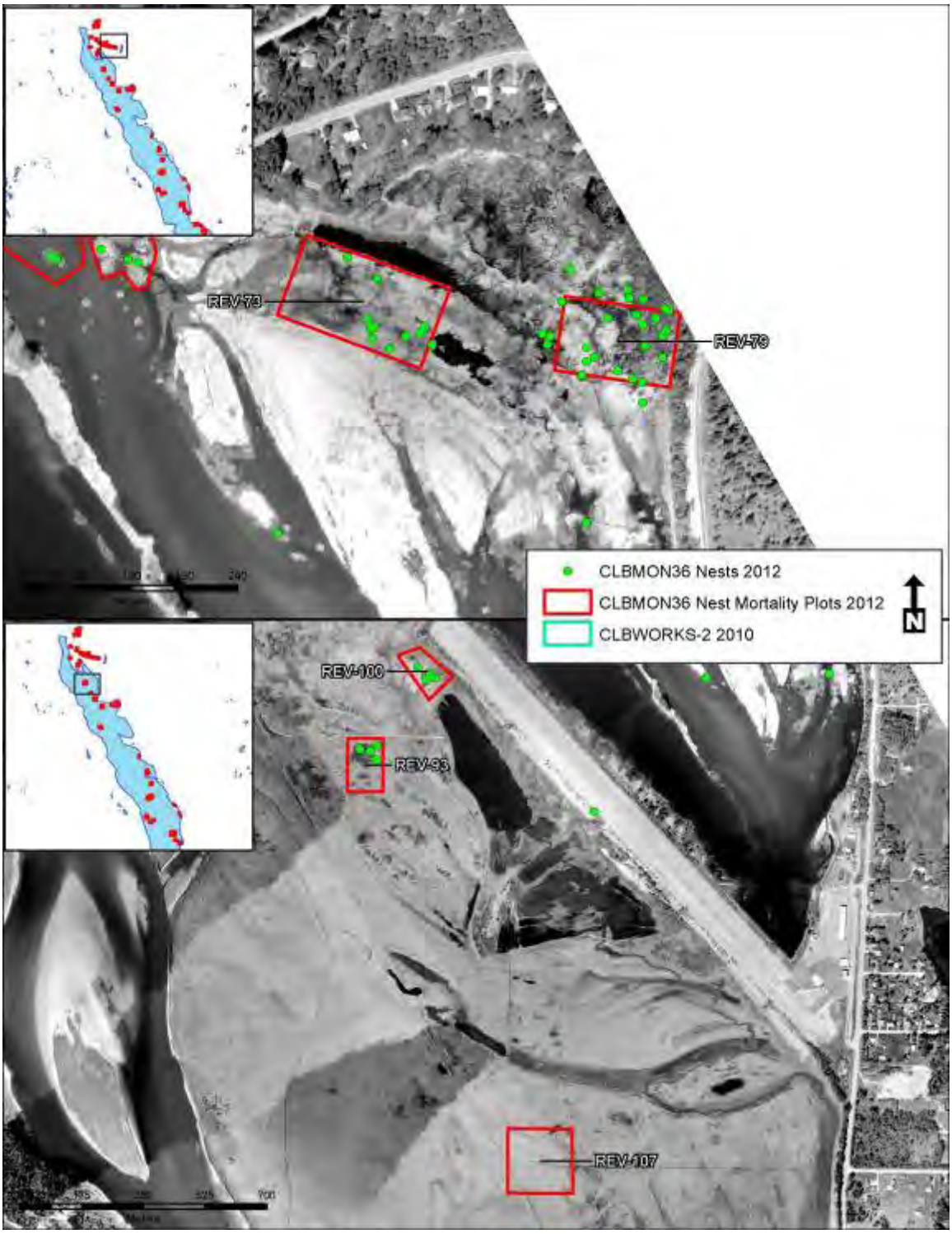


Sites that were monitored well enough in 2012 to determine productivity (sites without any potential nesting birds). Nests were found in other sites (not shown), which will need to be re-monitored in future years.

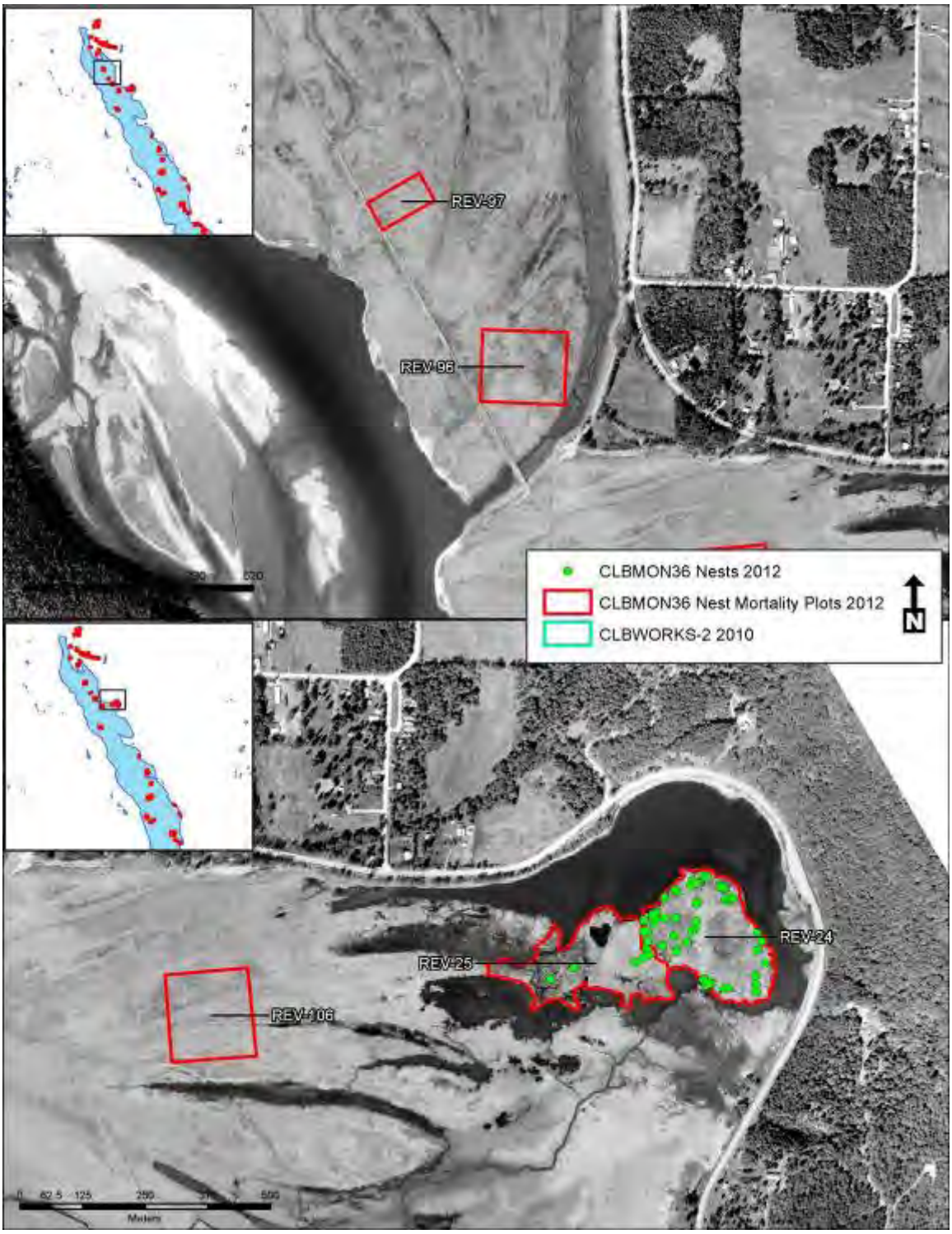
Appendix 6-6: Locations of study sites and nests at Revelstoke Reach



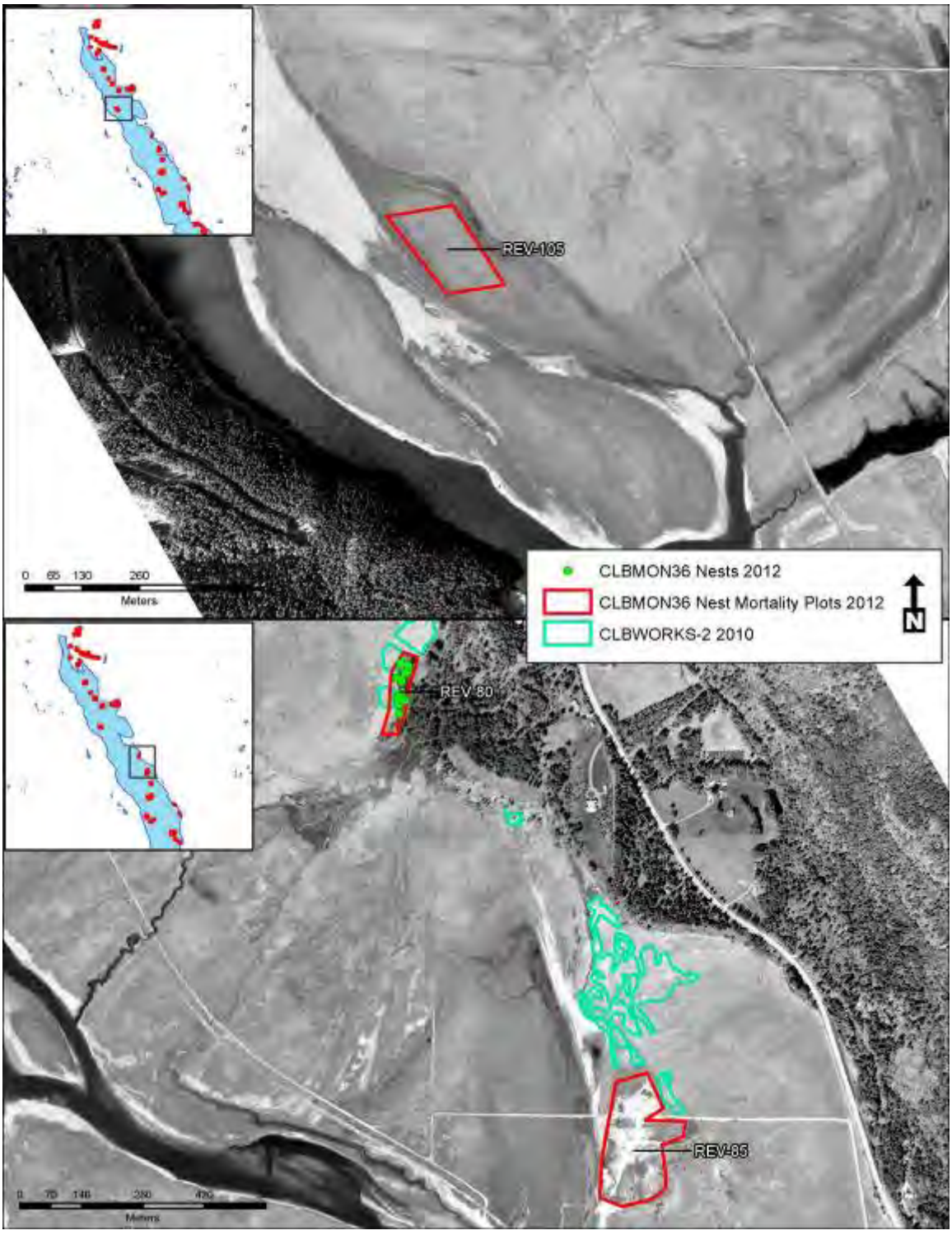
Northern Revelstoke Reach - Illecillewaet (top) and Machete Island/Airport Marsh (bottom)



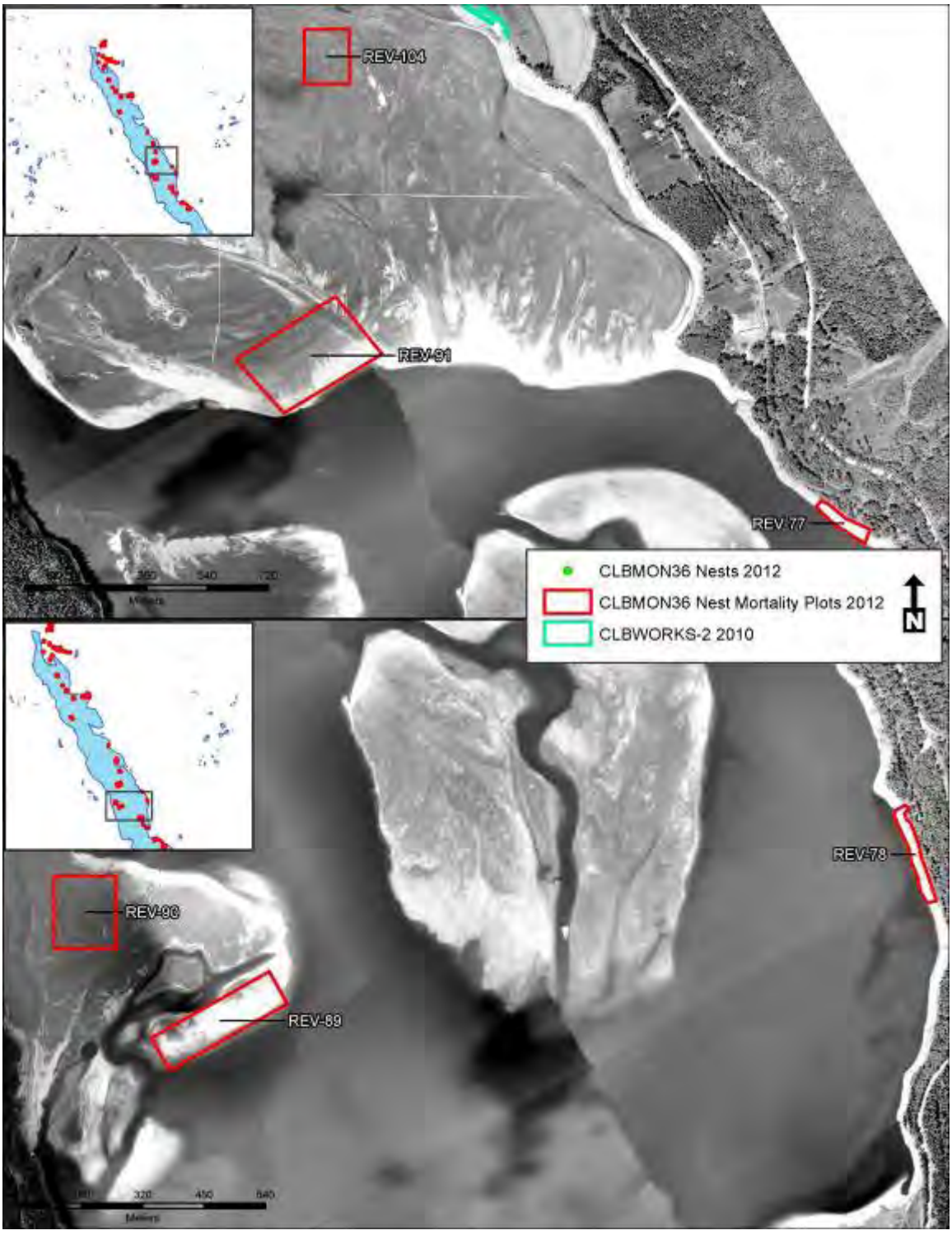
Northern Revelstoke Reach. Airport Marsh (top). West side of airstrip (bottom)



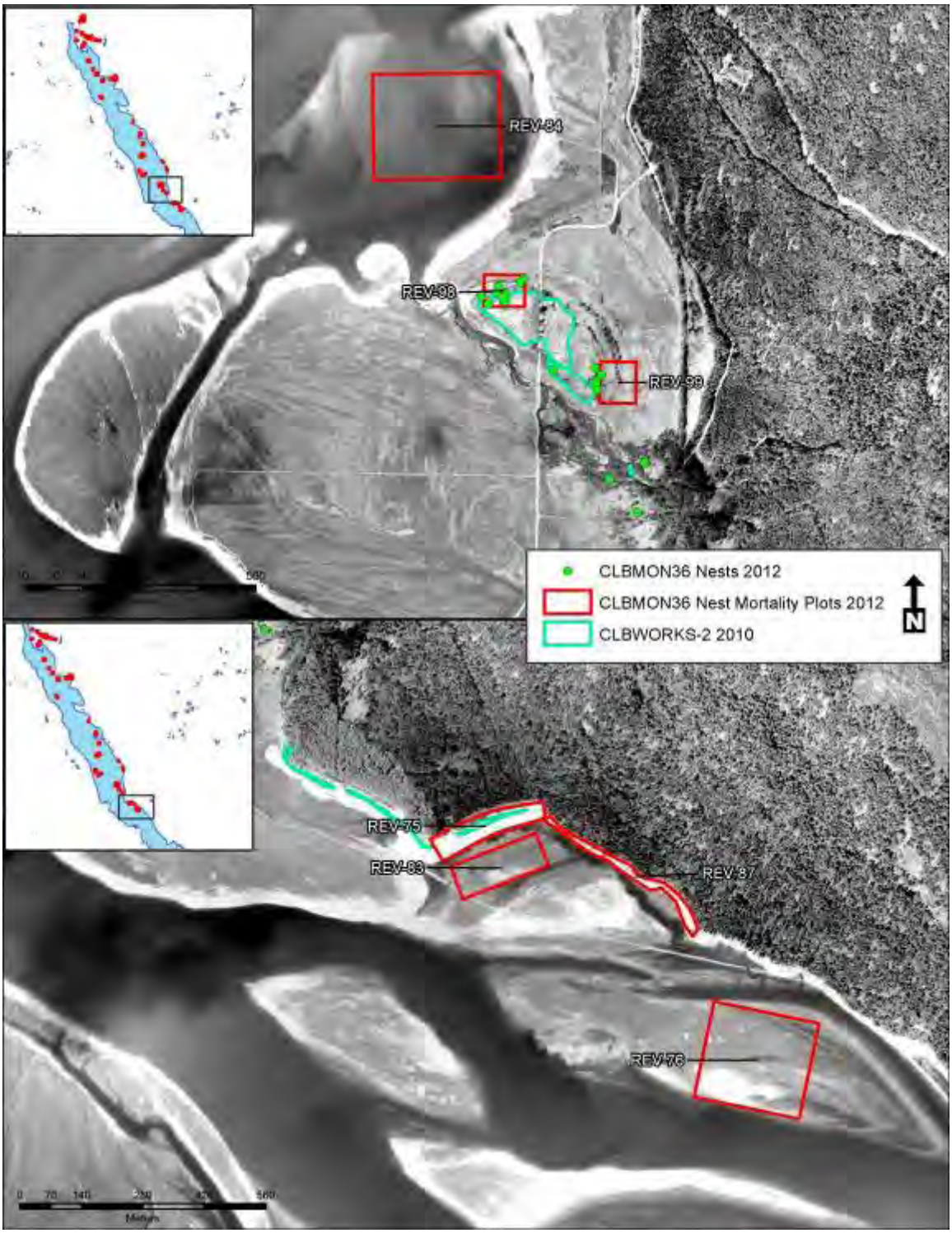
Revelstoke Reach Montana Bay area.



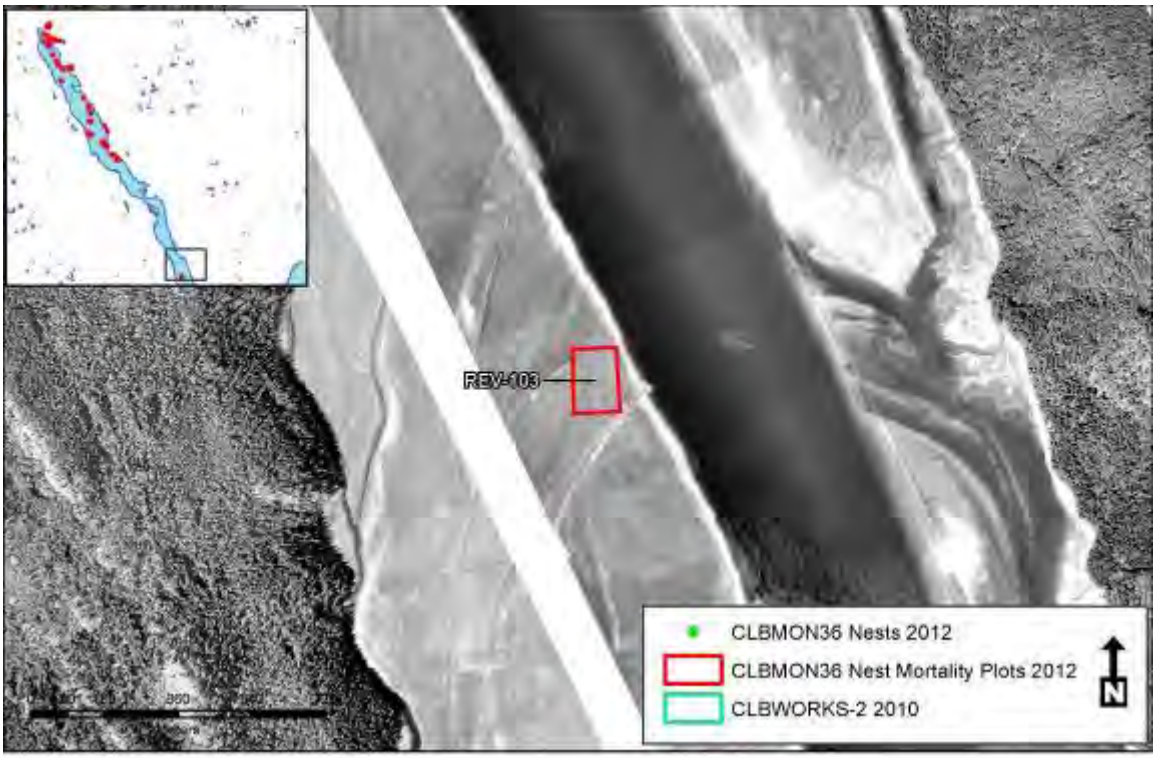
Revelstoke Reach - Cartier Bay (top); McKay Creek (bottom).



Revelstoke Reach. 12 Mile (top); near Mulvehill Creek (bottom).



Revelstoke Reach 12 Mile



Revelstoke Reach south end (Hall's Landing)

Appendix 6-7: Number of nests and supporting substrates in the nest mortality study sites in the drawdown zone in Kinbasket Reservoir and Arrow Lakes Reservoir in 2012

Kinbasket Reservoir

Common Name	Alder	Willow	Cottonwood	Stump	Raspberry	Ground	Ground (Moss)	Ground (Horsetail)	Ground (Grass)	Ground (Sedge)
Canada Goose				1						
Killdeer						5				
Spotted Sandpiper						1			2	2
Wilson's Snipe										1
Traill's Flycatcher	2		1							
Mountain Bluebird				2						
Cedar Waxwing	2									
Common Yellowthroat										1
Chipping Sparrow		1								
Savannah Sparrow						1	3	1	11	12
Lincoln's Sparrow					1		1		1	

Arrow Lakes Reservoir

Common Name	White Pine	Cottonwood	Willow	Alder	Dogwood	Hardhack	Red-osier Dogwood	Twinberry	Snowberry	Rose	Bulrush	Cattail	Ground	Ground (Moss)	Ground (Grass)	Ground (Sedge)
Pied-billed Grebe											1	2				
Canada Goose																1
American Wigeon	1			1										1	2	
Mallard						3						1	1	1	1	1
Cinnamon Teal															1	1
Unidentified Teal													1			
Green-winged Teal																2
Virginia Rail						1						1				
Sora						1						1				4
Killdeer													3			
Wilson's Snipe													1			4
Northern Flicker		1														
Traill's Flycatcher		1	25	3		1										
Least Flycatcher			1													
Dusky Flycatcher		1														
Unidentified Flycatcher			1													
Warbling Vireo		1														
Red-eyed Vireo							1									
Marsh Wren												6				
Veery			1	1												
American Robin		1														
Gray Catbird			4	1		3		1								

Continued... Common Name	White Pine	Cottonwood	Willow	Alder	Dogwood	Hardhack	Red-osier Dogwood	Twinberry	Snowberry	Rose	Bulrush	Cattail	Ground	Ground (Moss)	Ground (Grass)	Ground (Sedge)
Cedar Waxwing		2	28	6		2										
Yellow Warbler		2	32	3	2	7			1	1						
American Redstart		2	1													
MacGillivray's Warbler			1													
Common Yellowthroat			3			1					2	4			1	7
Chipping Sparrow		1	2													
Savannah Sparrow														1		
Song Sparrow			3	3		4						7	1	2		3
Red-winged Blackbird											2	13				7
Yellow-headed Blackbird											8	6				
Unidentified Bird	1					1					1					1

Appendix 6-8: Dates when new nests were found at a site in Montana Bay (REV-24) during the 2012 breeding season

Date	American Wigeon*	Cedar Waxwing	Common Yellowthroat	Gray Catbird	Mallard*	Savannah Sparrow	Song Sparrow	Sora*	Traill's Flycatcher	Unidentified Bird	Unidentified Teal	Wilson's Snipe*	Yellow Warbler	Total
2012-05-18					1		1							2
2012-05-24							1							1
2012-05-27							2							2
2012-06-04					1									1
2012-06-10											1			1
2012-06-13									1	1			3	5
2012-06-17							1							1
2012-06-20					1					1				2
2012-06-23				1	1		2							4
2012-06-26													1	1
2012-07-05				1			1						2	4
2012-07-08		1												1
2012-07-11		1		1										2
2012-07-16							1		1			3	1	6
2012-07-19	1											1		2
2012-07-22	2	1	1				1	1	1					7
2012-07-25	1								2				1	4
2012-07-28						1								1
2012-07-31										1				1
2012-08-03					1		1							2
2012-08-10		2												2
2012-08-27		1												1
2012-08-30		1												1
Total	4	7	1	3	5	1	11	1	5	3	1	4	8	54

* Species that typically nest early and may have moved to the site as the drawdown zone flooded

Appendix 6-9: Number of nests in each outcome category above and within the drawdown zone (DDZ). Bush Arm sites are not included due to the incompleteness of data at that site in 2012

Outcome	Canoe Reach		Revelstoke Reach	
	Above DDZ	Within DDZ	Above DDZ	Within DDZ
Failed for unknown reason	0	1	1	62
Predation	1	6	3	57
Reservoir operations	0	4	0	49
Successful	1	23	10	66
Unknown	0	0	6	46
Known	2	34	14	234
Nesting success (%)	50	68	71	28
Reservoir operations (%)	0	12	0	21

Appendix 6-10: Nest mortalities due to reservoir operations (flooding) in 2012 in each study area (RR = Revelstoke Reach, CR = Canoe Reach, NA = missing data)

Area	Nest ID	Nest Position	Species	Nest Elevation (m ASL)	Nest Height (m)
CR	43314	Shrub	Traill's Flycatcher	754.15	1.30
CR	45410	Low in Shrub	Common Yellowthroat	754.49	0.20
CR	44380	Ground	Savannah Sparrow	751.33	0.00
CR	44572	Ground	Savannah Sparrow	752.69	0.00
RR	41014	Ground	Mallard	436.16	0.00
RR	41138	Ground	Mallard	438.28	0.05
RR	42116	Ground	Mallard	439.37	0.00
RR	41436	Low in Shrub	Sora	438.19	0.01
RR	42916	Low in Shrub	Sora	435.97	0.10
RR	41768	Shrub	Traill's Flycatcher	438.90	0.85
RR	42301	Shrub	Traill's Flycatcher	438.50	1.30
RR	43073	Shrub	Traill's Flycatcher	437.30	1.05
RR	43096	Shrub	Traill's Flycatcher	437.94	1.60
RR	43231	Shrub	Traill's Flycatcher	438.42	1.35
RR	43397	Shrub	Traill's Flycatcher	439.18	1.40
RR	43405	Shrub	Traill's Flycatcher	437.20	1.95
RR	44023	Shrub	Traill's Flycatcher	438.34	2.00
RR	44112	Shrub	Traill's Flycatcher	438.02	NA
RR	44172	Shrub	Traill's Flycatcher	438.45	1.50
RR	42366	Shrub	Dusky Flycatcher	437.44	1.30
RR	43285	Shrub	Unidentified Flycatcher	438.17	0.90
RR	44239	Shrub	Unidentified Flycatcher	438.35	2.75
RR	43175	Low in Shrub	Veery	439.11	0.40
RR	44302	Shrub	Gray Catbird	439.53	1.40
RR	45396	Shrub	Gray Catbird	439.00	2.05
RR	43086	Shrub	Cedar Waxwing	438.53	1.60
RR	43414	Shrub	Cedar Waxwing	438.26	1.85
RR	43937	Shrub	Cedar Waxwing	437.22	NA
RR	44110	Shrub	Cedar Waxwing	438.14	NA
RR	41529	Shrub	Yellow Warbler	436.07	0.65
RR	41849	Shrub	Yellow Warbler	438.07	1.50
RR	44916	Shrub	Yellow Warbler	437.36	1.50
RR	45077	Shrub	Yellow Warbler	438.30	1.25
RR	45106	Shrub	Yellow Warbler	438.07	1.25
RR	45118	Shrub	Yellow Warbler	438.15	1.60
RR	45279	Shrub	Yellow Warbler	438.36	1.60
RR	43052	Low in Shrub	MacGillivray's Warbler	439.59	0.15
RR	41407	Low in Shrub	Common Yellowthroat	438.43	0.20
RR	41927	Low in Shrub	Common Yellowthroat	438.77	0.15
RR	43292	Low in Shrub	Common Yellowthroat	438.20	0.30
RR	44207	Low in Shrub	Common Yellowthroat	439.38	0.60
RR	41412	Low in Shrub	Song Sparrow	436.11	0.00
RR	41792	Low in Shrub	Song Sparrow	438.80	0.50
RR	41084	Low in Shrub	Red-winged Blackbird	438.19	0.65

Area	Nest ID	Nest Position	Species	Nest Elevation (m ASL)	Nest Height (m)
RR	41351	Low in Shrub	Red-winged Blackbird	438.28	0.25
RR	42286	Low in Shrub	Red-winged Blackbird	438.22	0.34
RR	42905	Low in Shrub	Red-winged Blackbird	438.52	0.30
RR	40835	Low in Shrub	Yellow-headed Blackbird	438.28	0.50
RR	41357	Low in Shrub	Yellow-headed Blackbird	438.25	0.30
RR	41432	Low in Shrub	Yellow-headed Blackbird	438.19	0.85
RR	42101	Low in Shrub	Yellow-headed Blackbird	438.19	1.00
RR	42346	Low in Shrub	Yellow-headed Blackbird	438.19	1.40
RR	42940	Low in Shrub	Yellow-headed Blackbird	438.22	0.75

Appendix 6-11: Outcomes of the 2012 telemetry pilot study of juvenile Savannah Sparrows (SAVS) and Yellow Warblers (YWAR). "Date" indicates when the juvenile was tagged. "Days Monitored" indicate how many days the focal bird was monitored while it was still alive

Bird ID	Species	Date	Days Monitored	Outcome
15	SAVS	2012-07-02	2	Transmitter failed
9	SAVS	2012-06-29	5	Killed by snake
17	SAVS	2012-07-09	1	Killed by snake
5	SAVS	2012-06-27	22	Survived
4	SAVS	2012-06-27	3	Unknown cause of death
19	SAVS	2012-07-27	0	Unknown cause of death
8	SAVS	2012-06-29	7	Undetermined predator
16	SAVS	2012-07-05	2	Undetermined predator
13	YWAR	2012-06-30	0	Drowned
10	YWAR	2012-06-29	1	Transmitter failed
2	YWAR	2012-06-25	0	Nest predated
1	YWAR	2012-06-24	19	Survived
14	YWAR	2012-07-01	19	Survived
3	YWAR	2012-06-25	4	Transmitter submerged
6	YWAR	2012-06-27	0	Transmitter submerged
11	YWAR	2012-06-30	2	Transmitter submerged
12	YWAR	2012-06-30	3	Transmitter submerged
18	YWAR	2012-07-10	3	Transmitter submerged

Appendix 6-12: Tables summarizing birds banded for CLBMON 36 in 2012

Newly capture birds (CBA = Cooper Beauchesne and Associates Ltd, SFU = Simon Fraser University, SAVS = Savannah Sparrow, YWAR = Yellow Warbler).

Agency	Species	AHY	ASY	HY	Local	SY
CBA	SAVS	8	0	8	61	0
CBA	YWAR	0	0	2	0	0
SFU	YWAR	0	25	34	0	33

Recaptured birds (CBA = Cooper Beauchesne and Associates Ltd, SFU = Simon Fraser University, SAVS = Savannah Sparrow, YWAR = Yellow Warbler).

Agency	Species	AHY	ASY	SY
CBA	SAVS	1	1	0
SFU	YWAR	0	15	2