Columbia River Project Water Use Plan

KINBASKET AND ARROW LAKES RESERVOIR

Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir

Implementation Year 6

Reference: CLBMON-11A

Study Period: 2013

Okanagan Nations Alliance, Westbank, BC

and

LGL Limited environmental research associates
Sidney, BC

May 21, 2014

EA3450

KINBASKET AND ARROW LAKES RESERVOIRS

Monitoring Program No. CLBMON-11A
Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir




2013 Annual Report
Final

Prepared for

BC Hydro Generation
Water Licence Requirements
6911 Southpoint Drive
Burnaby, BC

Prepared by

Okanagan Nation Alliance

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May 21, 2014

Suggested Citation:

V.C. Hawkes, N. Hentze, J. Muir, J. Sharkey, J. Gatten, B. McKinnon and P. Gibeau. 2014. CLBMON-11A. Kinbasket and Arrow Lakes Reservoirs: Wildlife Effectiveness Monitoring and Enhancement Area Identification for Lower and Mid-Arrow Lakes Reservoir. Annual Report – 2013. LGL Report EA3450. Unpublished report by Okanagan Nation Alliance, Westbank, B.C. and LGL Limited environmental research associates, Sidney, B.C., for BC Hydro Generation, Water Licence Requirements, Burnaby, BC. 59 pp. + Appendices.

EXECUTIVE SUMMARY

CLBMON-11A, initiated in 2008, is a long-term wildlife monitoring project that aims to assess the efficacy of revegetation prescriptions (i.e., CLBWORKS-1) in enhancing the suitability of habitats in the drawdown zone of Kinbasket Reservoir for wildlife. The focal species groups selected for this study are small mammals, arthropods and mammals (ungulates). These taxa were all sampled in 2013.

Monitoring was conducted annually from 2008 to 2012 by Cooper Beauchesne and Associates Ltd. The Okanagan Nations Alliance (ONA), in partnership with LGL Limited environmental research associates, continued monitoring in 2013. The existing study design and sampling protocols were closely followed in Year 6 (2013) to ensure backwards compatibility with previous study years, with the exception that vegetation sampling was not conducted because this is done by the CLBMON-9 and CLBMON-10 studies, and pitfall traps were substituted for pan traps to sample ground arthropods. In addition, two pilot studies were conducted in 2013 to assess the feasibility of using bats and birds to provide relevant data for answering the management questions. Bats were investigated because of the known relationships between bats, wetland and riparian habitat, and arthropods, which are their primary food source. Songbirds were also assessed to determine if sufficient numbers of insect foraging birds were present to warrant inclusion of this taxa in future CLBMON-11A monitoring.

Sampling in 2013 was conducted at control, treatment, and reference transects within each of seven sites in Kinbasket Reservoir. Control transects are in untreated (i.e., not revegetated) areas of the drawdown zone, treatment transects are located in areas where revegetation prescriptions have been applied and reference transects are in non-drawdown zone (i.e., upland habitats) that are monitored to document regional and natural variation in the taxa being studied.

Four management questions (MQs) are being addressed by this monitoring program: (1) How effective is the revegetation program at enhancing and increasing the utilization of habitat in the drawdown zone by wildlife such as amphibians, birds, small mammals, and ungulates? (2) To what extent does revegetation increase the availability of invertebrate prey (e.g. arthropods) in the food chain for birds, amphibians and small mammals? (3) Are revegetation efforts negatively impacting wildlife in the drawdown zone? For example, does revegetation increase the incidence of nest mortality in birds or create sink habitat for amphibians? and (4) Which methods of revegetation are most effective at enhancing and increasing the utilization of wildlife habitat in the drawdown zone?

Our ability to address each of the management questions is summarized below. The methods applied to date (small mammal live-trapping, ungulate surveys, and arthropod sampling) are not well-suited to answering the management questions associated with CLBMON-11A. The wrong species of small mammal are being targeted, the productivity (i.e., seed load) of plants that would be consumed by granivorous small mammals has not been assessed, songbirds have not been considered a focal taxa for CLBMON-11A, and the size of the revegetation prescriptions applied in the drawdown zone are likely of little benefit to ungulates given the proximity and spatial extent of suitable habitat adjacent to the drawdown zone. Overall, there does not appear to have been a connection made between the types of plants used in the revegetation program and how the use of those species would benefit wildlife using the drawdown zone of Kinbasket Reservoir.

Table 0-1: Relationships between management questions (MQs), methods and results, sources of uncertainty, and the future of project CLBMON-11A

MQ	Able to Address MQ?	Scope		Sources of Uncertainty
		Current supporting results	Suggested modifications to methods where applicable	
1 How effective is the revegetation program at enhancing and increasing the utilization of habitat in the drawdown zone by wildlife	Partially	Generally, diversity and relative abundance of indicator taxa are greater in non-drawdown habitat than in drawdown. Few differences were apparent between treatment and control transects within the drawdown, with the exception of spiders that were absent from most control transects.	• Increased frequency of sampling (i.e., annually) • Add additional focal groups (i.e., birds and bats) • Add other sites as physical works are implemented (e.g., woody debris removal) • Consider the development of physical works prescriptions (e.g., analogous to CLBMWORKS-29B for Arrow Lakes Reservoir)	• Lack of appropriate baseline (sampling did not occur prior to the application of the revegetation prescriptions) • Natural annual population variation • Variable reservoir operations • Widespread revegetation failure • Bi-annual sampling
2 To what extent does revegetation increase the availability of invertebrate prey in the food chain	Partially	General arthropod richness, relative abundance and biomass did not appear different between treatment and control transects. However spiders were notably absent from control transects, while present on the majority of treatment transects. No difference between control and treatment transects were noted for beetles. Arthropod communities in the drawdown zone (i.e., on both control and treatment transects) tend to be similar but are different from non-drawdown communities. General arthropod richness and biomass were significantly higher in non-drawdown. There was a clear trend of greater spider family and species-level diversity above the drawdown zone than within it.	• Sample insectivorous mammals (e.g., bats, shrews) • Annual sampling for all groups • Add other sites as physical works are implemented (e.g., woody debris removal) • Consider the development of physical works prescriptions (e.g., analogous to CLBMWORKS-29B for Arrow Lakes Reservoir)	• Lack of appropriate baseline (sampling did not occur prior to the application of the revegetation prescriptions) • Natural annual population variation • Unknown dietary preferences or intake rates for species in the drawdown zone • Variable reservoir operations • Bi-annual sampling
3 Are revegetation efforts negatively impacting wildlife in the drawdown zone?	No	No negative impacts detected. Some (very moderate) suggestions of localized benefits, e.g., high elk pellet counts found on treatment transect at Goodfellow Creek.	• Management question is suited for other current studies in the region, not well stated to be addressed in this program.	• Lack of appropriate baseline (sampling did not occur prior to the application of the revegetation prescriptions) • Natural annual population variation • Widespread revegetation failure • Lack of knowledge regarding the use of the drawdown zone in the winter • Variable reservoir operations

MQ	Able to Address MQ?	Scope		Sources of Uncertainty
		Current supporting results	Suggested modifications to methods where applicable	
4 Which methods of revegetation are most effective at enhancing and increasing the utilization of wildlife habitat in the drawdown zone	No	None	• Focus on any successfully revegetated areas • Modify study to evaluate success of woody debris removal programs.	• Lack of appropriate baseline (sampling did not occur prior to the application of the revegetation prescriptions) • Widespread revegetation failure • Lack of sufficient study design (i.e., appropriate size, replicates, controls) to address wildlife questions • Variable reservoir operations

Despite the overall assessment of ineffectiveness and issues associated with the current focal taxa, there are opportunities to modify CLBMON-11A to assess the use of the drawdown zone by wildlife and to evaluate whether physical works programs, such as the woody-debris removal program (CLBWORKS-16) can effectively enhance wildlife habitat in the drawdown zone. Further, consideration of physical works designed to protect specific habitats in the drawdown zone would likely be beneficial in Kinbasket Reservoir. The implementation of physical works in the drawdown zone has a high likelihood of enhancing the drawdown zone for wildlife by providing opportunities for the establishment and development of vegetation communities, which would subsequently be used by wildlife. Areas treated under CLBWORKS-1 in 2013 (KM 88) should be monitored. The area treated is larger than other areas treated previously, the sedge plugs used were larger, and the density of planting was higher.

The following recommendations are made for the implementation of CLBMON-11A in 2014:

1. **Modify the focal taxa** to focus on spiders, beetles, ungulates (pellet plots), and grass/ground-nesting birds. These taxa are more likely to exhibit a measureable response to habitat change in the drawdown zone. Ungulate pellet plots are recommended to continue to document the use of the drawdown zone by ungulates. Small mammals should not be monitored as they do not contribute data necessary to answering the management questions.
2. **Monitor KM 88** to assess wildlife use of the areas treated in 2013, which represent a different prescription (larger sedge plugs, larger area, and higher density of planting).
3. **Consider the development of physical works prescriptions for the drawdown zone of Kinbasket Reservoir.** Developing prescriptions to protect or enhance high quality habitats that exist in the drawdown zone (e.g., Ptarmigan Creek, Bush Arm Causeway, Ponds in the Valemount Peatland) would contribute to an overall improvement in wildlife habitat suitability (if the physical works are built).
4. **Explore the potential of woody debris removal for facilitating natural colonization and/or regeneration processes.** Anecdotal evidence suggests that reducing woody debris accumulation on sites with dormant seed and/or rhizome banks can stimulate rapid regrowth, possibly providing a more cost-effective route to site remediation over the long term than site stocking. In lieu of more costly physical works, we recommend that woody debris be removed from selected sites in the drawdown zone, and that CLBMON-11A evaluate the effectiveness of targeted woody debris removal in enhancing colonization and regeneration processes, which will ultimately results in increased

wildlife habitat suitability. This approach aligns with the proposed approach for CLBMON-9.

5. **Pre-treatment sampling.** If implementing recommendation 4, sample prior to woody debris removal. One of the limitations of this program is the lack of pre-treatment data, which makes it difficult to determine if any observed changes are treatment effects or related to pre-existing phenomena.
6. **Consider modifying the sampling program of CLBMON-11A from bi-annual to annual:** Collecting ecological data on an annual basis would provide a better indication of the annual variability associated with those species groups and their use of the drawdown zone (with particular emphasis on the use of control and treatment sites).
7. **Reconsider the frequency of aerial surveys for ungulates**. Aerial surveys may only need to be conducted every 5 years, during the winter, to assess the distribution and occurrence of ungulates (and other winter-active animals like wolves and wolverines) relative to the drawdown zone.
8. **Consider increasing the total area revegetated** in the drawdown zone (i.e., expand existing treatment areas) or add additional treatment areas of the same prescriptions applied previously to increase the number of replicates.
9. **Future revegetation.** If future revegetation is to occur, consider the species of wildlife that are likely to benefit from the revegetation to ensure the appropriate mix of plants is used, that the total area planted is likely to influence wildlife use of the drawdown zone, and that the revegetation prescriptions be applied in a replicated manner with sufficient stratification.

Key Words: Kinbasket Reservoir, ungulates, songbirds, arthropods, bats, revegetation, effectiveness monitoring, drawdown zone, hydro

ACKNOWELDGEMENTS

The authors express their appreciation to the following individuals for their assistance in coordinating and conducting this study: Margo Dennis, Guy Martel, and Phil Bradshaw (BC Hydro), James Pepper, Alan Peatt, Dixon Terbasket, and Alexis Freisen (Okanagan Nation Alliance), Dr. Robb Bennett (Royal British Columbia Museum), Claudia Copley, James Miskelly (Royal British Columbia Museum), and Bonnie Zand (Bonnie's Bugs IPM), Doug Adama (LGL Limited), Jeremy Gatten (LGL limited), Charlene Wood (LGL limited), Bryce McKinnon (LGL limited), Robin Tamasi (LGL Limited).

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ACRONYMS AND DEFINITIONS

These definitions are consistent with those used in the companion Arrow Lakes Reservoirs Wildlife Effectiveness study CLBMON11B1 (Hawkes et al. 2012). Definitions are presented in a logical, not alphabetical, order.

Drawdown Zone: the terrestrial portion of the reservoir that is inundated and exposed due to changing reservoir elevations, typically between 707.41–754.38 m ASL.

Non-drawdown Zone: non-reservoir habitats above the drawdown zone that contain Local Reference Transects and Causeway site Reference Transects (see below)

Revegetation Area: areas revegetated in the upper portion of the drawdown zone (~741–754 m ASL) under CLBWORKS-1 between 2008 and 2011 and in 2013.

Revegetation Prescription: the prescriptions implemented in the revegetation areas. Monitoring by CLBMON-11A was constrained to revegetated areas that were large enough for a transect to be established within them, and revegetation prescriptions that allowed for replication. For simplicity, these prescriptions were categorized as:

EPL: excavator-planted live stake

EPL/HPL: excavator-planted live stake and hand-planted live stake

HPL: hand-planted live stake

PS: plug seedling

Reach: refers to a broad geographic area of the reservoir used as the highest level of stratification for sampling. Two reaches within Kinbasket Reservoir were sampled for CLBMON-11A Canoe Reach in the north and Bush Arm in the south. Specific sites are sampled within each reach.

Site: Sampling location within a reach consisting of three transects (as feasible given site constraints), i.e., treatment, control and local reference, defined as follows:

Control Transect: area of the drawdown zone that was not revegetated using the revegetation prescriptions developed for CLBWORKS-1. A control transect was placed in an area of similar elevation, topography and substrate as that site's treatment transect.

Treatment Transect: area of the drawdown zone that was revegetated using one of the revegetation prescriptions developed for CLBWORKS-1.

Local Reference Transect[1]: A transect located adjacent to the site but above the drawdown zone (>754 m in elevation), in an area considered the most likely source for small mammals to disperse into the drawdown zone (CBA 2011a). One of the functions of the local reference transects is to allow for interpretation of naturally occurring changes in the relative abundance, diversity, richness or other metric associated with one or more of the focal groups over time.

Reference Transect: Transect type assigned to two transects that were established in 2010 in naturally revegetated areas above the drawdown zone at the Causeway site (# 121).

[1] The concept of a local reference was introduced by CBA (2009a and 2009b) and has been exclusively used by CBA for CLBMON-11A and CLBMON-36. Local reference sites have not been characterized ecologically, and are not recognized by the other monitoring programs or physical works.

Sampling Station: Each transect contains multiple sampling stations used to survey focal taxa (i.e., small mammal traps, ungulate pellet group counts, bat recordings, songbird point counts, and Malaise and pitfall traps for terrestrial arthropods). The transect design showing locations of the different sampling stations is illustrated in Figure 4-1.

Season: In the context of CLBMON-11A, seasons are defined as spring (April and May), early summer (June through mid-July), late summer (mid-July through mid-August) and late summer (mid-August to early September).

WLR: Water Licence Requirements

1.0 INTRODUCTION

Kinbasket Reservoir is located in southeast British Columbia between the towns of Donald and Valemount. The reservoir was created in 1974 to serve as the primary storage reservoir for power generation on the Columbia system. The 216 km reservoir is licensed to fluctuate 46.9 meters (the drawdown zone) throughout a year, resulting in erosion and habitat degradation in the reservoir's upper elevations (741—754 m ASL) (BC Hydro 2005). A Water Use Plan (WUP) was developed in 2007 as a result of a multi-stakeholder consultative process to determine how to best operate BC Hydro's facilities on the Columbia River to balance environmental values, recreation, power generation, culture/heritage, navigation and flood control (BC Hydro 2007). The process involved a number of interest groups, First Nations, government agencies and other stakeholders collectively referred to as the Consultative Committee (CC)[2]. The goal of the WUP was to accommodate these values through operational means (i.e., patterns of water storage and release) and non-operational physical works (in lieu of changing reservoir operations).

During the water use planning process, both the need and opportunity to improve wildlife habitat in the upper elevations of Kinbasket Reservoir was recognized (BC Hydro 2005). The CC reviewed the operating alternatives and supported the implementation of physical works in the Kinbasket Reservoir to help mitigate impacts to wildlife and wildlife habitat in lieu of changing reservoir operations. The CC supported a reservoir-wide planting program (CLBWORKS-1) compatible with both the current operating regime and proposed operating alternatives to maximize vegetation growth in the drawdown zone. Recognizing the need to assess the effectiveness of this program, the CC also recommended a number of studies to monitor and "audit" the effectiveness of planting efforts on vegetation communities and wildlife habitat use. This recommendation resulted in the creation of several monitoring programs including CLBMON-9 to assess the effectiveness of revegetation treatments in establishing vegetation communities within the drawdown zone, and CLBMON-11A, an 11-year monitoring program to assess the revegetation program effectiveness at increasing wildlife utilization within the drawdown zone of Kinbasket Reservoir. The terms of reference for CLBMON-11A (BC Hydro 2008) also states that this study's results will aid in more informed decision-making with respect to the need to balance requirements of wildlife that are dependent on wetland and riparian habitats, with other values such as recreational opportunities, flood control and power generation. The key water use planning decision affected by the findings of CLBMON-11A is whether revegetation, in lieu of changes to reservoir operations, is effective at enhancing wildlife habitat and reducing the negative effects of reservoir operations on wildlife. Results from this study will also support an adaptive management approach in refining the objectives and methods for enhancing wildlife habitat in the drawdown zone.

The terms of reference for CLBMON-11A (BC Hydro 2008) describes the objectives of the monitoring program, identifies a suite of indicator taxa (amphibians, birds, small mammals, ungulates and invertebrates) and provides recommendations for the study's implementation. A study design was developed in 2008 that monitors the response of terrestrial arthropods, small mammals and ungulates at control, treatment, and local reference sites (CBA 2010a). Monitoring was conducted annually from 2008 to 2012 by CBA (CBA 2009a, 2010b, 2011a,b) and by the Okanagan Nation Alliance and LGL Limited in 2013.

[2] The Okanagan Nation Alliance did not participate in this process

2.0 OBJECTIVES AND MANAGEMENT QUESTIONS

The overarching goal of CLBMON-11A is to monitor and audit the efficacy of revegetation efforts in increasing the suitability of wildlife habitats in the drawdown zone of Kinbasket Reservoir. The objectives of this program include the design and implementation of an 11-year monitoring program for selected indicator taxa to facilitate the audit, and provide feedback on how to improve habitat for wildlife through adaptive management. More specifically, the objectives as stated in the terms of reference are three-fold:

1. Develop an effectiveness-monitoring program to assess whether revegetation efforts in the drawdown zone of Kinbasket Reservoir improve habitat for wildlife.
2. Assess how effective the revegetation efforts are at improving habitat for wildlife in the drawdown zone between 741 m and 754 m ASL elevation.
3. Report and provide recommendations on the effectiveness of the revegetation program on improving habitat for wildlife in the drawdown zone in Years 5 and 10 (2012 and 2018, respectively)[3].

CLBMON-11A was initiated in 2008 and Objective 1 was completed with refinements to the study design incorporated annually. The monitoring of indicator taxa was performed between 2008 and 2012 with some sampling (i.e., ungulate pellet plots) conducted in only 2011 and 2012.

2.1 Management Questions and Hypotheses

To meet the objectives of the monitoring program, BC Hydro identified several key management questions and four associated management hypotheses that were designed to help address both the management questions and the study objectives.

The four management questions are:

1. How effective is the revegetation program at enhancing and increasing the utilization of habitat in the drawdown zone by wildlife such as amphibians, birds, small mammals, and ungulates?
2. To what extent does revegetation increase the availability of invertebrate prey (e.g. arthropods) in the food chain for birds, amphibians and small mammals?
3. Are revegetation efforts negatively impacting wildlife in the drawdown zone? For example, does revegetation increase the incidence of nest mortality in birds or create sink habitat for amphibians?
4. Which methods of revegetation are most effective at enhancing and increasing the utilization of wildlife habitat in the drawdown zone?

The management hypotheses to be tested by this study include:

H_1: Revegetation does not increase the utilization of habitats by amphibians in the drawdown zone.

- H_{1A}: Revegetation does not increase species diversity or seasonal (spring/summer/fall) abundance of amphibians in the drawdown zone.
- H_{1B}: Revegetation does not increase the abundance of amphibian prey (e.g. arthropods).

[3] The 5-year report that was to be developed in 2012 was deferred.

H_{1C}: Revegetation does not increase amphibian productivity (e.g., egg laying and young of year survival).

H_{1D}: Revegetation does not increase the amount of amphibian habitat in the drawdown zone.

H_2: Revegetation does not increase the utilization of habitats by birds in the drawdown zone.

H_{2A}: Revegetation does not increase the species diversity or abundance of birds utilizing the drawdown.

H_{2B}: Revegetation does not reduce nest mortality of birds that nest in the drawdown zone.

H_{2C}: Revegetation does not increase the survival of juvenile birds in the drawdown zone.

H_{2D}: Revegetation does not increase the abundance of songbird, shorebird, or marshbird prey (e.g. arthropods).

H_{2E}: Revegetation does not increase the amount of bird habitat in the drawdown zone.

H_3: Revegetation does not increase the utilization of habitats by small mammals in the drawdown zone.

H_{3A}: Revegetation does not increase the diversity or abundance of small mammals in the drawdown zone.

H_{3B}: Revegetation does not increase the abundance of small mammal prey (e.g. arthropods).

H_{3C}: Revegetation does not increase the amount of small mammal habitat in the drawdown zone.

H_4: Revegetation does not increase the utilization of habitat by ungulates in the drawdown zone.

H_{4A}: Revegetation does not increase the seasonal abundance (winter/spring) of ungulates in the drawdown zone.

H_{4B}: Revegetation does not increase the abundance (tonnes per hectare) of ungulate forage.

H_{4C}: Revegetation does not increase the amount of ungulate habitat in the drawdown zone.

H_5: Revegetation does not increase the area of extent of high value wildlife habitat in the drawdown zone.

Management question 4, "Which methods of revegetation are most effective at enhancing and increasing the utilization of wildlife habitat in the drawdown zone" is not associated with a management hypothesis, but will be addressed under CLBMON-11A. Management hypotheses testing whether the amount of habitat has changed for each indicator taxon (i.e., H_{1D}, H_{2E}, H_{3C}, H_{4C}) are not addressed by CLBMON-11A, however hypothesis H_5 that generally evaluates amount of high value wildlife habitat will be evaluated.

As described in the terms of reference several of the indicator taxa will be monitored under separate Water Licence Requirements (WLR) monitoring programs (e.g., CLBMON-37/58 monitors amphibians and reptiles; CLBMON-36 monitors nest mortality in birds). Consequently, CLBMON-11A does not monitor those taxa or the specific variables (e.g., nest mortality) associated with these monitoring programs. Table 2-1 illustrates the linkages between the management questions, the management hypotheses, and the different monitoring programs.

Table 2-1: Relationship between management questions, management hypotheses, and WLR studies undertaking effectiveness monitoring as identified in the terms of reference for CLBMON-11A. Studies are organized in columns by management questions (MQs)/themes and in rows by indicator species groups. "-" indicates where a MQ does not relate to a hypothesis. "NA" indicates where there is no existing study that addresses the MQ/hypothesis combination

	Management Question/Theme			
Hypothesis	**MQ1: Wildlife Diversity / Abundance**	**MQ2: Food Availability**	**MQ3: Negative Impacts**	**MQ4: Habitat**
	Amphibians			
H_{1A}	**CLBMON-37**	-	-	-
H_{1B}	-	**CLBMON-11A**	-	-
H_{1C}	-	-	**CLBMON-37/58**	-
H_{1D}	-	-	-	**CLBMON-37**
	Birds			
H_{2A}	**CLBMON-36/11A**	-	-	-
H_{2B}	-	-	**CLBMON-36**	-
H_{2C}	-	-	**CLBMON-36**	-
H_{2D}	-	**CLBMON-11A**	-	-
H_{2E}	-	-	-	**CLBMON-36**
	Small Mammals			
H_{3A}	**CLBMON-11A**	-	-	-
H_{3B}	-	**CLBMON-11A**	-	-
H_{3C}	-	-	-	**NA**
	Ungulates			
H_{4A}	**CLBMON-11A**	-	-	-
H_{4B}	-	**NA**	-	-
H_{4C}	-	-	-	**NA**
	General Habitat			
H_5	-	-	-	**CLBMON-11A**

2.2 CLBMON-11A Study Limitations

The ability to address the above management questions and hypotheses is constrained by several factors:

- The study design was limited by the small number of revegetation sites that in turn limited sample size for monitoring and reduced statistical power to detect treatment effects.
- There was no pre-treatment sampling at revegetated areas so comparisons before and after treatments cannot be made.
- There was a lack of replication in revegetation treatments across sites, thus different treatment effects couldn't be separated.
- Lack of replication of revegetation treatments across elevation gradients prevented stratification for this factor.
- The original 14 sites were not sampled every year, thus time series vary across sites. For example, some control transects were lost because revegetation treatments subsequently occurred at their locations. One site was destroyed by excavators (Windfall Creek) and a new site (Causeway) was added in 2010.
- Sites did not contain both treatment and control transects in 2008; this was remedied in 2009.
- Revegetated areas were typically of a size too small to effectively influence use by wildlife, i.e., it may be difficult to discern a treatment effect.

Finally, the apparent failure of the CLBWORKS-1 program to re-establish vegetation in the drawdown zone means that there are essentially no treatment effects to assess by the CLBMON-11A study. The most recent CLBMON-9 report evaluating the CLBWORKS-1 revegetation effectiveness (Hawkes et al. 2013b) concluded that most transplanted plants were unable to cope with the combination of inundation timing, frequency, duration and depth, or with the by-products of these factors such as erosion, woody debris scouring, and drought conditions. The report also stated that it did not appear that either the quality or quantity of native vegetation in the Kinbasket Reservoir drawdown zone had increased as a result of the planting program. Failure of some revegetation treatments was also noted during Year 3 of the CLBMON-11A study (CBA by CBA (2011a).

3.0 STUDY AREA

3.1 Physiography

The Columbia Basin in southeastern British Columbia is bordered by the Rocky, Selkirk, Columbia, and Monashee Mountains. The headwaters of the Columbia River begin at Columbia Lake in the Rocky Mountain Trench, and the river flows northwest along the trench for about 250 km before it empties into Kinbasket Reservoir behind Mica Dam (BC Hydro 2007). From Mica Dam, the river continues southward for about 130 km to Revelstoke Dam, then flows almost immediately into Arrow Lakes Reservoir behind Hugh Keenleyside Dam. The entire drainage area upstream of Hugh Keenleyside Dam is approximately 36,500 km^2.

The Columbia Basin is characterized by steep valley side slopes and short tributary streams that flow into Columbia River from all directions. The Columbia River valley floor elevation ranges from approximately 800 m near Columbia Lake to 420 m near

Castlegar. Approximately 40 per cent of the drainage area within the Columbia Basin is above 2,000 m elevation. Permanent snowfields and glaciers predominate in the northern high mountain areas above 2,500 m elevation. About 10 percent of the Columbia River drainage area above Mica Dam exceeds this elevation.

3.2 Climatology

Precipitation in the basin is produced by the flow of moist, low-pressure weather systems from the Pacific Ocean that move eastward through the region. More than two-thirds of the precipitation in the basin falls as winter snow. Snow packs often accumulate above 2,000 m elevation through the month of May, and continue to contribute runoff long after the snow pack has melted at lower elevations. Summer snowmelt is reinforced by rain from frontal storm systems and local convective storms. Runoff begins to increase in April or May and usually peaks in June to early July, when approximately 45 per cent of the runoff occurs. The mean annual local inflow for the Mica, Revelstoke and Hugh Keenleyside projects is 577 m^3/s, 236 m^3/s and 355 m^3/s, respectively.

Air temperatures across the basin tend to be more uniform than precipitation. The summer climate is usually warm and dry, with the average daily maximum temperature for June and July ranging from 20–32°C.

3.3 Kinbasket Reservoir

The approximately 216 km long Kinbasket Reservoir is located in southeastern B.C., and is surrounded by the Rocky and Monashee Mountain ranges. The Mica hydroelectric dam, located 135 km north of Revelstoke, B.C., spans the Columbia River and impounds Kinbasket Reservoir. The Mica powerhouse, completed in 1973, has a generating capacity of 1,805 MW, and Kinbasket Reservoir has a licensed storage volume of 12 million acre feet (MAF; BC Hydro 2007). The normal operating range of the reservoir is between 707.41 m and 754.38 m elevation, but can be operated to 754.68 m ASL with approval from the Comptroller of Water Rights (Figure 3-1).

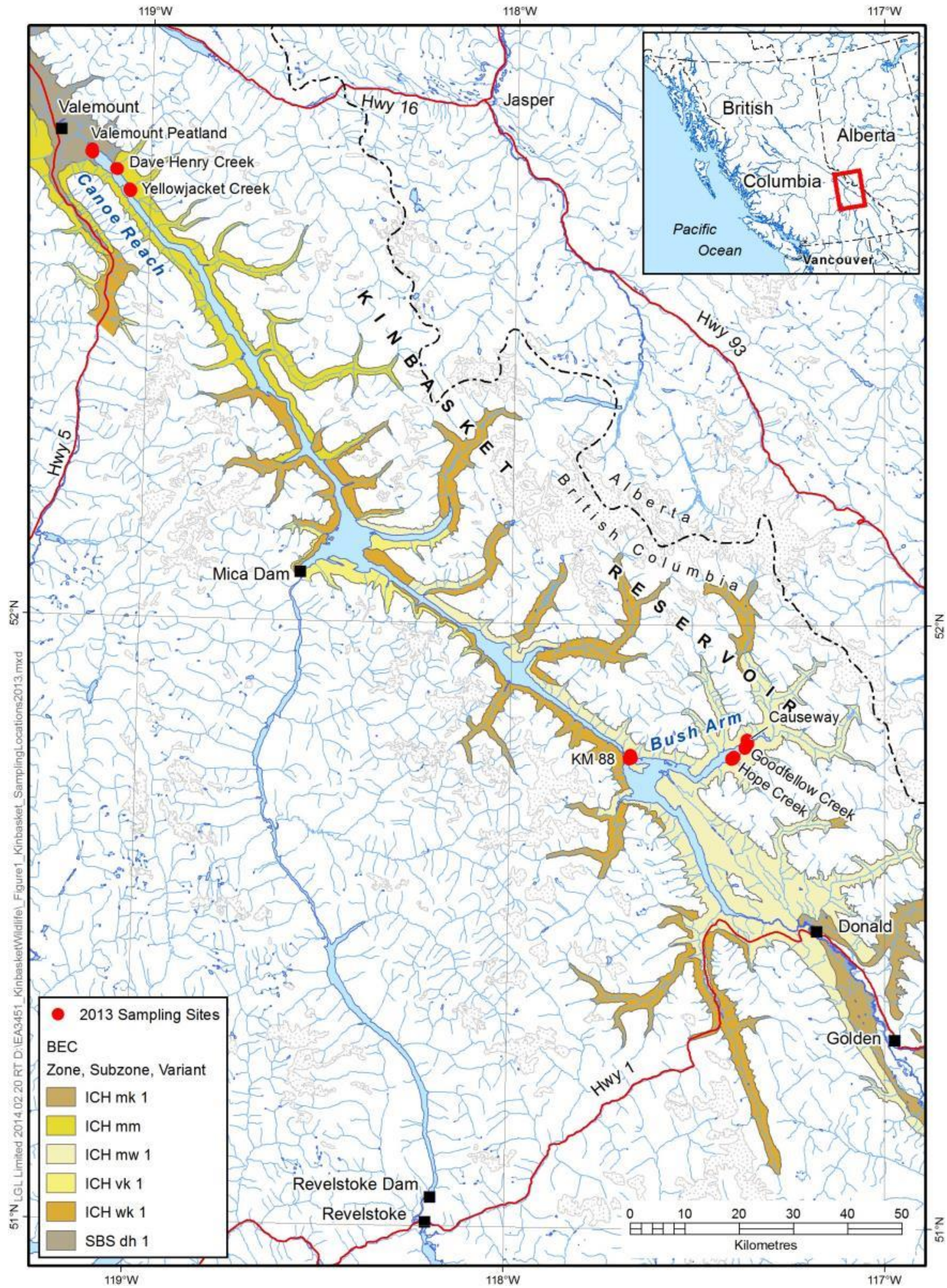

Figure 3-1: Location of Kinbasket Reservoir in British Columbia and locations sampled for CLBMON-11A in 2013. Naming follows Hawkes et al. (2007). Refer to Table 3-1 for descriptions of biogeoclimatic (BEC) zones

Kinbasket Reservoir is lowest during April to mid-May, fills throughout late spring and early summer, and is typically full by mid- to late-summer (Figure 3-2). Although there is some year to year variation, the general pattern is consistent. In 2012 and 2013 Kinbasket was filled beyond the normal operating maximum (i.e., > 754.38 m ASL) for the first time since 1997.

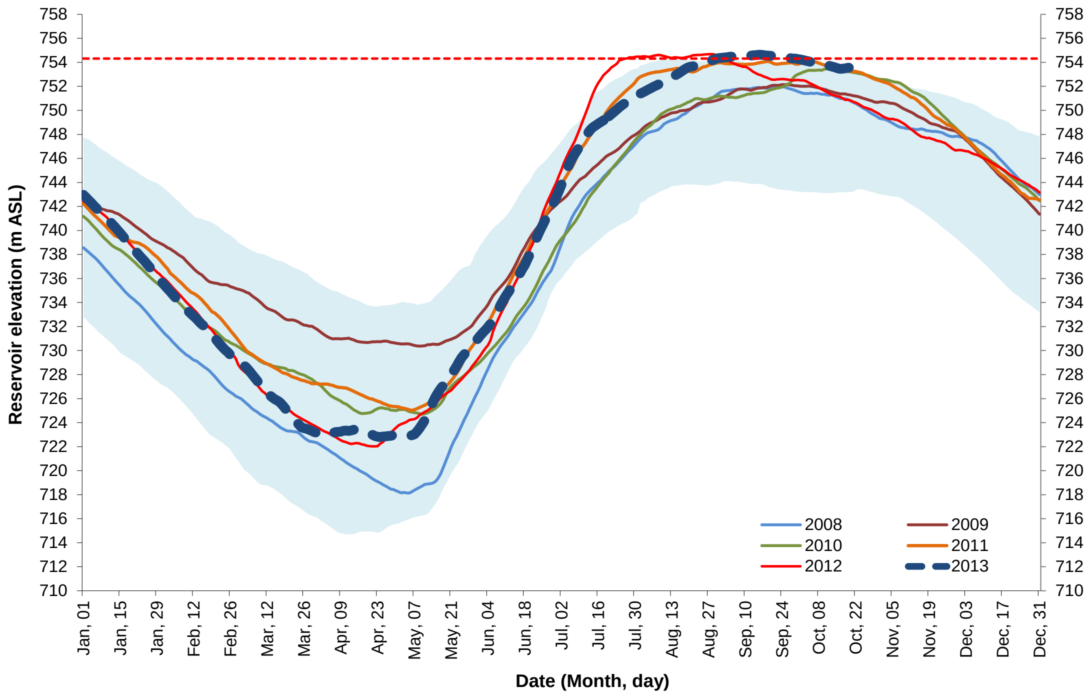

Figure 3-2: Kinbasket Reservoir hydrograph for the period 2008 through 2013. The shaded area represents the 10th and 90th percentile for the period 1976 to 2013; the dashed red line is the normal operating maximum

3.4 Biogeography

The reservoir is located predominately within the Interior Cedar-Hemlock (ICH) biogeoclimatic (BEC) zone and is represented by four subzone/variants (Table 3-1). The ICH occurs along the valley bottoms and is typified by cool, wet winters and warm dry winters. A small portion of the reservoir extends into the Sub-Boreal Spruce (SBS) BEC zone dh1 variant near Valemount. The climate of the SBS is continental, and characterized by moderate annual precipitation and seasonal extremes of temperature that include severe, snowy winters and relatively warm, moist, and short summers.

Table 3-1: Biogeoclimatic zones, subzones and variants occurring in Kinbasket Reservoir study area

SubZone	Zone Name	Subzone/Variant Description
ICHmm	Interior Cedar – Hemlock	mm: Moist Mild
ICHwk1	Interior Cedar – Hemlock	mk1: Wells Gray Wet Cool
ICHmw1	Interior Cedar – Hemlock	mw1: Golden Moist Warm
ICHvk1	Interior Cedar – Hemlock	vk1: Mica Very Wet Cool
ICHmk1	Interior Cedar – Hemlock	mk1: Kootenay Moist Cool
SBSdh1	Sub-Boreal Spruce	dh1: McLennan Dry Hot

The southern end of the reservoir includes Bush Arm and the Columbia Reach. Bush Arm is characterized by flat or gently sloping terrain that was created by fluvial deposition from Bush River and other inflowing streams. These features are often protected from wind and wave action by the islands and peninsulas that protrude along the shoreline. This combination creates the largest variety of valuable wildlife habitat in the entire reservoir. Extensive fens and other wetlands have been identified, and a high diversity of plants is supported (Hawkes et al. 2007).

The extensive Valemount Peatland at the northern end of the reservoir supports the greatest diversity and abundance of wildlife in Canoe Reach. Historically, this peatland was likely a combination of sedge and horsetail fen and a swampy forest dominated by spruce (Ham and Menezes 2008). The wildlife habitat in the peatland varies from highly productive riparian and wetland habitat, to highly eroded sand and cobble parent material. Large areas are virtually devoid of vegetation and portions of the peatland are covered by deposits of wood chips from the breakdown of floating logs (Hawkes et al. 2007). Other notable habitats in the northern end of Kinbasket reservoir include wetlands and ponds on the gently sloping banks along the reservoir's eastern side. High quality wildlife habitat also occurs near Mica Creek at Sprague Bay and Encampment Creek.

4.0 METHODS

4.1 Experimental Design

The CLBMON-11A study assesses and contrasts trends in terrestrial and flying arthropod, small mammal and ungulate relative abundance and diversity across revegetated and control areas in the drawdown zone, and non-drawdown zone transects over time. These findings are used to assess the effectiveness of the CLBWORKS-1 revegetation program for enhancing wildlife habitat. The experimental design for this study was initially outlined in the terms of reference (BC Hydro 2008) and then formalized by Cooper, Beauchesne, and Associates (CBA 2009b). Modifications were made to the original study design and/or sampling protocols as specified in the annual reports (CBA 2009a, 2010a, 2011a, b) and in revised sampling plans (CBA 2010b). The existing study design and sampling protocols were closely followed in Year 6 (2013) to ensure backwards compatibility with previous study years, although some modifications were made (see Section 4.0). A pilot study to monitor birds and bats was conducted in 2013 to assess the feasibility of using these taxa to provide relevant data for answering the management questions.

Sampling sites (Table 4-1) were located at revegetation areas within the drawdown zone that:

1. Had one of the four main revegetation prescription applied (i.e., EPL, EPL/HPL, HPL. PS);
2. Contained a revegetation treatment polygon large enough to accommodate the experimental unit (i.e., 140 m transect, see section 4.2 for details); and
3. Had a nearby area that could be used as a suitable control, i.e., an area in the drawdown zone that was not revegetated under CLBWORKS-1.

Sites included locations at the east end of Bush Arm (e.g., the Bush Arm Causeway – Site 121), the south side of Bush Arm (e.g., Hope Creek – Site 87), and on the east side of Canoe Reach in and near the Valemount Peatland (Figure 3-1). Sites were assigned to two geographic strata: Canoe Reach and Bush Arm. Sample size limitations precluded further stratification of sites by subzone, vegetation community or elevation.

A total of seven sites were sampled in 2013 (Table 4-1). We had planned surveys at Ptarmigan Creek (Site 25) on the eastern side of Canoe Reach, but a bridge wash-out prevented access. Sampling site locations were based on the ten most recently sampled sites in Year 3 (2010) of this study (CBA 2011b). We did not sample three of these ten sites in 2013 because one site was destroyed by excavators and the revegetation treatment had failed at the other site. A new site (KM 88) was treated (under CLBWORKS-1) in 2013 and as such was included in the monitoring program.

Although the experimental design requires replicated sampling at sites across the duration of this study, only five of the sites used in 2013 have been sampled in all study years. Fourteen sites were originally established in Year 1 (2008) of the study, twelve of these were resampled in year 2 (2009); site 32 was removed because no revegetation treatment was applied and site 88b was removed to ensure site independence (CBA 2010b) with two new sites added for a total of 14 sites. Only nine of these 14 sites were resampled in Year 3 (2010). Five sites had poor revegetation success from the applied prescriptions, and as such, no longer had a defensible treatment that could be assessed for effects. A new site (121) for a naturally revegetated area was also added in 2010 at BC Hydro's request (CBA 2011b).

Table 4-1: List of sites sampled in each year from 2008 to 2013. Site names were introduced in 2013 and are shown for planned sampling sites. "X" denotes that all taxa were surveyed for. "U" denotes where only ungulate pellet plot samples were collected. "N" denotes not sampled

Reach	Site #	2013 Site Name	Revegetation Treatment	Treatment Status	2008	2009	2010	2011	2012	2013
Canoe Reach	2				X	X	X	U	U	
	8	Valemount Peatland	PS/Seed		X	X	X	U	U	X
	9			Failed	X	X				
	12	Dave Henry Creek	PS		X	X	X	U	U	X
	15	Yellowjacket Creek	PS		X	X	X	U	U	X
	25	Ptarmigan Creek	LS/PS		X	X	X	U	U	N
	32		None	NA	X					
	33			Failed	X	X				
	34		PS	Failed		X				
Bush Arm	80	KM 88								X
	83				X	N	X	U	U	
	84				X	X	X	U	U	
	85			Failed		X				
	87	Hope Creek	PS		X	X	X	U	U	X
	88	Goodfellow Creek	LS/PS		X	X	X	U	U	X
	88b		Site Removed from 11-A study in 2009	NA	X					
	91		None	NA	X	X				
	121	Causeway	LS				X	U	U	X
Total					14	13	10	10	10	7

After 2008[4], each site, with the exception of Causeway (site 121)[5], contained three 140 m long transects (treatment, control and local reference). A treatment transect and its paired control transect were established in the drawdown zone within a revegetation treatment area and an untreated area respectively. The local reference transect was established above the drawdown zone (> 754 m ASL) directly upslope of the treatment and control transects (Appendix 9-A). The main comparisons in CLBMON-11A are between drawdown zone treatment and control transects within a site. Comparisons are also made between drawdown and non-drawdown (local reference and Causeway site reference A and B) transects within a site to control for effects of environmental variation.

Transects were linear, with all stations situated at the same elevation and generally oriented parallel to the reservoir shoreline. Slight variation was required in some locations to account for local topography (e.g., curving shoreline) or shape of the treatment area. Transects avoided crossing rivers, roads and trails that could act as a dispersal barrier to small mammals. The control and treatment transects were offset to minimise trap interference. Coordinates of all sampling stations were recorded using GPS (Garmin 60Csx).

Table 4-2: The distribution of transect types at sites sampled in 2013. Ref = reference

Reach	Site Number	Site Name	Control	Treatment	Local Reference	Ref A & Ref B	Total
Canoe Reach	8	Valemount Peatland	1	1	1	-	3
	12	Dave Henry Creek	1	1	1	-	3
	15	Yellowjacket Creek	1	1	1	-	3
	25	Ptarmigan Creek	0	0	0	-	0
Bush Arm	80	KM88	1	1	1	-	3
	87	Hope Creek	1	1	1	-	3
	88	Goodfellow Creek	1	1	1	-	3
	121	Causeway	-	1	-	2	3
	Total		6	7	6	2	21

4.2 Transect Sampling Design

Sampling for each indicator taxon was conducted at each transect at each surveyed site. The original sampling design (CBA 2011b, Figure 4-1 A) used fifteen sampling stations located at 10 m intervals along a transect to conduct ungulate pellet counts and small mammal trapping. A Malaise trap was set up at each end of a transect to sample terrestrial arthropods. Pan traps were positioned underneath the Malaise traps in 2010 to

[4] Each site in 2008 had 2 transects: one (treatment or control) in the drawdown zone and a local reference transect in non-drawdown (CBA 2009a).

[5] Causeway was established in Year 3 of the study and originally contained two transects in naturally revegetated non-forested habitat above the drawdown zone; these are referred to as “reference” transects A and B (RFTA, RFTB). We added a treatment transect to this site in 2013 in a previously revegetated area within the drawdown zone.

improve the ability to sample ground dwelling arthropods, particularly Coleoptera (CBA 2011a). The pan traps consisted of a pair of troughs constructed of 4” PVC plumbing pipe to collect samples from both sides of the centre wall of the trap.

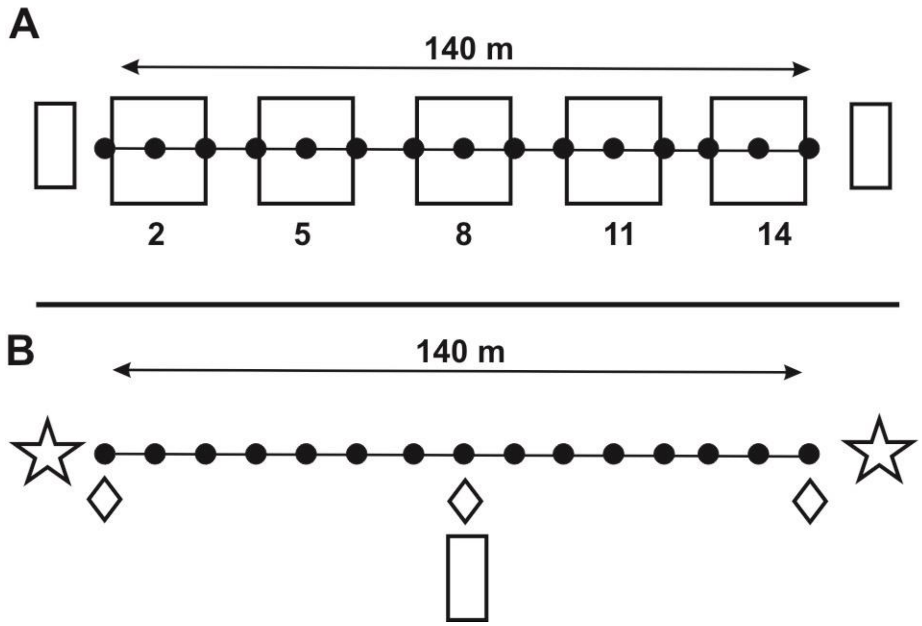

Figure 4-1: Original (A: 2008-2012 [CBA 2011a]) and revised (B: 2013) 140-meter sampling transect showing the position of the habitat plots (squares), Malaise traps/pan trap arrays (rectangles [A], Malaise (triangle) and array of three pitfall (diamonds) traps [B]), small mammal traps and pellet plot stations (circles), and songbird point count stations (stars [B])

The following changes were made to the sampling design in 2013 (Figure 4-1 B):

1) We installed only a single Malaise trap adjacent to each transect’s midpoint. Malaise traps are a broadcast method for sampling and it was unnecessary to duplicate the effort with two traps.

2) We did not sample habitat characteristics along transects. Site level vegetation monitoring in Kinbasket Reservoir is already performed by the CLBMON-09 Vegetation Effectiveness Monitoring project (Yazvenko 2008, Yazvenko et al. 2010, Fenneman and Hawkes 2012, Hawkes et al. 2013b) and CLBMON-10 Kinbasket Reservoir Inventory of Vegetation Resources (Hawkes and Muir 2008, Hawkes et al. 2007, 2010, 2013).

3) We replaced pan traps with arrays of three pitfall traps. Pan traps are not flush with the ground and are unlikely to effectively collect spiders (Araneae) and ground-dwelling beetles (Coleoptera) (Dr. R. Bennett, RBCM, pers. comm.). We installed pitfall traps to improve capture of Araneae, Coleoptera and other ground dwelling arthropods using the same methodology (see Section 4.4.5), as used in CLBMON-11B1 (Hawkes et al. 2010b, 2011, 2012). An array of three pitfall traps was positioned near each Malaise trap, and at each end of a transect.

4) We added a songbird point count station to each end of a transect, resulting in two point counts per transect. Because the general radius for the point count is 75 m (see Section 4.4.4), each point count station was slightly offset from the end of the 140 m sampling transect to prevent double counting.

5) Autonomous acoustic monitoring devices were deployed to assess the presence and distribution of bats. Two devices were deployed in Bush Arm (KM 88 and Causeway) and two in Valemount Peatland (one north, one south). The bat detectors were deployed in each general area, not along the transect.

4.3 Field Schedule

Unlike previous years, Bush Arm and Canoe Reach were sampled simultaneously in 2013 to reduce the confounding effects of seasonality when interpreting results. The sampling period for CLBMON-11A was previously drawn out from early June to mid-July as sampling rotated across sites in Canoe Reach, followed by Bush Arm. This approach introduced unnecessary environmental variability because climate conditions vary substantially over this period.

The 2013 field sampling schedule followed a similar timeline to that previously implemented by CBA; though, as mentioned above, Bush Arm was sampled earlier in the year relative to previous years. Field sampling in 2013 was conducted primarily during June to count and clear ungulate pellet plots and to coincide with peak periods in abundance for invertebrates, small mammals and birds prior to inundation of drawdown zone transects. This timing also coincided with the height of the breeding season for most songbird species, at which time all locally breeding birds are on territory and are highly vocal, enabling surveyors to accurately document the number and diversity of breeding birds. Bats were sampled later in the summer, beginning in late July and continuing through to the third week of August. As with many CLBMON projects, the sampling schedule was also determined by reservoir levels. For example, small mammal sampling at most control and treatment transects would not be possible during the late summer/autumn due to high reservoir levels.

4.4 Indicator Taxa Sampling Protocols

Small mammals, ungulates, bats and songbirds were surveyed as described below. Sampling protocols were consistent with methods used in the CLBMON-11B1 project (Hawkes et al. 2010b, 2011, 2012). Incidental mammal observations (e.g., visual sightings and wildlife signs such as bones, hair, scat) were also documented at all transects.

4.4.1 Small Mammals

Sampling focused on voles (*Myodes gapperi* and *Microtus* spp.) and mice (*Peromyscus maniculatus* and *Zapus princeps*). Incidental captures of shrews (*Sorex* spp.), red squirrel (*Tamiasciurus hudsonicus*), yellow-pine chipmunk (*Neotamias amoenus*) and short-tailed weasel (*Mustela* erminea) were expected based on previous years' captures (CBA 2009a, 2010b, 2011a, b; see Appendix 9-D). Small mammal trapping and handling followed provincial standards described by the Resources Inventory Committee (1998a and 1998b), and was in compliance with all conditions of our wildlife capture/handling permit (Permit #: VI13-86208; Ministry of Forests, Lands and Natural Resource Operations).

Two Sherman traps (H.B. Sherman Traps, Tallahassee, FL) were set within four metres of each sampling station on a transect (for a total of 30 traps per transect). Traps were generally placed on both sides of a transect, and next to a habitat feature such as woody debris, stumps, or grass clumps when available. A plywood cover board was placed over each trap to provide shelter from sun and precipitation. Each trap was set-up and locked open for two nights without bait prior to the commencement of trapping to allow acclimatization by animals to trap presence. Following the acclimation period, the traps were baited with sunflower seeds, a small slice of apple, and a smear of peanut butter, all rolled up in a cotton ball for bedding. Each trap was checked twice daily (first thing in the morning and again in the late afternoon/evening). We marked captured animals for recapture identification by using a small pair of scissors to cut the guard hairs from a small patch of fur along the animal's back (Hoffman et al. 2010, Figure 4-2). This procedure allowed for instant recognition of a recaptured animal within a season, while being temporary and minimally invasive.

Figure 4-2: A marked deer mouse (*Peromyscus maniculatus*). The silvery tips of the guard hairs along the back of the animal have been cut, exposing the darker fur beneath

Data collected on each capture included the species, sex, age class (juvenile, sub-adult or adult), body condition, reproductive condition, whether this was a new capture or recapture, and weight (to the nearest 0.1 gram using a Pesola® scale). Care was taken (e.g., gloves worn) when handling small mammals to avoid being bitten and prevent exposure to potential disease risks (Resource Inventory Committee 1998a and 1998b). Animals were handled as gently as possible and held for the minimum amount of time feasible. All equipment was cleaned and sterilized with bleach following each field session.

4.4.2 Ungulates

Pellet group count surveys were conducted at each of a transect's 15 sampling stations using the same protocols and permanent circular 3.99 m radius (50 m^2) plots as in previous years (CBA 2011a). A minimum of 10 pellets in proximity to each other was needed to constitute a pellet group (Resources Inventory Committee 1998c). Each pellet group was identified to species, (i.e., Elk (*Cervus canadensis*), Moose (*Alces alces*) and deer (*Odocoileus* sp.)), recorded and physically cleared from the plot. All deer pellet groups were classified as "deer", because identification to species, i.e., White-tailed Deer (*Odocoileus virginianus*) and/or Mule Deer (*Odocoileus hemionus*) was not possible in most cases.

Scat from other species was recorded when reliably identified (e.g., bear, canids, snowshoe hare). Snowshoe hare pellets were not counted in groups due to the overwhelming abundance of pellets at some sites. Instead, hare pellets were classified at a sampling station as either low density (<25 pellets), moderate density (25–200 pellets), or high density (>200 pellets).

4.4.3 Bats

Four Song Meter SM2BAT+ 192kHz Stereo Ultrasonic Recorder units (Wildlife Acoustics, Inc.) were used to assess the presence of bats within the drawdown zone at two locations within the Valemount Peatland site in Canoe Reach (Valemount Peatland - North, Valemount Peatland – South) and two sites in Bush Arm (KM 88 and Causeway). The bat detectors were positioned in or angled toward a revegetation treatment, or over areas of the drawdown zone that were likely to attract bats (e.g., wet depressions, ponds, and wetlands) (Figure 4-3).

Figure 4-3: Example of a typical Song Meter SM2BAT unit set-up on an elevated feature with the microphone aimed in the direction of the desired habitat

Bat detectors were programmed to record for a total of 6.5 hrs each night between 19:30 (approximate sunset time) and 00:30, and from 04:00 (approximately one hour before sunrise) to 05:30. Under ideal conditions bats will be detected in an airspace of 30 to 100 m from the microphone (Figure 4-4). Bats emitting higher frequencies (e.g., *Myotis septentrionalis*) will be detected more often in the 30 m zone and bats emitting lower frequencies (e.g., *Lasionycteris noctivagans* and *Lasiurus cinereus*) can be detected out to ~100 m from the microphone (Table 4-3). The microphone is omnidirectional, meaning it will sample in all directions, but sensitivity is weakest directly behind the microphone (Figure 4-4).

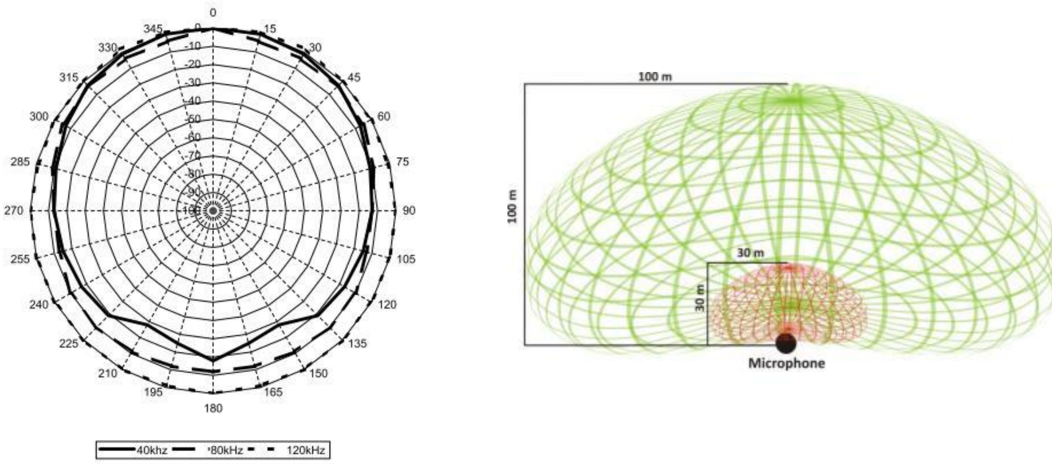

Figure 4-4: Representation of the bat detector sampling area for three example frequencies (40 kHz, 80 kHz, 120 kHz) relative to a compass rose (left), and distances over which the probability that a high (red ellipse) and low frequency (green ellipse) bat species would be detected is greatest (right). Image on left courtesy of Wildlife Acoustics, Inc. Image on right, LGL Limited

Table 4-3: Typical frequencies (kHz) associated with a selection of bat species expected to occur in habitats associated with the drawdown zone of Kinbasket Reservoir. "Characteristic fc" represents the frequency of the call at its lowest sweep, "hi f" and "lo f" are the highest and lowest apparent frequencies respectively. Data based on Sonobat (2008)[6]

Frequency (kHz)	*Myotis lucifugus*	*M. evotis*	*Eptesicus fuscus*	*Lasionycteris noctivagans*	*Lasiurus cinereus*	*M. septentrionalis*	*M. volans*
Characteristic *fc*	40 - 43	33 - 37	27 - 31	25 - 28	19 - 24	40 - 46	40 - 44
Highest apparent hi *f*	70 - 94	71 - 97	65 - 90	36 - 53	20 - 39	90-116	77 - 100
Lowest apparent lo *f*	35 - 40	26 - 30	26 - 30	24 - 27	19 - 24	32-41	34 - 39

4.4.4 Songbirds

Time-constrained, variable-radius[7] point count surveys were used to assess the diversity and relative abundance of songbirds (Ralph et al. 1995). Only one visit was made to each point count station for this pilot study. Surveys commenced at sunrise and ended within ~4 hours of sunrise (Ralph et al. 1995). Songbird surveys were conducted only during favourable conditions (i.e., no heavy wind or precipitation) to standardize surveys and minimize variability in detections due to sub-optimal environmental conditions.

An observer stood at a point count center and documented all birds seen and/or heard within 75 m of the observer during a 6-minute count period. Furthermore, because detectability of different bird species varies depending on the amount of time devoted to each survey (Bibby et al. 2000), the portion of the 6-minute count period in which each individual is detected was recorded (0-3 minutes, 3-5 minutes, 5-6 minutes). The following data were collected at each point count station:

1. **Physical information:** site number, point count number, GPS coordinates, weather (wind speed, temperature, relative humidity [measured with a Kestrel® 4000 Pocket Weather Meter], current survey conditions), date, time of day, visit number;

[6] http://www.sonobat.com/download/RockyMtn_Acoustic_Table-Mar08.pdf
[7] Variable in the sense that observations at varying distances from the point count centre are recorded.

2. **Bird observations (sight or sound) in point count plots:** species, approximate age (adult/juvenile), sex (when known) and location of each bird heard or seen within point count plot, location mapped on point count form, estimate of the horizontal distance between each detected bird and the observer, detection type (call, song, or visual). Notes were made to differentiate fly-over birds from the rest of the detections; and
3. **Bird observations outside point count plots:** incidental observations of birds located outside the point count area at each site.

4.4.5 Terrestrial Arthropods

Terrestrial arthropods were sampled at all sites using Malaise and pitfall traps. We used similar methods for Malaise traps as in 2010 (CBA 2011a) and used protocols for pitfall trapping that matched those used in CLBMON-11B1 (Hawkes et al. 2012). Except where noted, all methods were consistent with those described in Resources Inventory Committee (1998d).

Sampling at each transect collected one 4-day sample to assess biomass followed by a 1-day sample for identification that allowed relative abundance and diversity of arthropod taxa to be determined (see analysis methods described in section 4.5.5, below).

Collection jars and cups used in Malaise and pitfall traps were filled one-third to half with a saturated salt-water solution. This solution was prepared by filling a large blue water jug with water, adding salt until the solution was saturated (i.e., salt no longer dissolved), followed by one squirt of unscented dish soap to act as a surfactant. The jug was clearly marked with “Do Not Drink” and “Salt Water Solution” for easy identification and safety in the field.

Each Malaise trap (Figure 4-5) was positioned near the centre of the transect and oriented perpendicular to the transect line, with the collection jar pointed in the direction of the reservoir to intercept insects flying parallel to the reservoir edge.

Figure 4-5: A Townes-style Malaise trap in the field and specimens collected in a collecting head

Pitfall traps were set up in triangular arrays with ~1 m sides. Each array contained three traps, i.e., one at each point of the triangle, inserted into the ground following a similar approach to CLBWORKS-11B1 (Hawkes et al. 2012). Pitfall trap cups were installed with a small trowel to a depth of approximately 10 cm so that the top rim of the cup was flush with the ground (Figure 4-6). Two cups (one on top of the other) were installed to prevent the hole from collapsing when the collection cup was removed to process the sample.

Figure 4-6: Close-up of a pitfall trap

Collection methods, processing and storage of samples was similar for both trap types. The sample contents were first poured through a sieve and the salt water collected in another container for reuse. Specimens in the sieve were rinsed with water from a wash bottle to remove soapy residue. The sieve was placed in a Whirl-Pak® bag and the handle tapped against a hard object to dislodge specimens into the bag. The sieve was then rinsed with 70% ethanol into the Whirl-Pak® to remove any remaining invertebrates into the bag. Invertebrates are thus preserved inside the bag with a small amount (<1 cm of ethanol). Care was taken not to include any large debris or worms/slugs with the samples. If a vertebrate such as a shrew or salamander is found dead in a pitfall trap, the animal was also collected, with details on the sighting recorded.

A label written in pencil on a small piece of Rite-in-the-Rain® paper was placed inside each Whirl-Pak® bag with a sample. Each label consisted of the collection date, location (site and treatment) and collection method. For example, a Malaise sample collected on June 26, 2013 from Site 121 (Causeway) treatment transect would be written as: 26JUNE13-121T-M. An external label with the same information was written in Sharpie® marker or indelible pen on the outside of the bag. The top of the Whirl-Pak® bag was then folded over several times and the ends twisted securely. Samples were stored in a plastic container with lid (to avoid crushing and to catch any leaks) and in a cool place.

4.5 Data Analysis

4.5.1 Small Mammals

Data analyses were limited to descriptive summaries and plots illustrating the number of captures by species, species richness across transect types and comparisons of relative abundance based on Catch per Unit Effort (CPUE) for each recorded species by transect type and reach. Both the total number of captures for each species and the number of unique individuals capture per species was reported. Unique individuals were determined by eliminating identified recaptures of an individual. CPUE was calculated from the number of unique captures of a species per 100 trap nights.

Box plots were used to compare relative abundance (CPUE) of Deer Mouse (*Peromyscus maniculatus*) within and above the drawdown zone in both reaches. Boxplots were only constructed for Deer Mouse because other recorded species had few individuals captured.

4.5.2 Ungulates

Simple data summaries and plots were presented to compare presence and relative abundance of elk, deer spp. and moose across reach, site, transect type, and drawdown versus non-drawdown habitat. Snowshoe Hare was not a target of these surveys, but as pellets were frequently encountered, a simple summary by site and reach was also presented.

4.5.3 Bats

Bat calls were recorded as a .wac file and subsequently analysed using Kaleidoscope Pro software (Wildlife Acoustics, Inc.). Bat species and activity levels were determined based on recording characteristics. Bat calls were first processed via Wildlife Acoustics' WAC2WAV 3.0.0 software, which removed most noise segments and generated time-stamped .wav files that contained potential bat sonograms. These audio clips were then processed in Kaleidoscope Pro (Version 1.1.20), which uses a decision engine based on quantitative analysis from bat species reference calls. The program classified each .wav file to a potential species based on several parameters that describe the time-frequency and time-amplitude trends of each bat call. Note that more than one species may be assigned to a .wav file because of overlapping bat call frequencies (Table 4-3). An output summary table was generated as an MS Excel file.

The MS Excel file was used to generate summaries of effort by detector, bat recording activity during each 6.5 hour nightly recording session by time period (Evening Twilight (19:30-22:00), Night (22:00-00:30) and Morning Twilight (04:00-05:30)), and species richness by site and reach. We created species accumulation curves to determine how many nightly recording sessions it took to record all detected species at each site. We also compared activity of each species by site. Species activity was calculated as a detection rate, i.e., the number of .wav files identified for each species per hour.

4.5.4 Songbirds

Only data summaries were produced due to the relatively low effort during this pilot study (i.e., only a single survey was conducted at each point count station). Analyses comparable to those conducted for CLBMON-11B1 (Hawkes et al. 2013) will be performed in future years if songbirds are formally added to the CLBMON-11A study.

Point counts specifically target songbirds, and may fail to adequately detect other groups (e.g., grouse). Therefore only simple summaries were presented for major bird groups. Most detections of birds flying over were excluded from reported summaries because their presence overhead may not be indicative of their use of the habitat below. However, fly-overs were included for swallows (included within songbirds), swifts and hummingbirds, as they are rarely (swallows and hummingbirds) or virtually never (swifts) detected perched.

We examined individual species presence and counts for songbirds, swifts and hummingbirds within both 30 m and 75 m of point count centres to (1) provide an overview of the avifauna documented within each reach and transect type; and (2) examine difference in species richness and abundance between the 30 m and 75 m buffer distances. We also assessed differences in species richness and relative abundance within and above the drawdown zone by reach. Only observations within the 75 m point count radius were used for this assessment because few observations were made within the 30 m point count radius.

Analyses in CLBMON-11B1 use the 75 m point count radius to compare differences in songbirds, swallows, swifts and hummingbirds between the drawdown zone and upland habitats, but only use songbirds detected within 30 m of the point count centre when assessing revegetation treatment effects. The 75 m buffer extends into upland habitat at some locations, therefore this constraint ensures that only birds documented within a given treatment or control polygon will be used to assess treatment effects.

4.5.5 Terrestrial Arthropods

The 1-day samples were tallied and identified to order or family (Diptera, Hymenoptera), or species (Araneae, Coleoptera, Orthoptera) when possible. Specimens of ground beetles (Coleoptera: Carabidae) and rove beetles (Coleoptera: Staphylinidae) were identified to lower taxonomic levels (Subfamily, Genus, or Species). Araneae (spiders) were identified to species because of their potential use as indicators to assess habitat changes associated with the application of revegetation prescriptions in the drawdown zone of mid- and lower Arrow Lakes Reservoir.

Each 4-day biomass sample was weighed, identified to order (e.g., Diptera, Hymenoptera), family (e.g., Linyphiidae, Staphylinidae) or species (e.g., cupripenne) when possible, placed in a drying oven for 48 hrs and reweighed (dry weight). The dry weight of each identified Order and Family in a 4-day sample was estimated based on the composition percentage of these taxonomic units in the 1-day sample at that sample's transect. These methods are consistent with previous years (for both CLBMON-11A and CLBMON-11B1).

4.5.5.1 Richness, Relative Abundance and Biomass Analyses

Arthropod richness was calculated by summing the number of identified orders/families/species for each trap type on each transect at each site. Richness therefore represents the highest taxonomic ID given to each specimen. Data from the 4-day biomass trapping session and 1-day ID trapping session were pooled to assess overall taxonomic richness. Because of the difficulty assigning higher-level taxonomic ID to some specimens, the total number of taxa is conservative (i.e., if each specimen was assigned to family or species the total taxa would be higher). Taxonomic summaries were presented for both trap types separately and pooled. We also standardized taxonomic richness for effort ("corrected richness") by dividing the number of taxa by the total number of sampling hours, then multiplying by 10 hours (i.e., catch per unit effort; CPUE).

The relative abundance of arthropods (CPUE) was computed to correct for variation in the total time each trap was set at each transect. CPUE was calculated as the number of individuals in each family per 10 hours (h) of sampling, and was calculated separately for each trap type.

Catch per unit effort (CPUE) of biomass was also computed to account for slight variations in sampling time across transects, and to standardize biomass by sampling method (i.e., Malaise versus pitfall traps). Biomass CPUE was calculated as the total biomass (mg dry weight) recorded for each sampling method at each transect divided by the total time (hours) the trap(s) was set, expressed as biomass of insects per hr (mg/hr).

Corrected richness, relative abundance and biomass of terrestrial arthropods were compared across transect types, sites and reaches using box plots, and both one-way and two-way analyses of variance (ANOVA). Box plots and ANOVA were computed in the R language (version 3.0.2). ANOVAs were tested with 9,999 permutations. The box with a box plot represents between 25 per cent and 75 per cent of the ranked data. The horizontal line inside the box is the median. The length of the boxes is their interquartile range. Whiskers are drawn from the top of the box to the largest observation within 1.5 interquartile range of the top, and from the bottom of the box to the smallest observation within 1.5 interquantile range of the bottom of the box.

4.5.5.2 Community Similarity

We used clustering and ordination techniques to determine if arthropod communities were similar across transect types and sites. We expected differences between non-drawdown (local reference/ Causeway reference A and B) compared to drawdown zone transects, while anticipating that differences between control and treatment transects would be minor because revegetation treatments appear to have been largely unsuccessful. If the level of similarity of arthropod communities was higher among transect types than sites, the transect types would form distinct groupings or clusters in the ordination plots. Conversely, if community similarity was a function of site (and not transect type), then all transects from a given site would group together.

We used the Bray-Curtis distance (D14) coefficient to compute the similarity of arthropod communities across different transect types and sites. The analysis was performed separately for each trapping method. The Bray-Curtis distance gives the same weight to abundant and rare families when computing the similarity distances (Legendre and Legendre 1998). Each pair of transects was compared in terms of a) which arthropod families were present in both (species composition), and b) how the relative abundance of each family compared between that pair. The Bray-Curtis distance coefficient is both quantitative and asymmetric, i.e., double zeroes are excluded in computations, meaning that the double absence of one family was not considered to be a sign of similarity between items being assessed (Legendre and Legendre 1998).

The similarity among transects within and across sites was then represented with an ordination technique. Principal Coordinates Analysis (PCoA) was used to perform the ordinations, as it allows the representation in a Euclidian space of a similarity or distance-based matrix (Legendre and Legendre 1998). As the scale on the two axes was forced to be the same, the distance between sites in the ordination diagram approximated their actual distance. The closer transects or sites are in the ordination diagrams, the more similar their arthropod communities are. The distance coefficients and the PCoAs were computed with the R language (version 3.0.2, 2013).

4.5.5.3 Arthropod Assemblages

The objective of this analysis was to find and group species or families that were similar with respect to their association to transect type and/or sites. In other words, the analysis assessed if the taxa were distributed independently of one another across the study area or if they were significantly and positively associated into recognizable groups of species (Legendre 2005). The analysis was performed separately for data collected by Malaise and pitfall traps.

Kendall's coefficient of concordance (W) was used to assess whether families of arthropods formed significant groups or assemblages, which are defined simply as groups of species recognized as a cluster following the application of a clearly stated set of rules without the implication of positive biological associations (Legendre 2005). The identification of groups of species that cluster together enables an investigation into the ecological requirements common to the group rather than evaluating the ecological needs of each species individually (Legendre 2005). Kendall's coefficient of concordance is a measure of the agreement among several species relative to a given set of *n* objects (Legendre 2005), which in this case are the treatments.

The analysis contains many different steps (e.g., computation of the concordance, K-Means partitioning, ordinations) that are described below. The computation of the concordance W (functions available online on Pierre Legendre's website), K-Means and PCA were computed with the R software language (version 3.0.2). The W coefficient and K-Means partitions were tested with 100,000 permutations. Species that occurred in at least two sites were included in the analyses.

Community composition data frequently contain a large number of zeroes, which tends to produce highly skewed frequency distributions (Legendre 2005). Transforming the data is often necessary to make them suitable for Principal Component Analysis (PCA) or canonical analyses, which preserves Euclidian distances (Legendre and Gallagher 2001). For these analyses a Hellinger distance transformation was applied to the relative abundance values calculated for each species or family detected within each treatment. The Hellinger transformation corresponds to taking the square root of the proportion of each taxon at each treatment (Legendre and Gallagher 2001).

An overall test of independence of all species or families was conducted. If the results of this test were found significant, the test suggests that certain (or all) species are concordant in their estimation of common properties of sites (Legendre 2005). Principal Component Analysis allows for the representation of the complex multidimensional data in a Euclidian, reduced space. Scaling was of type 2, which means that the angles between vectors approximate the correlation between variables. The analysis of the ordination diagram allowed for the identification of clusters of arthropods, or potential specie assemblages. Once the clusters were identified, the ecological meaning of those clusters could be investigated.

A second overall test of independence was performed, but separately for each group. If the tests were significant for one or both groups, the contribution of each species, within each group, was then tested individually. That allowed a determination as to which of the individual species were associated with one or several of the other species (Legendre 2005). To preserve an approximately correct experiment wise error rate, the probabilities of the tests were adjusted for multiple testing (Legendre 2005). The correction of Holm (1979) recommended for sets of non-independent tests by Wright (1992) was used.

4.5.5.4 Indicator species

Additional analyses were conducted to assess the feasibility of using spiders (Araneae) and beetles (Coleoptera) as potential indicators of habitat changes associated with the application of revegetation prescriptions in the drawdown zone of Kinbasket Reservoir.

We used simple plots to describe the richness of spider species within families and beetle family/species by transect type, site and reach. We also compared spider family/species richness between the drawdown and non-drawdown zone.

5.0 RESULTS

5.1 Environmental Conditions

Environmental conditions such as temperature, precipitation, precipitation, and to a lesser extent relative humidity, can affect the activity of some animals. We used environmental conditions recorded at the BC Wildfire Management Branch Howard Creek weather station (latitude 52.37208 N, longitude -118.66028 E) at 838 m ASL to create boxplots that compared temperature, relative humidity and precipitation during January−October 2011−2013 (Figure 5-1, to Figure 5-3). The Howard Creek station is located in the approximate centre of the Kinbasket reservoir on the west side.

The overlap of monthly boxes across years in each plot suggests that environmental conditions were comparable from year to year. The level of observed variation is consistent with seasonal changes, and is not considered sufficient to affect the activity levels and thus detections of the focal taxa sampled in this study.

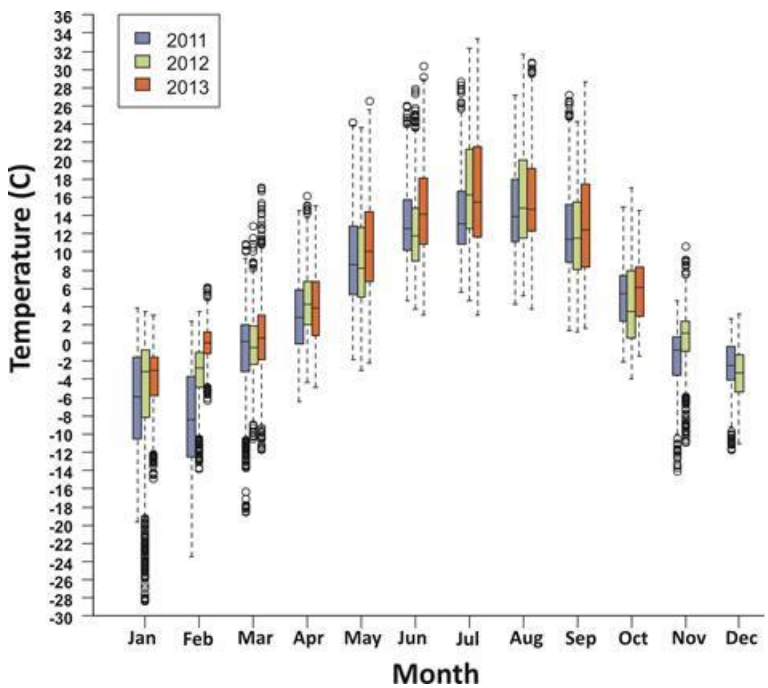

Figure 5-1: Daily temperature (°C) measured at Howard Creek, Kinbasket Reservoir in 2011, 2012, and 2013 (January to October only). Data source: BC Wildfire Management Branch

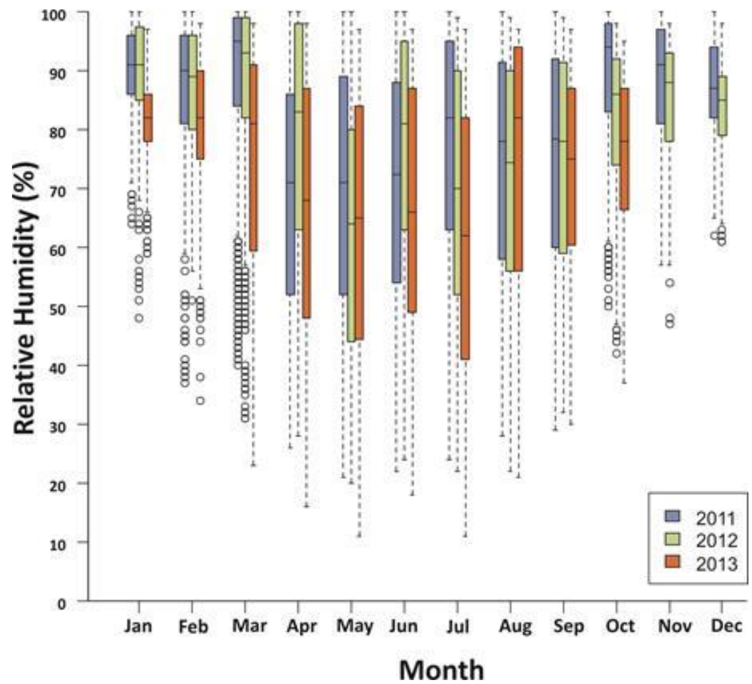

Figure 5-2: Relative humidity (%) measured at Howard Creek, Kinbasket Reservoir in 2011, 2012, and 2013 (January to October only). Data source: BC Wildfire Management Branch

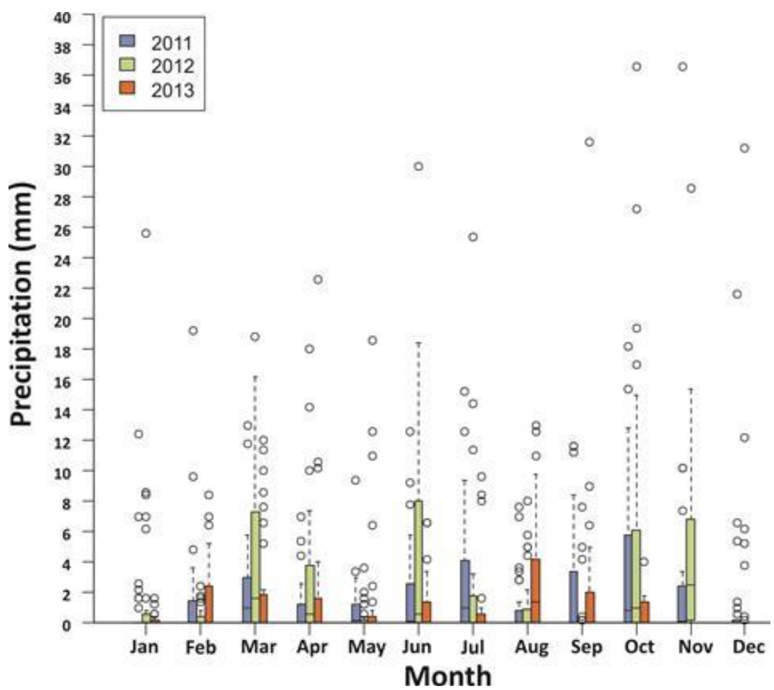

Figure 5-3: Precipitation (mm) measured at Howard Creek, Kinbasket Reservoir in 2011, 2012, and 2013 (January to October only). Data source: BC Wildfire Management Branch

5.2 Field Sampling Reservoir Conditions

The elevation of Kinbasket Reservoir during 2013 ranged from a low of 722.80 m ASL to a maximum of 754.63 m ASL (Figure 3-2). Reservoir elevations were lowest from mid-March to mid-May and substantial areas within the drawdown zone were available for sampling. Water levels increased substantially from May through mid-July, and most of the previously available habitat was inundated. Reservoir levels reached their maximum on 16 September, and began to drop slowly after that time.

Most work was conducted from June 8 to 19, 2013, although bat sampling using autonomous recording units was conducted from 26 July to 20 August. Water levels during the first field session in June increased from 733.43 m ASL to 737.60 m ASL (Table 5-1) but all transects remained above the water level and our ability to sample pellets, arthropods, small mammals or songbirds was unaffected. However, the reservoir elevation had climbed to 745.06 m ASL by the second field session held in early July. This prevented sampling both treatment and control transects point count stations at the Dave Henry Creek site. A single point count survey was conducted at a temporary station located in untreated habitat at a higher elevation in the drawdown zone. Bat detectors were successfully deployed in late July, but sampling was limited at one site because inundation prevented batteries from being replaced at two detectors in mid-August.

Table 5-1: Kinbasket Lake Reservoir water elevations during field sampling periods in 2013. Note that Field Session 3 lasted only a single day due to high reservoir levels

				Reservoir Elevation (m ASL)		
Field Session	**Taxa Surveyed**	**Start Date**	**End Date**	**Min**	**Max**	**Mean**
1	Small mammals, arthropods, pellet plots, songbirds	08 June	19 June	733.43	737.60	735.49
2	Songbirds	04 July	04 July	745.06	745.06	745.06
3	Bats	26 July	12 August	750.59	752.66	751.65
4	Bats	18 August	20 August	753.44	753.63	753.54
	-	01 January	31 December	722.80	754.63	741.11

5.3 Small Mammal Trapping

Small mammal trapping occurred over 10 days from June 8th to 19th. A total of 630 Sherman traps were set for 4 days each across the seven sites, resulting in a total of 2,520 potential trap nights. However, because traps may be set off due to environmental factors (e.g., rain, wind, temperature fluctuations), animals (either by being captured or by contacting the trap without entering it), or other factors (e.g., being struck by falling or blowing debris), the actual number of trap nights was reduced to 2,313. In general, the number of actual trap nights was similar across transect types at each site, and close to the 120 potential trap nights (mean: 110.14, SD: 6.67, range: 97–120).

There were 180 captures of four small mammal species of which 71 (39%) were unique individuals (Figure 5-4). The remaining 109 captures were either recaptures of the same individuals (n=107) or unknowns (i.e., the animal escaped before it could be assessed as unique or a recapture [n=2]). Only two mortalities occurred. Most captures (both unique individuals and recaptures) were of Deer Mouse (*Peromyscus maniculatus*; n=63 unique individuals), with low numbers of Meadow Voles (*Microtus pennsylvanicus*; n=6) trapped. All capture of Meadow Voles were unique captures. There were single captures of Long-tailed Vole (*Microtus longicaudus*) and Yellow-pine Chipmunk (*Neotamias amoenus*).

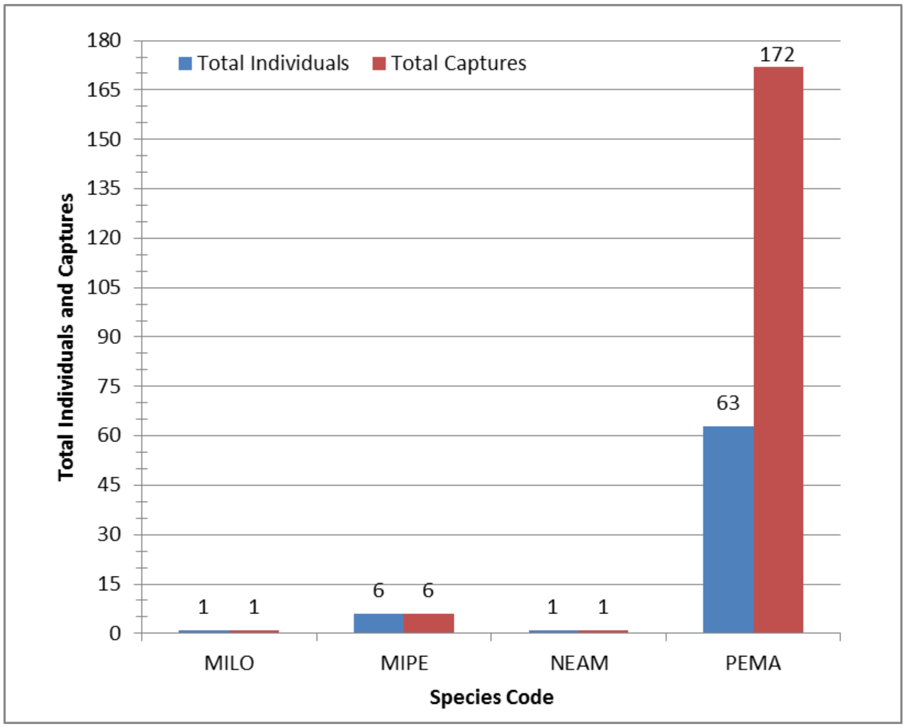

Figure 5-4: Total number of unique individuals and total captures (unique individuals and recaptures) of small mammals trapped during summer 2013 live-trapping in and adjacent to the drawdown zone of Kinbasket Reservoir. MILO = *Microtus longicaudus*; MIPE = *Microtus pennsylvanicus*; NEAM = *Neotamias amoe*nus; PEMA = *Peromyscus maniculatus*

The majority of transects (15 out of 18) had only a single species recorded. The highest species richness (three species) was at the Goodfellow Creek treatment transect. No species were captured at control transects at three sites: KM88, Dave Henry Creek and Valemount Peatlands. The remaining two transects (both local reference transects) had two species each. Two of the four transects that captured Meadow Vole captured no other species.

The relative abundance of the four species based on Catch per Unit Effort (CPUE) varied by reach, site, and transect type (Figure 5-5, Figure 5-6). Deer mouse had the highest CPUE along the Reference A transect in Bush Arm, followed by local reference transects. For sites with at least one capture, Deer Mouse had its lowest CPUE on control transects in both reaches. Meadow Vole had its highest CPUE along the Reference B transect. The single captures of Long-tailed Vole and Yellow-pine Chipmunk both occurred in Bush Arm, on a treatment and local reference transect respectively.

Deer Mice were captured at all sites, however relative abundance was variable across sites, and both low and high relative abundances of Deer Mouse occur in each reach. Relative abundance of Meadow Voles was fairly comparable across the four sites in which this species occurred.

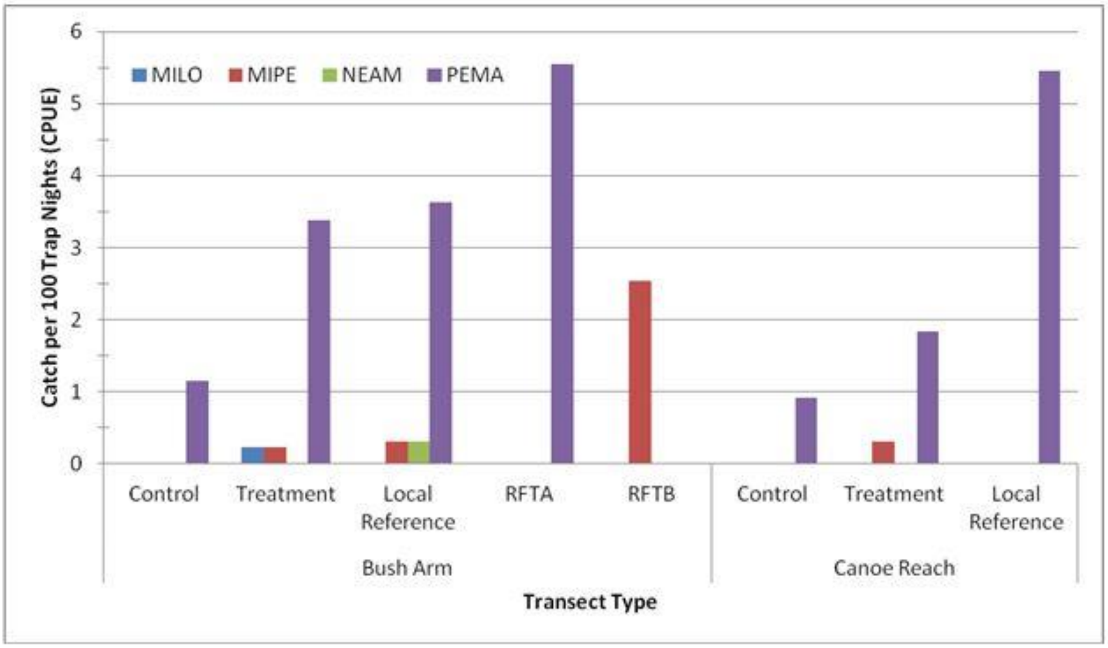

Figure 5-5: The relative abundance (Catch per Unit Effort, CPUE) of small mammals trapped at by transect type for each reach during summer 2013 live-trapping in and adjacent to the drawdown zone of Kinbasket Reservoir. RFTA = Reference Transect A, RFTB = Reference Transect B. Only unique captures reported here. MILO = *Microtus longicaudus*; MIPE = *Microtus pennsylvanicus*; NEAM = *Neotamias amoenus*; PEMA = *Peromyscus maniculatus*

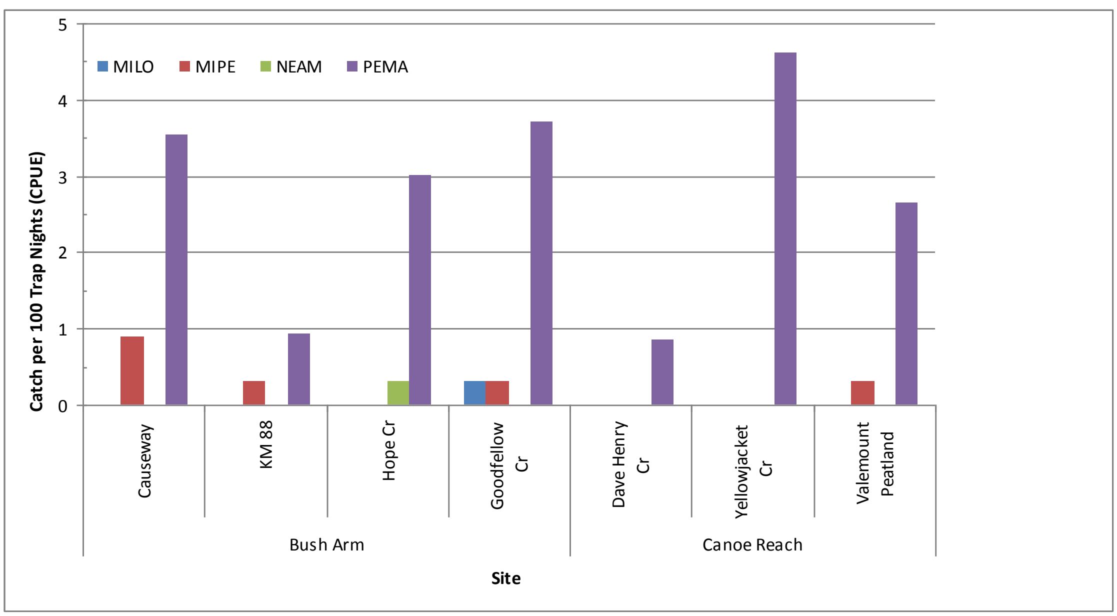

Figure 5-6: The relative abundance (Catch per Unit Effort, CPUE) of small mammals trapped at each site during summer 2013 live-trapping in and adjacent to the drawdown zone of Kinbasket Reservoir. Only unique captures reported here. MILO = *Microtus longicaudus*; MIPE = *Microtus pennsylvanicus*; NEAM = *Neotamias amoenus*; PEMA = *Peromyscus maniculatus*.

The highest CPUE of Deer Mouse was above the drawdown zone in both reaches; this trend was most evident at Canoe Reach (Figure 5-7).

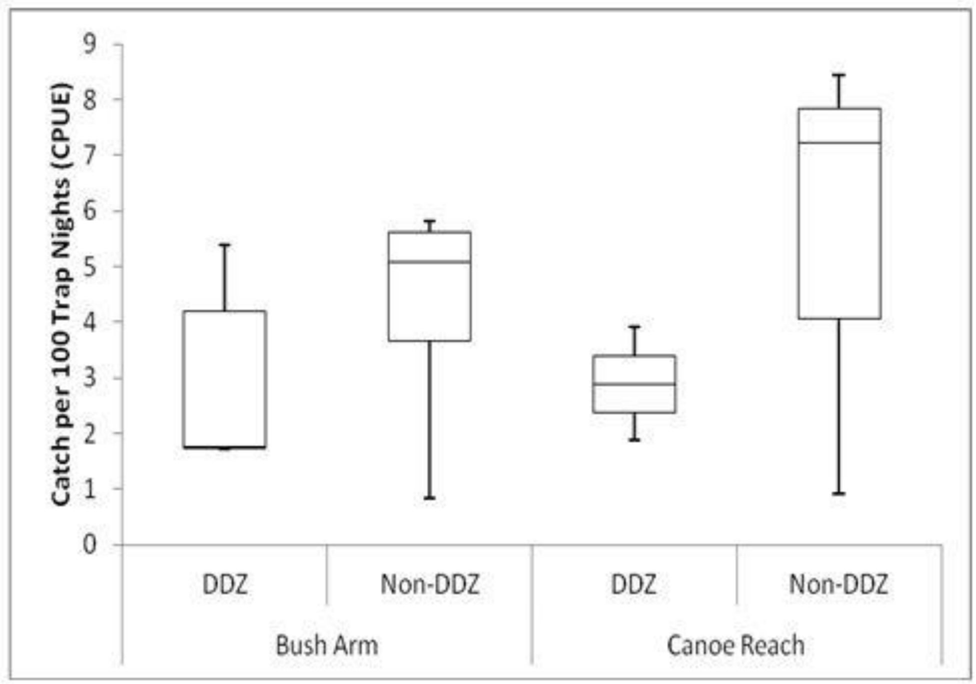

Figure 5-7: Catch per Unit Effort (CPUE) for Deer Mouse within (DDZ) and outside (Non-DDZ) the drawdown zone for both reaches. The "whiskers" represent the maximum (top) and minimum (bottom) values, the top and bottom of the boxes represent the third and first quartiles respectively, and the horizontal line in the box is the median value. The median line in Bush Arm DDZ boxplot is slightly above the first quartile for that box, which is just above the minimum value

5.4 Ungulates

Surveys were completed between June 11th and 17th. A total of 315 pellet plot stations covering a survey area of 15,750 m² were sampled, with a total of 136 ungulate (deer, Elk, and Moose) fecal pellet groups counted (Table 5-2). The most commonly detected species was Elk followed by deer and Moose, with 91, 44, and 1 pellet groups respectively (Table 5-2).

Most pellet groups (88%) were detected in Bush Arm; most of these were of Elk (76%), of which 65% were located on treatment transects, while the remainder were on local reference (n=31) and Ref B transects (n=1). Deer pellets were predominantly observed on local reference transects (88%) and were the only recorded pellets on control transects. Only one Moose pellet group was observed; this was located on a treatment transect. Only deer pellets were recorded in Canoe Reach, with 94% of pellets recorded on reference transects and the remainder on a treatment transect.

Table 5-2: Total ungulate fecal pellet groups by reach and transect type recorded in the Kinbasket Reservoir, 2013. Deer species (White-tailed and Mule deer) are pooled due to difficulty in differentiating these species by pellets

Ungulate Species	Bush Arm					Canoe Reach			Totals
	Control	Treatment	Local Reference	RFTA	RFTB	Control	Treatment	Local Reference	
Moose	0	1	0	0	0	0	0	0	**1**
Elk	0	59	31	0	1	0	0	0	**91**
Deer spp	3	3	22	0	0	0	1	15	**44**
Totals	**3**	**63**	**53**	**0**	**1**	**0**	**1**	**15**	**136**

The distribution of pellet groups by species across sites was notable. All observations of Elk pellet groups were made in Bush Arm at the Causeway and Goodfellow Creek Sites, and only on local reference, Reference B (RFTB), and treatment transects (Figure 5-8). Deer were the most widely recorded species across sites being observed in Bush Arm at Goodfellow Creek, and KM 88, and in Canoe Reach at Dave Henry Creek, and Valemount Peatland in control, treatment and local reference transects.

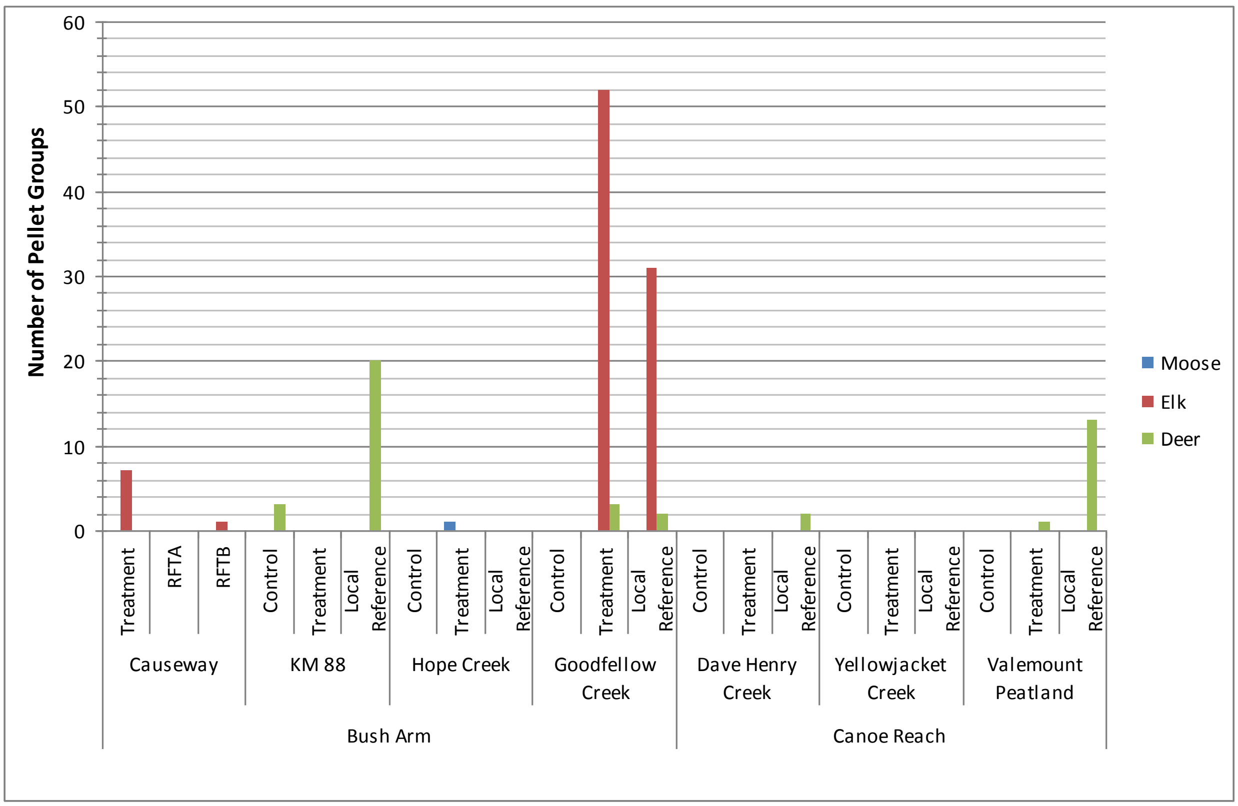

Figure 5-8: Number of ungulate fecal pellet groups by site and transect type in the Kinbasket Reservoir, 2013, for transects with one or more pellet groups. Deer pellets cannot reliably be identified to species, but together can be differentiated from other ungulates. Sites are ordered from south to north in the Kinbasket Reservoir

Similar total numbers of pellet groups were detected within the drawdown zone (n=67) and non-drawdown zone (n=69) (Figure 5-9). This was due in large part to the high number of Elk pellets recorded on the treatment transect at Goodfellow Creek in Bush Arm. In contrast, deer pellets were mostly detected above the drawdown zone in both reaches.

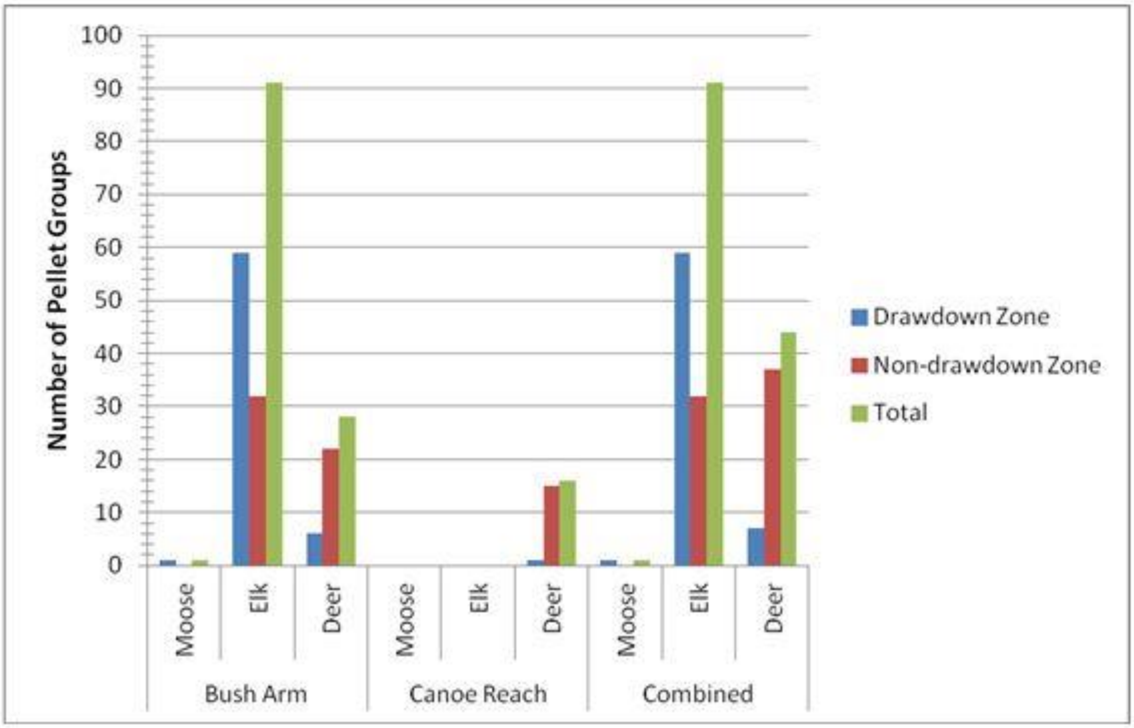

Figure 5-9: Number of pellet groups recorded for Moose, Elk and deer within the drawdown zone (control and treatment transects pooled) and above the drawdown zone (local reference, Ref A and Ref B transects) by reach and combined over both reaches

Snowshoe Hare (*Lepus americanus*) frequently utilized the forested areas above the drawdown zone but were not recorded within the drawdown zone itself. Pellets were typically in low densities (Table 5-3).

Table 5-3. Snowshoe Hare pellets by three density categories recorded during pellet plot surveys by reach and site.

		Station Pellet Density			
Reach	**Site**	**Low (<25 pellets)**	**Moderate (25-200 pellets)**	**High (>200 pellets)**	**Total**
Bush Arm	Causeway	0	0	0	0
	Hope Creek	10	2	0	12
	Goodfellow Creek	7	0	0	7
	KM 88	0	0	0	0
Canoe Reach	Dave Henry Creek	14	1	0	15
	Valemount Peatland	3	0	0	3
	Yellowjacket Creek	6	2	3	11
	Total	**40**	**5**	**3**	**48**

5.5 Bats

The detector located at the KM 88 site in Bush Arm malfunctioned completely and no data were recorded. This detector was therefore omitted from all data summaries and analyses. The remaining three bat detectors recorded bat activity during July and August 2013 (Table 5-4) for a total of 174 hours (Table 5-5). The detector at Causeway was active approximately 2.5 times longer than either of the Valemount Peatland detectors. The total recorded hours varied among detectors due to battery issues, equipment malfunctions and inability to replace detector batteries when sites were inundated due to high reservoir levels. Survey effort was evenly spread across the evening twilight and night time periods, with less effort during morning twilight.

Table 5-4: Bat detector recording schedule at each sampling location in Kinbasket Reservoir, July to August 2013. Orange-shaded squares indicate dates recording occurred

Date	26-Jul-13	27-Jul-13	28-Jul-13	29-Jul-13	30-Jul-13	31-Jul-13	1-Aug-13	2-Aug-13	3-Aug-13	4-Aug-13	5-Aug-13	6-Aug-13	7-Aug-13	8-Aug-13	9-Aug-13	10-Aug-13	11-Aug-13	12-Aug-13	13-Aug-13	14-Aug-13	15-Aug-13	16-Aug-13	17-Aug-13	18-Aug-13	19-Aug-13	20-Aug-13
Causeway			X	X	X	X	X	X	X	X	X	X	X	X	X	X								X	X	X
Valemount Peatland - North	X	X	X	X	X								X	X	X											
Valemount Peatland - South					X	X							X	X	X	X	X	X								

Table 5-5: Total survey hours per bat detector and time period at monitoring locations in Kinbasket Reservoir, 2013

Detector Location	Time Period: Evening Twilight (19:30-22:00)	Night (22:00-00:30)	Morning Twilight (04:00-05:30)	Total Hours
Valemount Peatland - North	15	15	9	39
Valemount Peatland - South	15	15	9	39
Causeway	37.5	37.5	21	96
Totals	**67.5**	**67.5**	**39**	**174**

A total of 827 bat detection (.wav) files were produced after analysis by the Kaleidoscope software. These files contained bat detections identified to most likely species (Table 5-6). The majority of bat detections were recorded at night (~74%), followed by evening twilight.

Table 5-6: Number of .wav files that contained bat calls identified to most likely species by time period per detector in Kinbasket Reservoir, 2013

	Time Period: Evening Twilight (19:30-22:00)	Night (22:00-00:30)	Morning Twilight (04:00-05:30)	Total
Detector Location	Files	Files	Files	Files
Valemount Peatland - North	18	76	4	98
Valemount Peatland - South	108	126	12	246
Causeway	37	409	37	483
Total	**163**	**611**	**53**	**827**

Eight species of bat were detected across the three sites (Table 5-7). Species of note include the Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*). Although ranked yellow provincially, the Little Brown Myotis was assessed as 'Endangered' in a February 2012 emergency assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). This status was assigned due to severe declines in abundance throughout much of its eastern North American range caused by mortality from the fungal disease white-nosed syndrome (Blehert 2009). Northern Myotis is blue-listed provincially and ranked 'Endangered' by COSEWIC due to mortalities from white-nose syndrome, and threats such as habitat loss and degradation due to forest harvest and pine-beetle kill.

Table 5-7: Species presence by site in Kinbasket Reservoir, 2013. 'X' indicates presence

Common Name	Scientific Name	Species Code	CDC* Status	COSEWIC* Status	Site Name: Valemount Peatland - North	Site Name: Valemount Peatland - South	Site Name: Causeway
Big Brown Bat	*Eptesicus fuscus*	EPFU	Yellow	N/A	X	X	X
Hoary Bat	*Lasiurus cinereus*	LACI	Yellow	N/A	X		X
Silver-haired Bat	*Lasionycteris noctivagans*	LANO	Yellow	N/A	X	X	X
California Myotis	*Myotis californicus*	MYCA	Yellow	N/A			X
Long-eared Myotis	*Myotis evotis*	MYEV	Yellow	N/A	X	X	X
Little Brown Myotis	*Myotis lucifugus*	MYLU	Yellow	Endangered	X	X	X
Northern Myotis	*Myotis septentrionalis*	MYSE	Blue	Endangered	X	X	X
Long-legged Myotis	*Myotis volans*	MYVO	Yellow	N/A	X	X	X
Totals					**7**	**6**	**8**

*CDC = Conservation Data Centre; COSEWIC = Committee on the Status of Endangered Wildlife in Canada

The Causeway site in Bush Arm had the highest species richness, detecting all identified species. This could be due to a much larger sampling effort at this location; however, most species were recorded at all three sites. Exceptions were California Myotis that was only detected at Causeway, and Hoary Bat that was not detected at Valemount Peatland - South. This could be an indication of habitat specificity or preference, but more sampling is needed to assess this possibility.

The bat detector at the Causeway site in Bush Arm recorded seven of its eight documented species after one nightly recording session (i.e., 6.5 hours, from evening twilight to morning twilight), with the last species recorded after four more sessions (Figure 5-10). Both Valemount Peatland sites had a more gradual species accumulation until all documented bat species had been recorded by the fourth (South site) or fifth (North site) session.

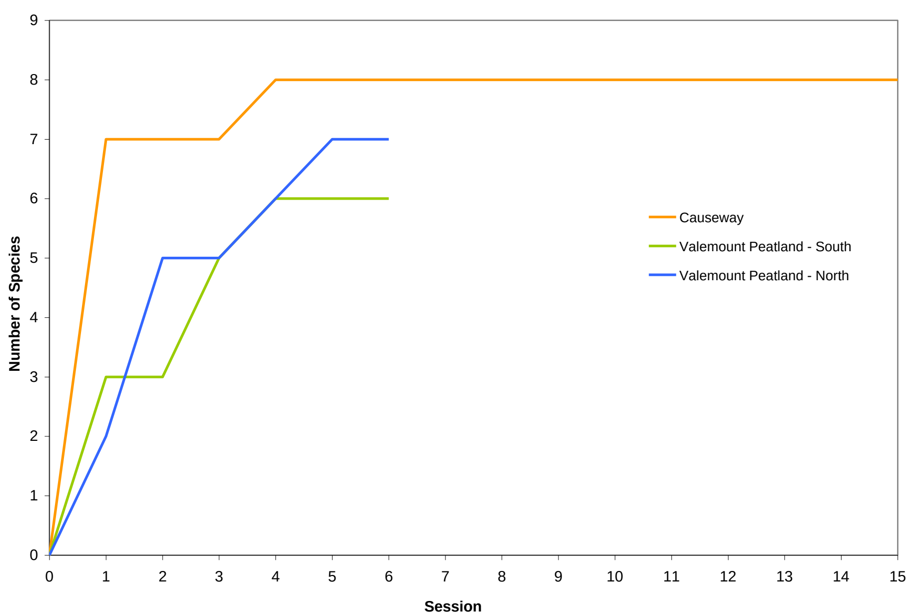

Figure 5-10: Species accumulation curves by site based on nightly recording sessions (i.e., 6.5 hours, from evening twilight to morning twilight) in Kinbasket Reservoir, July to August 2013

The most frequently detected species across all sites was Little Brown Myotis, followed by Northern Myotis and Long-eared Myotis (Figure 5-11). Valemount Peatland - South had the highest detection rate pooled across all species, followed by Causeway, and Valemount Peatland – North (Figure 5-12). This could be due to the Valemount Peatland - South site containing a relatively large vegetated pond.

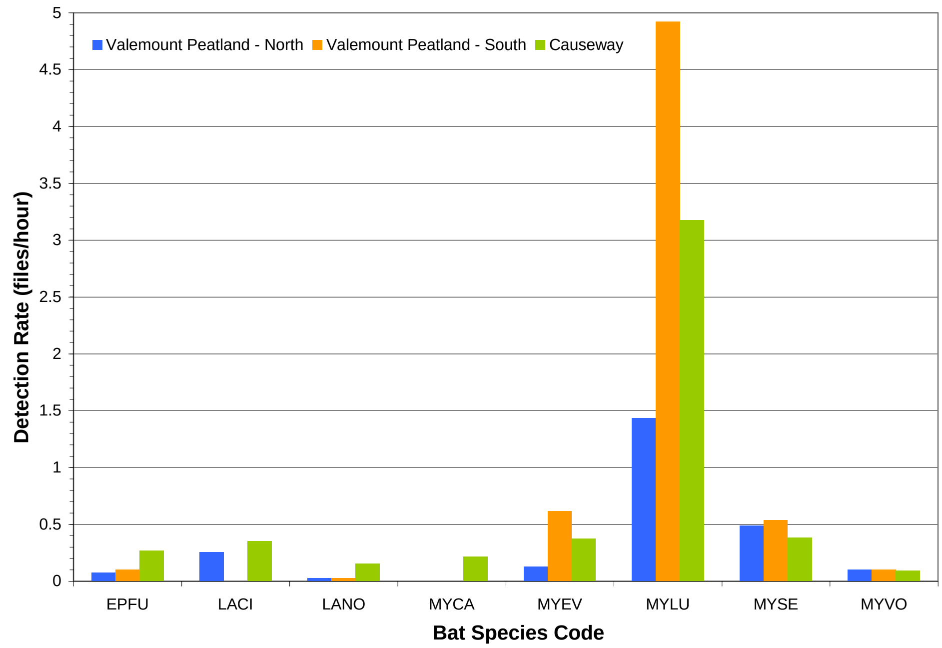

Figure 5-11: Bat species activity shown as detection rates (identified files per hour) corrected for survey effort across sites for each species detected during autonomous bat detector surveys in Kinbasket Reservoir, July to August 2013. EPFU = Big Brown Bat; LACI = Hoary Bat; LANO = Silver-haired Bat; MYCA = California Myotis; MYEV = Long-eared Myotis; MYLU = Little Brown Myotis; MYSE = Northern Myotis; MYVO = Long-legged Myotis

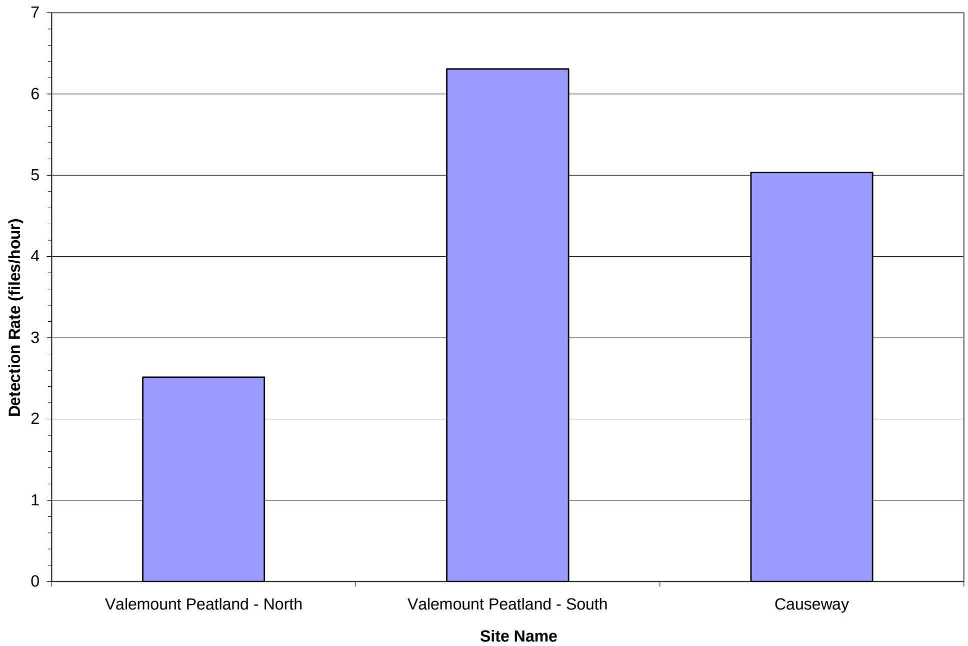

Figure 5-12: Bat activity shown as detection rates (identified calls per hour) pooled across species at sampled sites during autonomous bat detector surveys in Kinbasket Reservoir, July to August 2013

5.6 Songbirds

Songbirds were surveyed for one session at each reach: Bush Arm from June 14 to 17, 2013 and Canoe Reach on July 4, 2013. Survey effort varied by reach. While a total of 39 point count stations were sampled, only 15 of these were located within Canoe Reach where three sites were sampled compared to four sites in Bush Arm (Table 5-8). In addition, high water levels prevented planned sampling of the two treatment and two control transect point count stations at the Dave Henry Creek site in Canoe Reach. Instead, a single point count was conducted within the drawdown zone in an untreated area; this point count station was considered a “control” point count for reporting.

Table 5-8: Number of point counts sampled per site and transect type in 2013.

Reach	Control	Treatment	Local Reference	Reference A	Reference B	Total
Bush Arm	6	8	6	2	2	24
Canoe Reach	5	4	6	0	0	15
Total	11	12	12	2	2	39

A total of 357 detections of 51 species were made when all bird groups were considered (Table 5-9). Songbirds were by far the most frequently detected group with 40 species encountered during surveys, while other groups had three or less species documented. Bush Arm had much greater songbird species richness (n=40) compared to Canoe Reach (N=17). This disparity could be due to the greater sampling effort in Bush Arm, though this may also reflect greater habitat diversity in Bush Arm sampling locations.

Table 5-9: Total species observed and detections per bird group recorded in and adjacent to the drawdown zone in 2013. Spp = Number of Species; Est = Estimated number of individuals. Blanks indicate no observations

2013	KM 88		Hope Creek		Goodfellow Creek		Causeway		Valemount Peatland		Dave Henry Creek		Yellowjacket Creek		Total	
Group	Spp	Est	Spp	Est	Spp	Est	Spp	Est	Spp	Est	Spp	Est	Spp	Est	Spp	Est
Hawks, Eagles, Falcons and Allies							1	1							1	1
Kingfishers and Allies							1	1							1	1
Pheasants, Grouse, Quail and Allies					1	1									1	1
Shorebirds, Gulls, Auks and Allies					1	1	2	9	1	2			1	4	2	16
Songbirds	**20**	**66**	**12**	**44**	**18**	**50**	**19**	**61**	**12**	**34**	**9**	**16**	**5**	**18**	**40**	**289**
Swifts and Hummingbirds	**1**	**1**			**1**	**1**	**1**	**2**							**2**	**4**
Waterfowl	2	7			1	30	2	4							3	41
Woodpeckers and Allies	1	3			1	1									1	4
Total Species and Detections	**24**	**77**	**12**	**44**	**23**	**84**	**26**	**78**	**13**	**36**	**9**	**16**	**6**	**22**	**51**	**357**

No songbirds, swifts or hummingbirds were detected within 30 m of either control or treatment point count locations, possibly due to the relatively low sampling effort of this pilot study. However, 11 detections of 7 species were made within the 30 m radius at local reference transects, suggesting that these species groups may instead use the non-drawdown zone habitat that provides cover and possibly greater food resources.

A total of 49 individuals from 41 observations that represented 16 species were detected within the 75 m radius (Table 5-10). Local reference transects in both reaches, particularly Bush Arm, had higher species richness and abundance of songbirds, swifts and hummingbirds compared to drawdown zone transects; however results may be affected by the low survey effort in this pilot study (Table 5-8).

Table 5-10: Total species observed and detections for songbirds, swifts and hummingbirds recorded within a 75 m radius from point count centres in 2013. Spp = Number of Species; Est = Estimated number of individuals. Dashes indicate no sampling. Total species numbers represent the number of unique species across the site/transects being combined

Reach	Transect Type											
	Control		Treatment		Local Reference		Ref A		Ref B		Total	
	Spp	Est	Spp	Est	Spp	Est	Spp	Est	Spp	Est	Spp	Est
Bush Arm	2	3	3	5	14	22	1	1	1	3	16	34
Canoe Reach	1	2	-	-	5	13	-	-	-	-	6	15
Total	**2**	**5**	**3**	**5**	**14**	**35**	**1**	**1**	**1**	**3**	**16**	**49**

Within the 75 m radius, only three species were detected within the drawdown zone (i.e., on control or treatment transects) across both reaches: Chipping Sparrow (*Spizella passerine*, n = 2), Mountain Bluebird (*Sialia currucoides*, n=2), and Savannah Sparrow (*Passerculus sandwichensis*, n=6) (Figure 5-13) compared to 15 species and 39 individual birds that were detected in the non-drawdown zone (local reference, Ref A and Ref B transects). The Mountain Bluebird was detected solely within the drawdown zone, while the Savannah Sparrow was only detected at two transects outside of the drawdown zone (Causeway Site Reference A and Reference B). Chipping Sparrows were observed on four local reference transects in the non-drawdown zone.

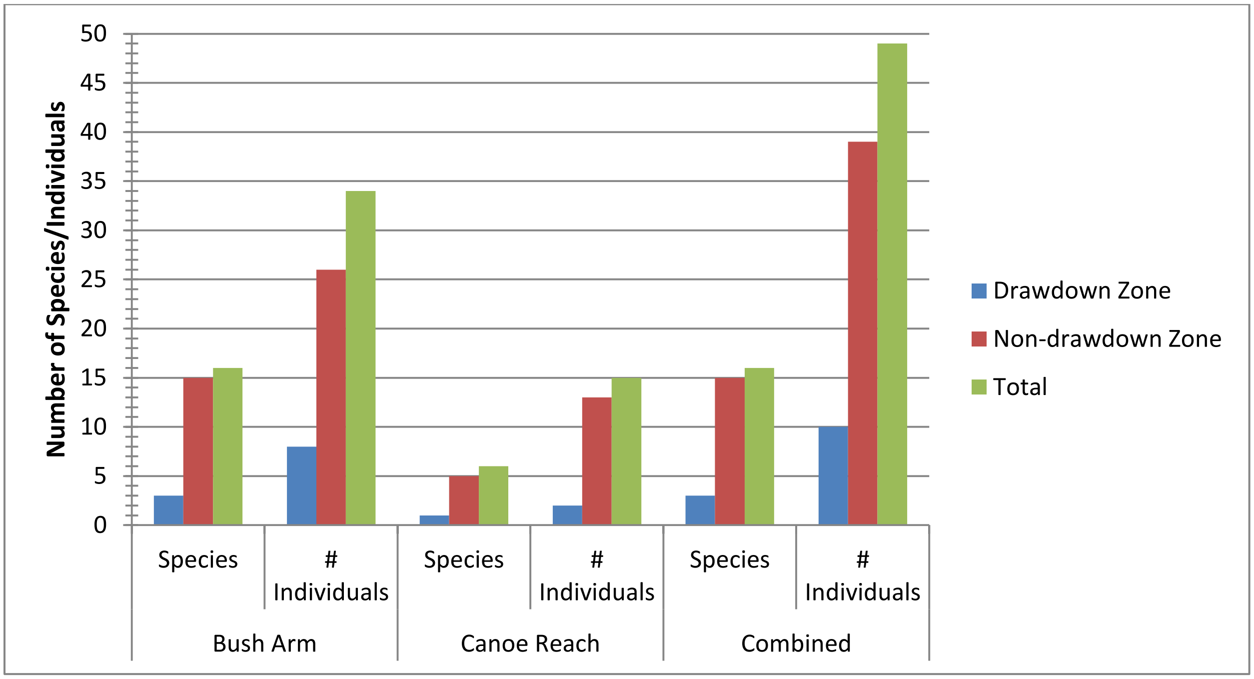

Figure 5-13: Species and number of individuals detected in 2013 for songbirds, swifts and hummingbirds recorded within a 75 m radius from point count centres within the drawdown zone (pooled control and treatment transects) and above the drawdown zone (local reference, Ref A and Ref B transects) by reach and combined over both reaches

5.7 Terrestrial Arthropods and Spiders

5.7.1 Sampling Effort

Arthropod surveys using Malaise and pitfall traps were conducted at all sites between June 8 and 19, 2013. Total sampling effort for the 4-day biomass and 1-day identification sampling was 9,390.4 hrs (Malaise: 2,460.4 hrs; pitfall: 6,930.0 hrs). Sampling effort was generally evenly distributed among transect types and sites; however, less identification effort occurred at the Goodfellow Creek and KM 88 sites in Bush Arm. In addition, pitfall traps were not used on the local reference transect at KM 88 because the ground was too wet. No incidental vertebrate captures occurred in pitfall traps during 2013.

5.7.2 Arthropods

5.7.2.1 Taxa Richness

With the exception of the Valemount Peatland, species richness was highest at the local reference sites (Figure 5-14). Valemount Peatland was had greater richness on the control transect, and most taxa were found on the treatment transect at both Causeway and Goodfellow Creek.

A total of 135 taxa were captured across both trap types. Similar total numbers of taxa were captured by each trapping method (Malaise: N= 89, pitfall: N= 87). In addition, each trapping method captured similar numbers of unique taxa (Malaise: N=48, pitfall: N=46), indicating that use of both trapping methods provides complementary effort, i.e., different taxa are targeted by Malaise and pitfall traps.

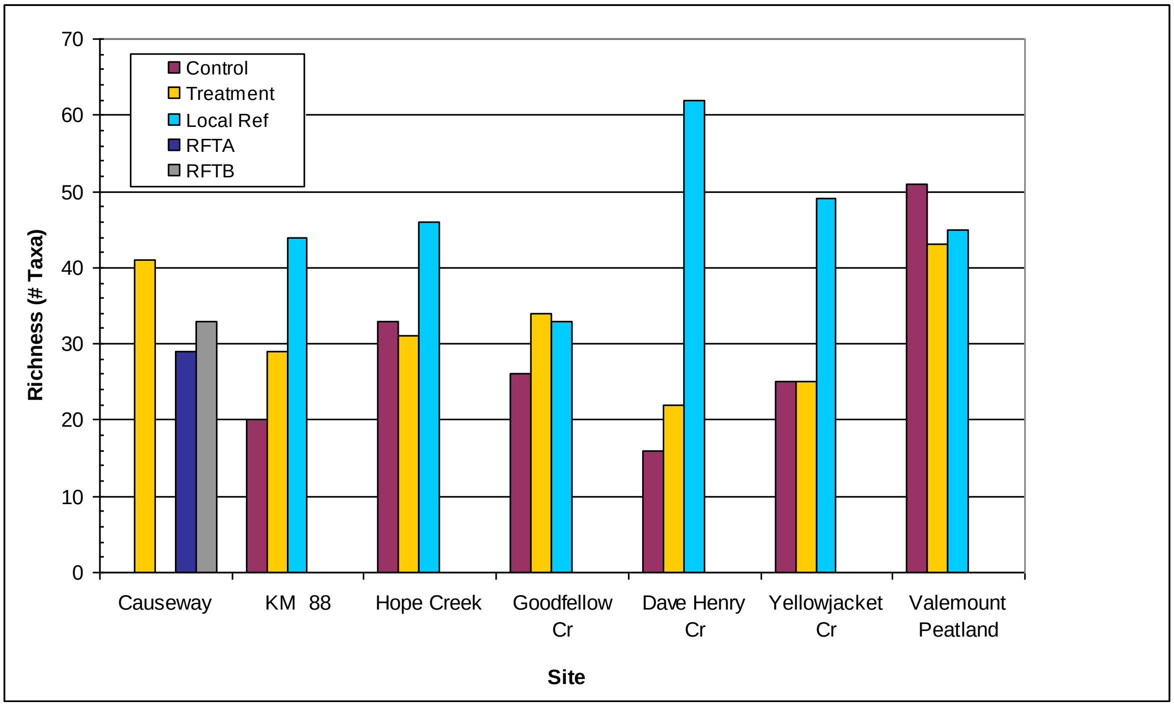

Figure 5-14: Variation in richness (# of taxa) of insects caught in both Malaise and pitfall traps among transect types and sites, in 2013. Sites are ordered from south to north within the Kinbasket reservoir

Patterns of arthropod richness and corrected richness were generally similar across transect types and sites for Malaise traps (Figure 5-15). These patterns were also similar to those shown above (Figure 5-14) when sampling methods were pooled. Insect species richness associated with Malaise traps did not differ between reaches or among treatments (p >0.05).

Arthropod richness across transect types and sites was lower for pitfall traps (Figure 5-15). As with Malaise traps, richness tended to be highest on local reference transects that were not in the drawdown zone. However this difference was evident at all sites with pitfall trapping as richness was generally double that of other transects at the site. Richness was also highest on the reference A and B transects in non-drawdown zone habitat at the Causeway site. The differences in corrected richness using pitfall traps were statistically significant among transect types (F=12.9, p=0.0006), but not among sites (p> 0.05).

Local reference transects at both reaches generally had higher average richness than drawdown zone transects for both trapping methods (Figure 5-15). The reference transects at Causeway also had higher average richness compared to the drawdown zone treatment transect when pitfall traps were used. Differences in mean richness across local reference, control and treatment transect types were significant for pitfall traps (F=16.0, p=0.0016). This significant difference was due to the high mean richness at local reference transects; there was no difference in mean richness between control and treatment transects when these were tested separately (p> 0.05). Malaise traps had no significant differences in mean richness across transect types (p>0.05). Corrected average richness for each transect type was generally higher in the Bush Arm compared to Canoe Reach for Malaise traps but the opposite pattern was seen with pitfall traps. None of these differences were significant (p>0.05).

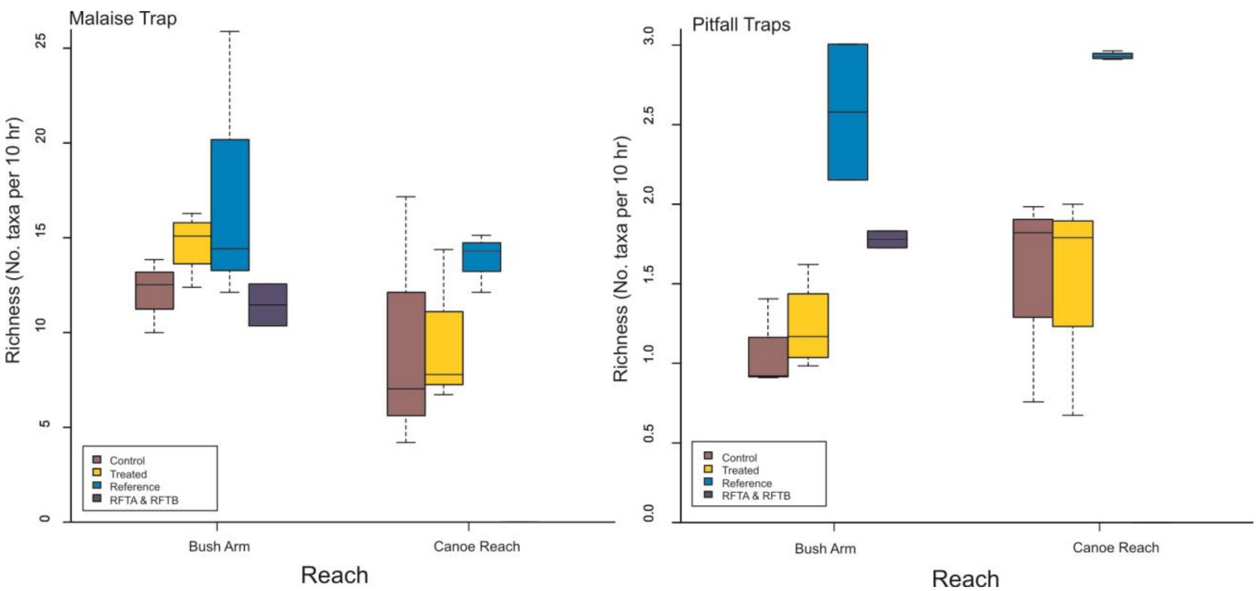

Figure 5-15: Variation in corrected richness (# taxa per 10hr) of insects caught in Malaise traps (left) and pitfall traps (right) among transect types, and between Bush Arm and Canoe Reaches, in 2013. Note the different y-axes

5.7.2.2 Relative Abundance

The relative abundance (CPUE) of insects caught by Malaise traps was highest at the control transect in the Valemount Peatland site (because of large numbers of Sciaridae) followed by transects in the non-drawdown, i.e., the reference B transect at Causeway and the local reference transects in KM 88, Dave Henry Creek, and Yellowjacket Creek (Figure 5-16). Relative abundance was similar, but lower, across the reference A transect at Causeway and all transect types at the Hope Creek and Goodfellow Creek sites. The differences in CPUE were not statistically significant among sites or transect types (p> 0.05).

Relative abundance was much lower in the pitfall traps than in the Malaise traps (Figure 5-16). The CPUE was highest in the treatment transect at KM 88, because of large numbers of Collembola. Otherwise, CPUE was higher in the non-drawdown zone local reference and reference transects at each of the remaining sites. Valemount Peatland was an exception to this pattern because its local reference transect showed the lowest relative abundance. None of these differences were statistically significant (p> 0.05).

The mean relative abundance of sampled arthropods did not differ across reaches or transect types (p> 0.05) for either Malaise traps or pitfall traps (Figure 5-16).

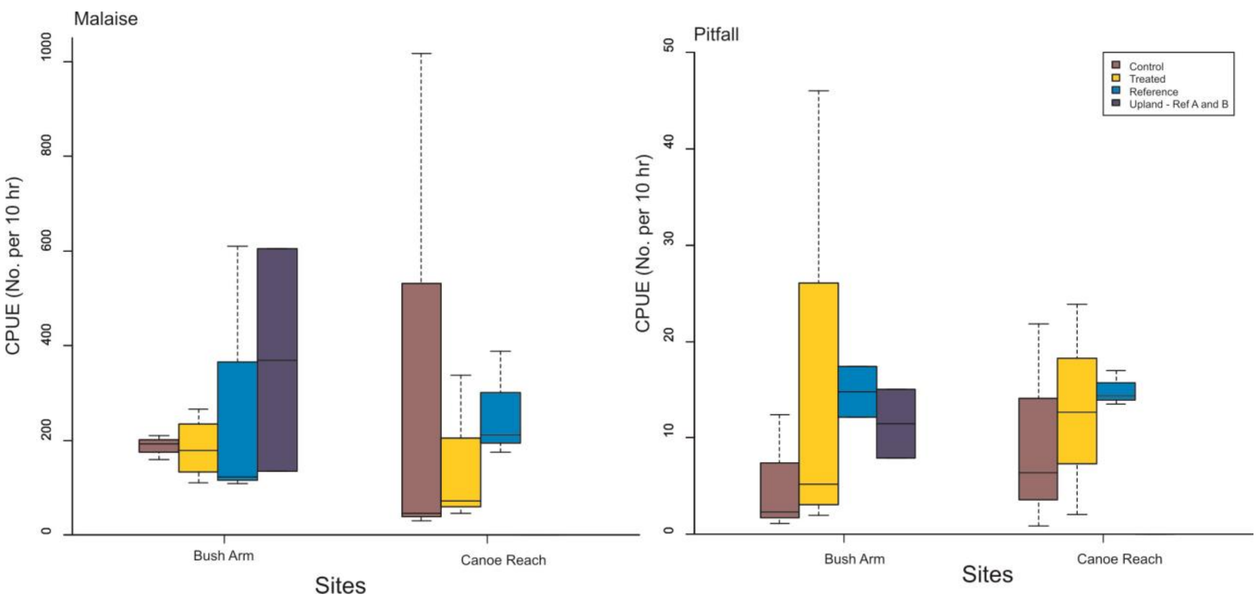

Figure 5-16: Variation in relative abundance (CPUE) of insects caught in Malaise traps (left) and pitfall traps (right) among transect types and reaches in 2013. Note the different y-axes

5.7.2.3 Biomass

Arthropod biomass (dry weight, mg/hr) varied relative to transect type, site and reach for both trap types (Figure 5-17). Total biomass was much higher for Malaise traps compared to pitfall traps. Total biomass was also higher in non-drawdown zone transects compared to those in the drawdown. Local reference transects consistently showed the highest biomass at each site, with the exception of Valemount Peatland where the control transect was highest for Malaise trapping. The Reference A transect also had the maximum biomass at Causeway for both trapping methods. No consistent pattern was evident for either trap type when total biomass levels were compared between drawdown zone control and treatment transects within sites. Given the failure of the revegetation efforts (Hawkes et al. 2013) any differences in biomass observed are likely related to differences in habitat between drawdown and non-drawdown zone sites and not due to revegetation efforts.

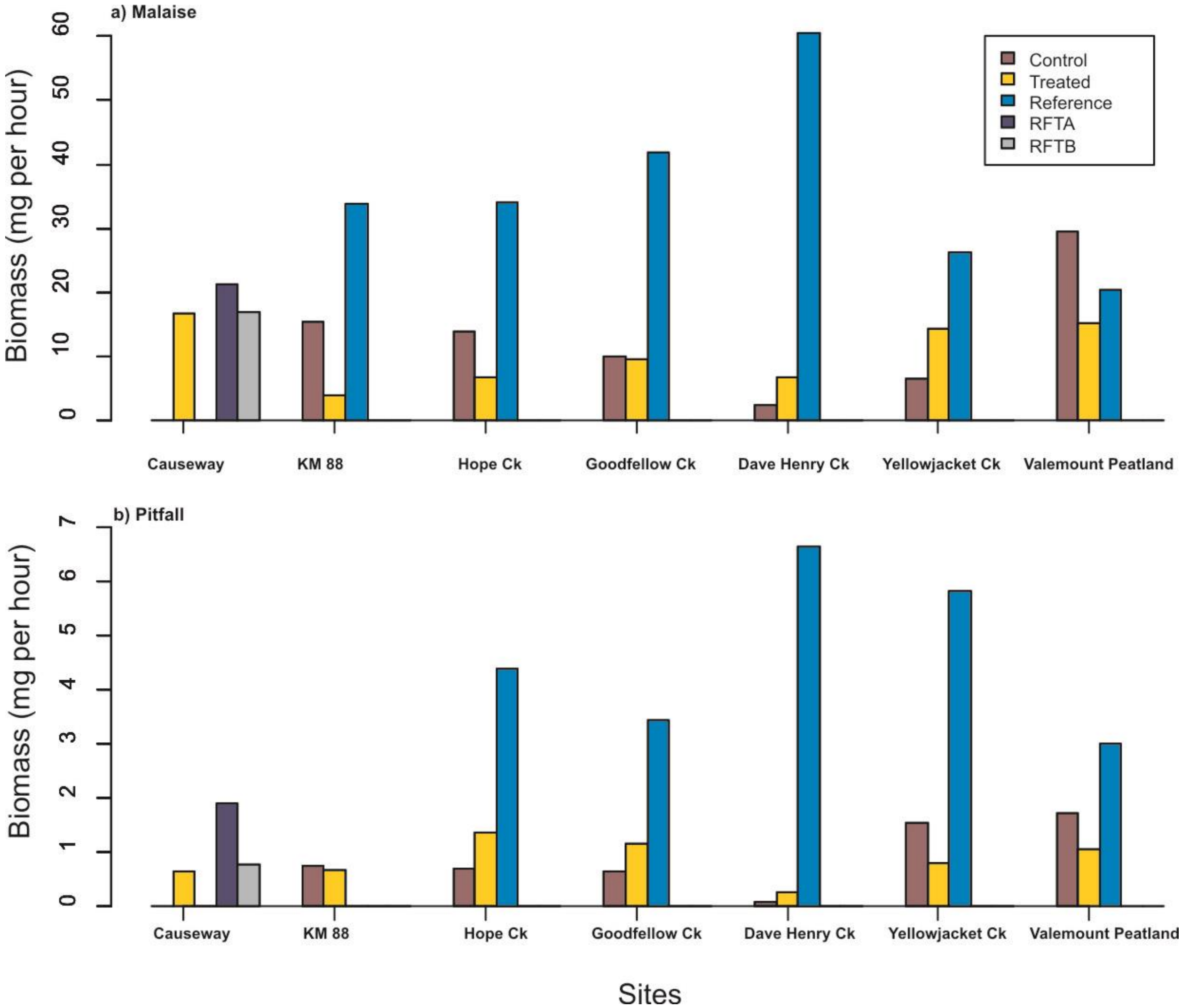

Figure 5-17: Variation in total arthropod biomass (dry weight, mg per hr) captured by a) Malaise traps and b) pitfall traps, for each site and transect type in the Kinbasket reservoir in 2013. Sites were ordered from south to north within the reservoir

5.7.2.4 Community Similarity

Non-drawdown zone local reference transects in Dave Henry Creek, Valemount Peatland, Yellowjacket Creek, Goodfellow Creek, and Hope Creek had similar composition of insect taxa (Figure 5-18). The communities in the control and treatment transects of Yellowjacket Creek and Dave Henry Creek, both in Canoe Reach were also similar, as were the control and treatment communities of Goodfellow Creek, KM 88, and Hope Creek (control). The two upland reference communities at the Causeway site appeared quite dissimilar. The insect community in the local reference transect of KM 88 was more similar to the control and treated communities of Valemount Peatland, and the Reference B community in Causeway, than to the other local reference transects. In general the treatment and control areas within each reach were similar suggesting that that insects do not respond to changes in vegetation, or more likely, that revegetation efforts were not successful (as per Hawkes et al. 2013).

Figure 5-18: PCoA diagram showing the similarity among transect types across sites and reaches in the Kinbasket Reservoir in 2013, based on their composition in insect taxa (D14) as sampled in Malaise traps. Axis 1 explains 27% of the similarities, and axis 2, 25%. Symbols represent the reaches in either Canoe Reach (Δ), or Bush Arm (°). Colors code for the types of zone: black: control, orange: treated, green: local reference, blue: Causeway reference transects

Results for pitfall trapping were similar to those for Malaise traps (Figure 5-19). The non-drawdown zone local reference transects in Dave Henry Creek, Valemount Peatland, Yellowjacket Creek, Good Fellow Creek, and Hope Creek again had similar composition of insect taxa. The communities in the control and treatment transects of Goodfellow Creek and Dave Henry Creek were also very similar, as were the control and treatment communities of KM 88, Valemount Peatland and the two upland reference communities in Causeway.

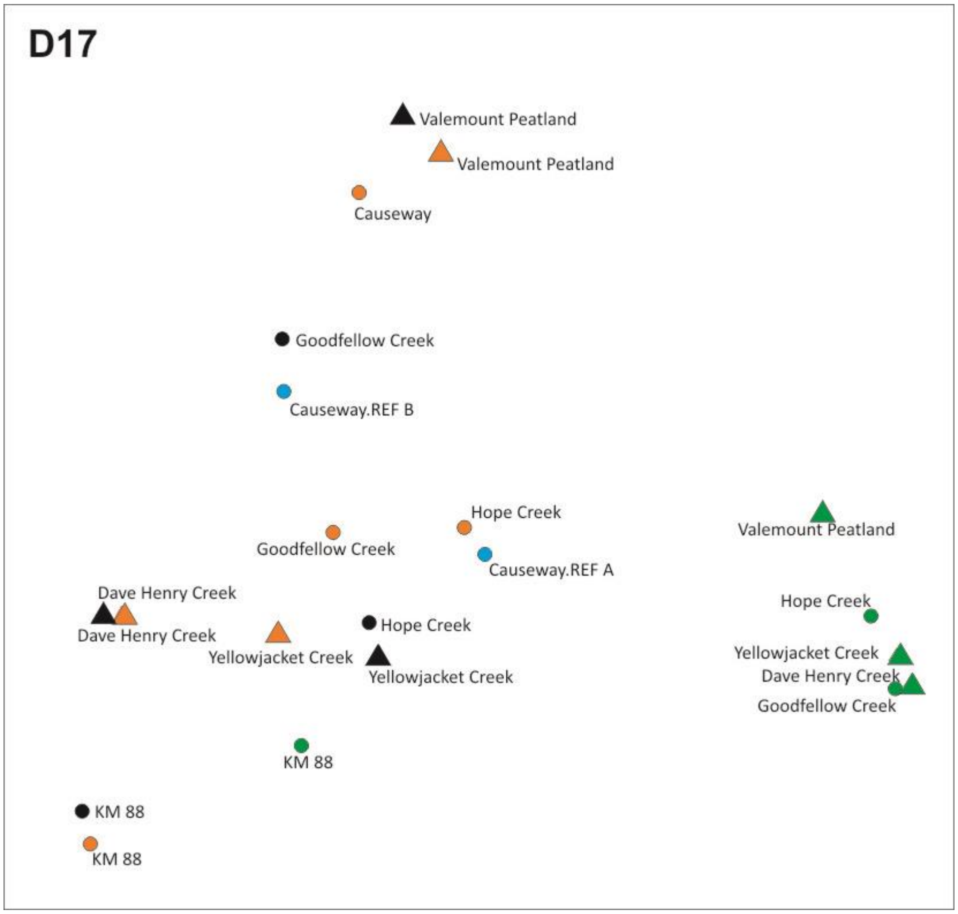

Figure 5-19: PCoA diagram showing the similarity among transect types across sites and reaches in the Kinbasket Reservoir in 2013, based on their composition in insect taxa (D14), as sampled in pitfall traps. Axis 1 explains 20% of the similarities, and axis 2, 18%. Symbols represent the reaches in either Canoe Reach (Δ), or Bush Arm (°). Colors code for the types of zone: black: control, red: treated, green: local reference, blue: Causeway reference transects

Results from both trapping methods indicated that arthropod communities in the drawdown zone (i.e., on both control and treatment transects) tend to be similar, but are different compared to non-drawdown communities. The drawdown communities in the Valemount Peatland site seemed to be somewhat unique compared to those at other sites.

5.7.2.5 Species Assemblages

None of the insect taxa sampled by malaise or pitfall traps were associated with the treatment sites established in the drawdown zone (irrespective of treatment). This suggests that the application of the treatment did not influence the use of the revegetation areas by insects. The insect taxa sampled by Malaise traps split into two main groups based on site type: one associated with the local reference sites and one with the drawdown zone (both control and treatment areas), which is consistent with the results shown on the PCoAs above (Figure 5-18, Figure 5-19). Some of the taxa sampled by Malaise traps appeared to be associated with one another (i.e., they were consistently found together; W=0.07, p=0.0001) (Figure 5-20). After correcting for multiple testing one taxon was associated with the local reference sites (Diapriidae) and two (Braconidae and Vespidae) were associated with the treatment transect at the Bush Arm Causeway, the local reference transect in KM 88, and the control transect in Hope Creek (Figure 5-20).

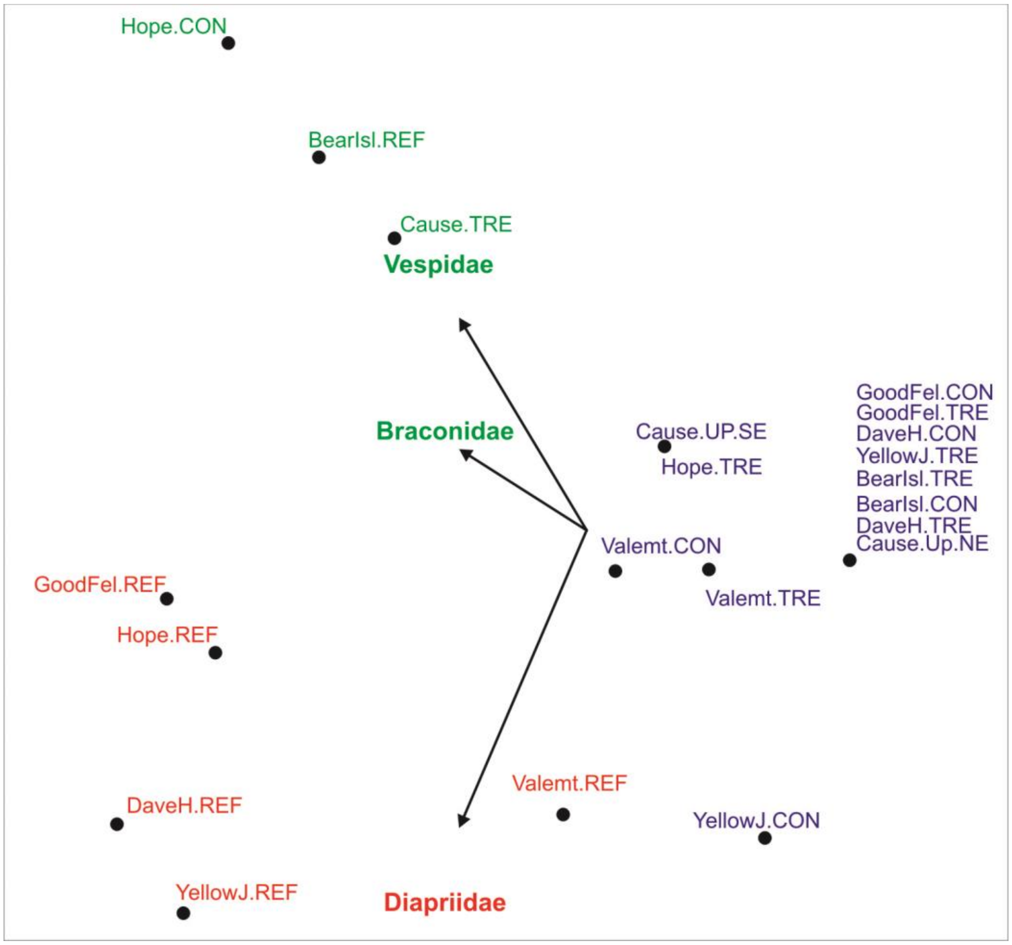

Figure 5-20: Principal Components Analysis ordination diagram with superposition of the partition results by K-Means and Kendall Concordance analysis. Black vectors represent taxa sampled by malaise traps. Taxa represented are those strongly associated with a given type of site (reference) or group of sites. The split between reference and drawdown sites is also apparent. Axis X expresses 76 per cent of the variation of the data set, and axis Y, 12 per cent. Coloured text represents associations between taxa and sites

The insect taxa sampled by pitfall traps also split in two groups: one characteristic of the local reference transects, and one associated with the control and treated transects (and the upland reference transects in Causeway, and local reference transect in KM 88; Figure 5-21). Several taxa of insects were associated with a given type of site ($W=0.08$, $p=0.013$) and after correcting for multiple testing, the associations of three taxa with a given site type were significant at $p<0.05$ (Mycetophilidae, Clusiidae, and Microcoryphia) and one taxon was significant at $p<0.1$ (Staphylinidae). Mycetophilidae, Clusiidae, and Microcoryphia were associated with the local reference transects of the five sites, while Staphylinidae was associated with the control transects in KM 88, Valemount Peatland, and Yellowjacket Creek, as well as the upland reference A transect communities in Causeway (Figure 5-21).

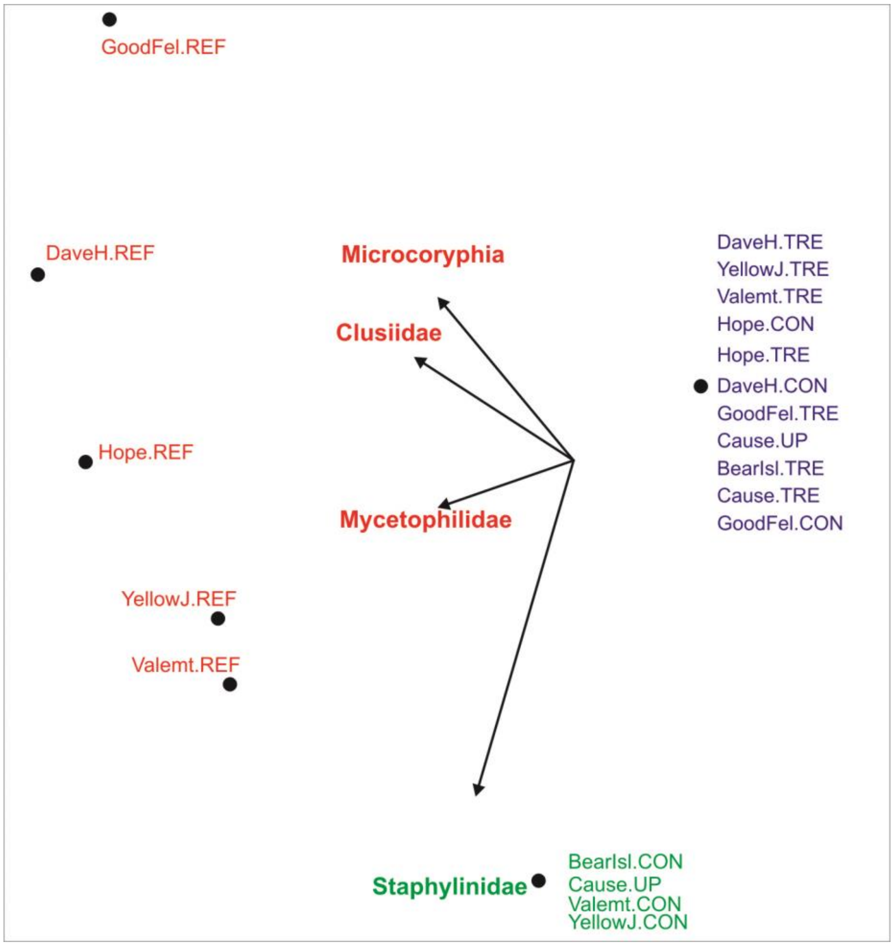

Figure 5-21: Principal Components Analysis ordination diagram with superposition of the partition results by K-Means and Kendall Concordance analysis. Black vectors represent taxa sampled by pitfall traps. Taxa represented are those strongly associated with a given type of site (reference) or group of sites. Axis X expresses 58 per cent of the variation of the data set, and axis Y, 21 per cent. Coloured text represents associations between taxa and sites

5.7.3 Indicator Species

The potential to use spiders (Araneae) and beetles (Coleoptera) as indicators of habitat change was assessed. Buchholz (2010) provides a compelling review and convincing arguments for using spiders as a suitable model group to assess the effectiveness of habitat restoration in improving habitat quality. Both groups, being predominantly terrestrial, were mainly captured in pitfall traps. However 8.5% and ~27% of spider and beetle captures respectively came from Malaise traps.

5.7.3.1 Araneae (Spiders)

Twenty-nine species of spiders from ten families were identified in 2013 (Figure 5-22). Linyphiidae (sheet-web and dwarf sheet spiders) was the most diverse family encountered, with 10 species captured, followed by Lycosidae (wolf spiders; n = 7 species). The remaining families had only one or two representative species. Linyphiidae and Lycosidae spiders were also the most diverse families captured in insect sampling undertaken in the Arrow Lakes Reservoir (Hawkes et al. 2010, 2011, 2012).

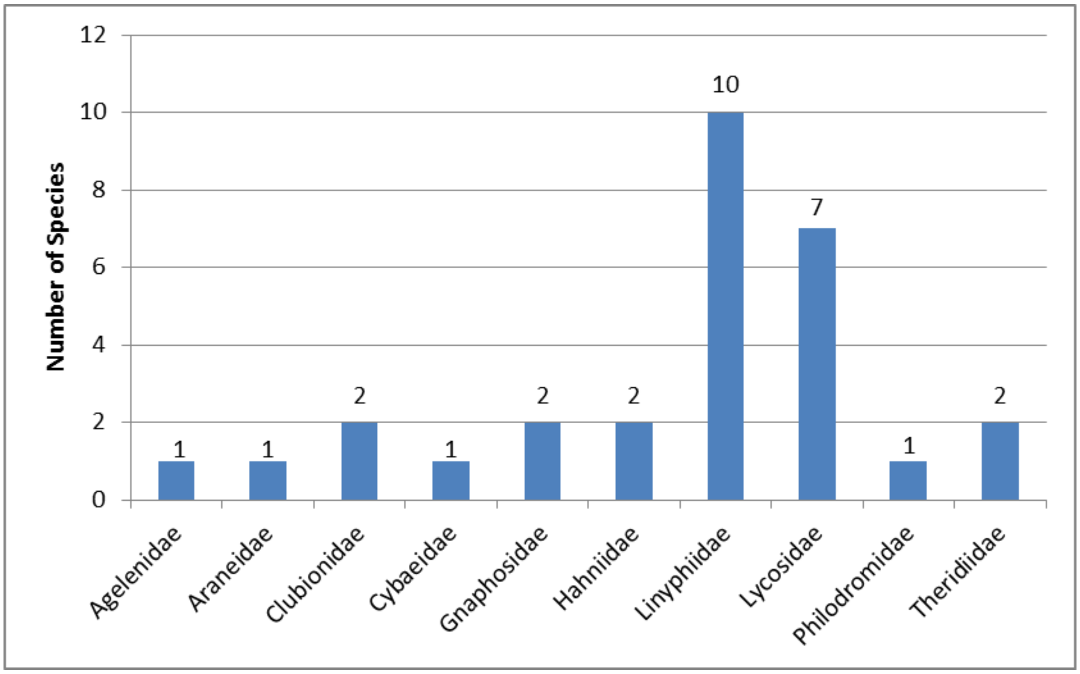

Figure 5-22: Spider families and number of representative species documented in Kinbasket Reservoir in 2013. Data were pooled across transects, sites and reaches

The number of spider families and species varied among reach and transect type (Figure 5-23). Most species occurred on the local reference transects of Dave Henry Creek and Yellowjacket Creek, and most families were trapped on the local reference transect of Dave Henry Creek. Spiders were only recorded from one control transect (Valemount Peatland; n=3 species), while four treatment transects had at least one species.

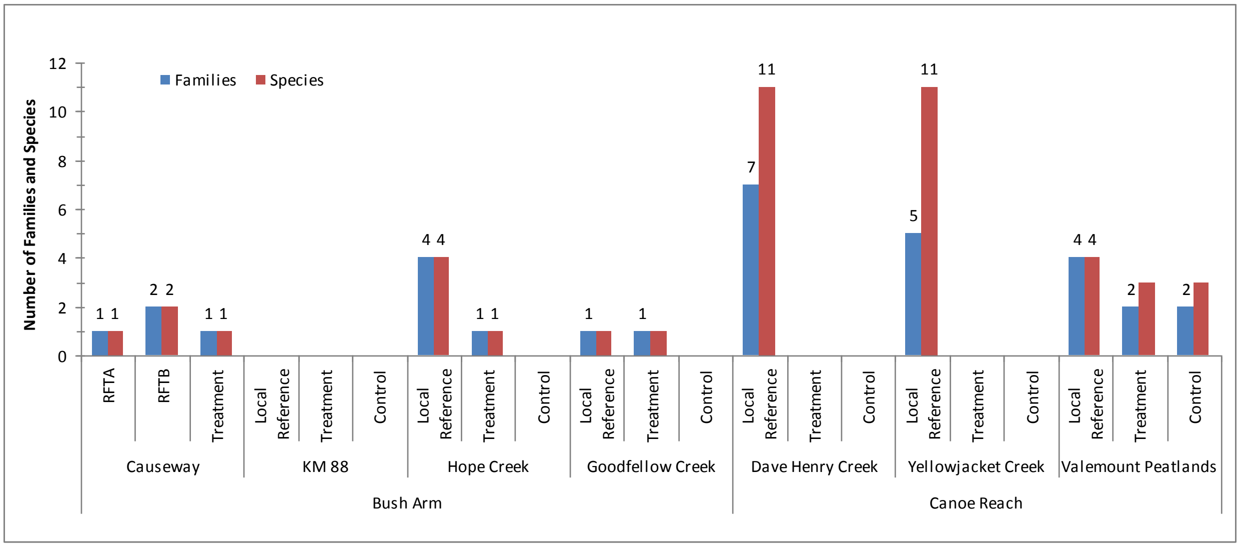

Figure 5-23: Spider families and species documented per site and transect type in the Kinbasket Reservoir in 2013

There was a clear trend of greater family and species-level diversity above the drawdown zone than within it (Figure 5-24).This trend was largely driven by the relatively high diversity at local reference transects, low diversity at treatment transects, and near complete absence of spiders from control transects.

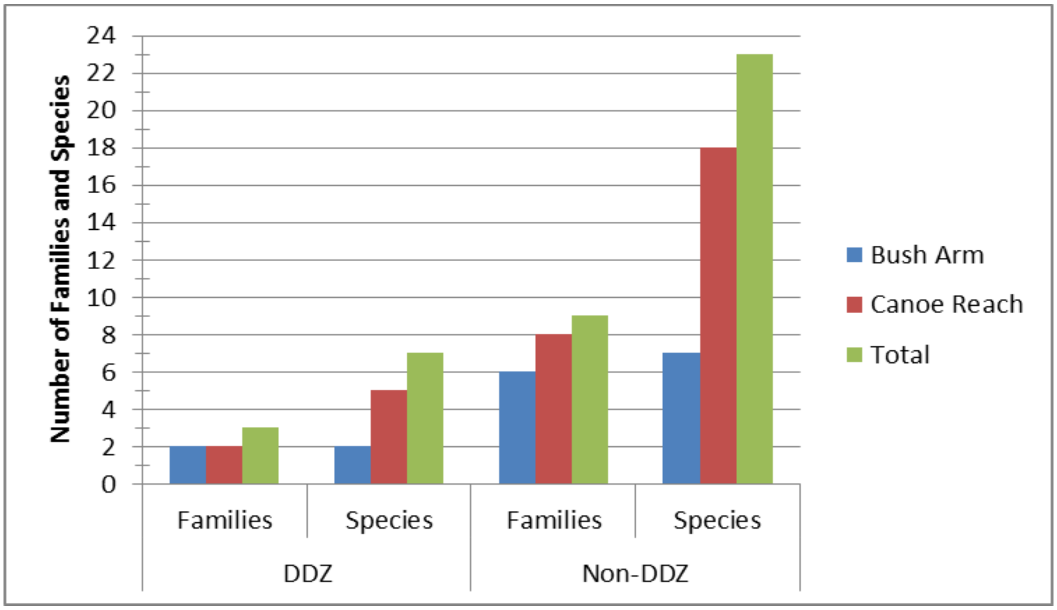

Figure 5-24: Spider families and species documented within the drawdown zone (control and treatment transects pooled) and above the drawdown zone (RFTA, RFTB and local reference transects)

These results suggest that it may be feasible to use spiders to assess changes in habitat quality associated with revegetation of the drawdown zone. The greater richness of spiders in local reference transects indicate that species and family diversity may be a good indicator of revegetation success. In particular, the complete absence of spiders from control transects, with the exception of the Valemount Peatland, could potentially indicate a treatment effect on most sites. There were also unique families and species recorded by transect type. Within sheet-web and dwarf sheet spiders (Linyphiidae) and wolf spiders (Lycosidae) that were the two most dominant families, there are unique species within each of the drawdown and non-drawdown zones. The ability to use spiders as indicators of revegetation success, either by overall diversity or by recording unique species, will require additional data.

5.7.3.2 Coleoptera (Beetles)

Thirty-four species of beetle from 17 families were identified in 2013 (Figure 5-25). Carabidae (ground beetles) and Staphylinidae (rove beetles) were the most frequently encountered, with ten and nine species respectively. All remaining families had only one identified species.

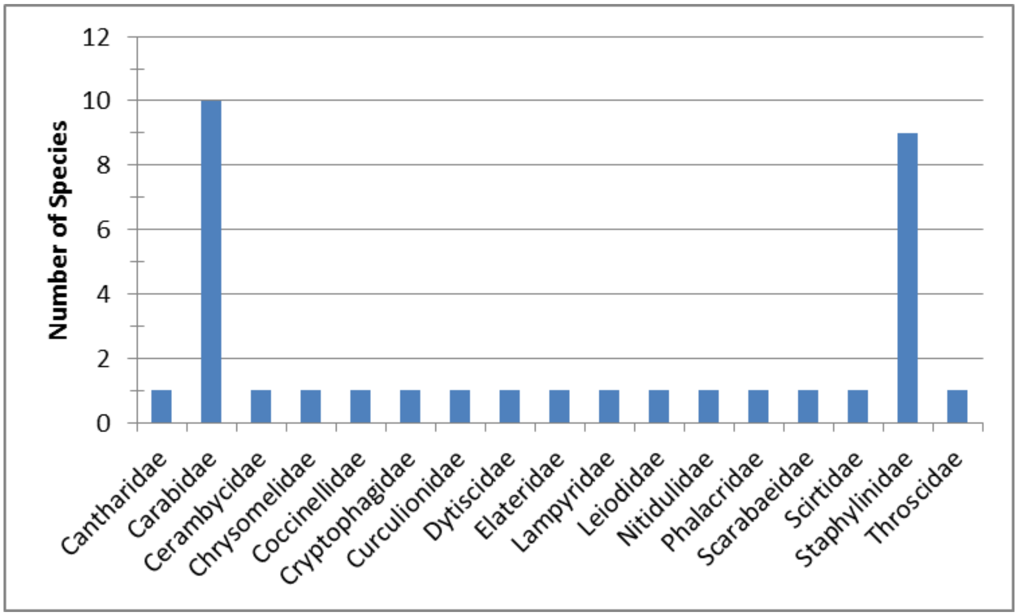

Figure 5-25: Beetle families and number of representative species documented in Kinbasket Reservoir in 2013

Unlike spiders, beetles were captured on all transects across sites, with the exception of the control transect at Dave Henry Creek (Figure 5-26). This may be due to beetles' ability to fly and therefore disperse more easily between sites or transect types. Their flying ability is also demonstrated by the relatively high incidence of beetle captures in Malaise traps compared to spiders. Beetle diversity appeared to peak in local reference transects (Figure 5-27). Unlike spiders, beetle diversity appears similar among treatment and control transects, perhaps owing to their vagility.

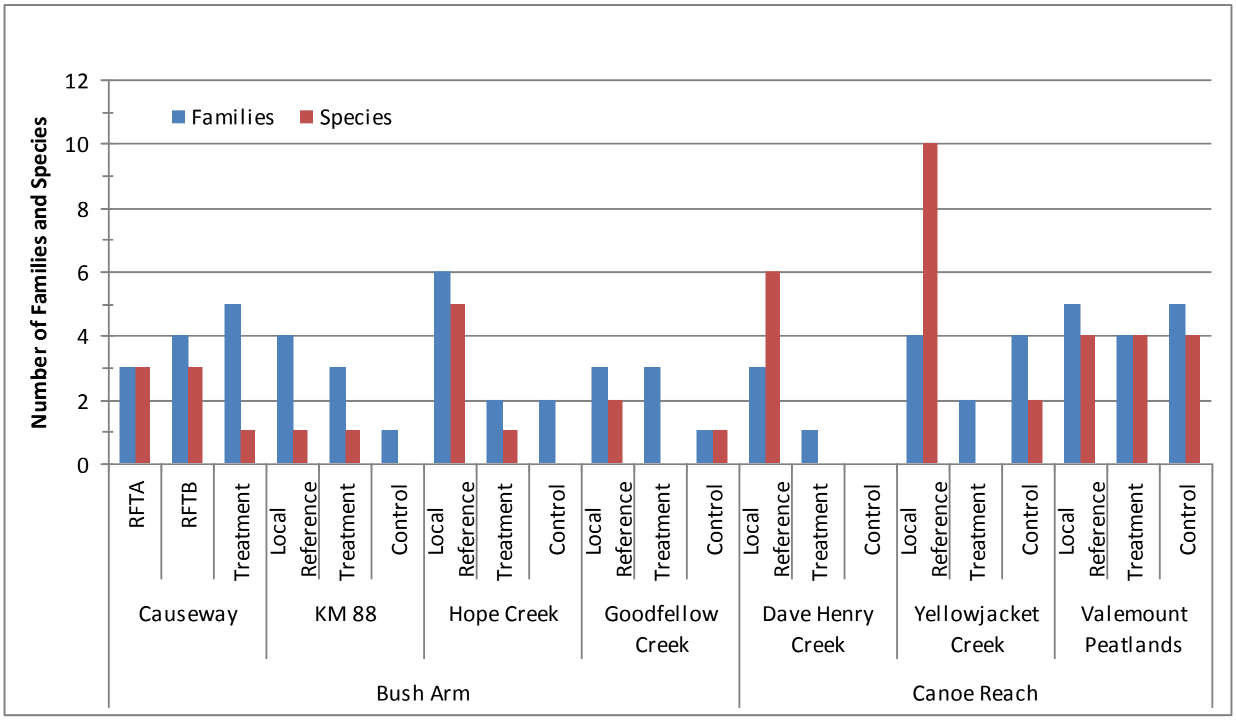

Figure 5-26: The number of beetle families and species identified at each site and transect type. Note that the actual number of species is higher than that represented here, as not all individuals were identified to species. This is particularly true where the number of families exceeds the number of species

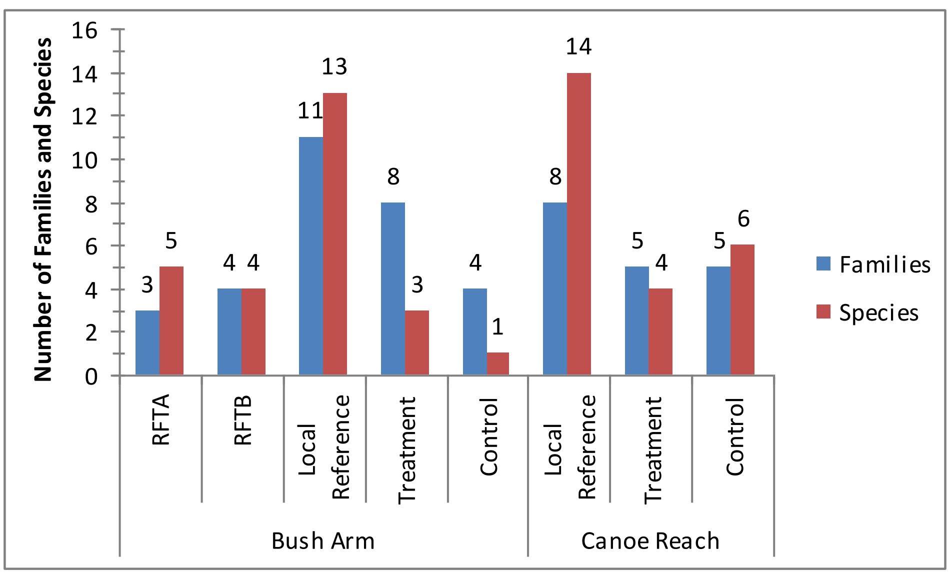

Figure 5-27: The number of beetle families and species identified at each reach (sites pooled) and transect type

No taxa of Coleoptera sampled by Malaise traps were found to be indicator taxa based on statistical analyses. However, Staphylinidae were found to be an indicator taxa using data collected with pitfall traps (stat=0.952, p=0.001). Staphylinidae were found only on local reference transects and in the control transects of Yellowjacket Creek and

Valemount Peatland, which is consistent with Figure 5-21. The potential for Staphylinidae to be an indicator of habitat change could be explored further in future years; however, it does not appear that there are substantive difference between revegetated and control sites, which may limit the utility of beetles as indicators of revegetation effectiveness.

5.8 Incidental Observations

Incidental observations, while lacking effort data required for more formal analyses, help to provide a more complete picture of wildlife use within and outside of the drawdown zone, and between the two reaches. A total of 29 animal species were recorded incidentally, including Western Toad (*Anaxyrus boreas*; only recorded in the Valemount Peatland), 20 species of birds, and 8 species of mammal (Table 5-11). The distribution of these sightings is also informative. Appendix 9-D provides a list of the incidental species and total number of individuals observed per site.

Table 5-11: Number of species (Spp), number of observations (observations may represent more than one individual), and number of individuals of incidental wildlife recorded in the Kinbasket Reservoir in 2013. See Appendix 9-D

	Amphibians			Birds			Mammals		
Reach	Spp	# Obs	# Ind	Spp	# Obs	# Ind	Spp	# Obs	# Ind
Bush Arm	0	0	0	16	19	53	3	23	57
Canoe	1	4	2 (plus 5,010 tadpoles)	11	16	25	7	29	46

6.0 DISCUSSION

This entire study hinges on the revegetation efforts conducted under CLBWORKS-1 Kinbasket Reservoir Revegetation. That is, it is only possible to test the effects of revegetation when that revegetation is successful. It has been noted anecdotally previously, and fully documented by CLBMON-9 *Kinbasket Reservoir Monitoring of Revegetation Efforts and Vegetation Composition Analysis* (Hawkes et al. 2013), that revegetation efforts in the Kinbasket Reservoir have low success. This is likely due to the combination of inundation timing, frequency, duration and depth, or with the by-products of these factors such as erosion, woody debris scouring, and drought conditions. Hawkes et al. (2013) determined that there were no statistically significant differences between treatment and control plots either in percent cover of vegetation or species diversity within any plant community, elevation band, or region of the reservoir; therefore, neither the quality nor quantity of native vegetation in the Kinbasket Reservoir drawdown zone increased as a result of CLBWORKS-1. Based on those results, the interpretation of any trends is complicated.

When comparing the utilization of the drawdown zone between controls and treatments by mammals the response appears mixed. While there appears to be more captures in treatment transects relative to controls (and fewer than in reference transects), that trend only applies to 2013. The relative abundance (CPUE) of total captures per treatment type varied from previous sampling years, with 2013 typically representing the lowest relative CPUE across treatment types. However, there are confounding factors such as population cycles, seasonal timing and duration of sampling sessions, and capture probabilities that are generally associated with all small mammal trapping. For example, in contrast with previous years, no Southern Red-backed Voles (*Myodes gapperi*) were trapped in 2013. This could be a reflection of declining habitat quality for this species, natural population fluctuation, or other unknown factors. Species richness was highest in a treatment transect, owing to one capture of a Long-tailed Vole. However, as only one animal was involved on one transect, it could equally be considered an outlier as it could an indicator. The small mammals targeted by this study design are not insectivorous, so correlations with invertebrate richness or biomass would be uninformative.

The pattern is also opaque with regards to ungulate pellet plots. While the results were clear for Canoe Reach, with virtually all pellet groups in reference transects, the number of pellet groups was highest in treatment transects in Bush Arm. Here again though, this was largely due to the abundance of elk pellets at a single transect at Site 88 . While revegetation may be the cause of this apparent trend, it could also be related to edge effects – the proximity of that transect to the forest (the reference transect there also having numerous pellet groups) relative to the control transect. This pattern, which does not appear to apply to other ungulate species, will require additional years of data collection to elucidate.

It is clear from our initial bat sampling that most of the expected species of bat occur within the drawdown zone of Kinbasket Reservoir. Limited sampling and technical issues (related to equipment malfunction and reservoir levels) prevent any comparisons to be made. As several listed species were detected, and as bats are insectivorous and therefore potentially good indicators for addressing the management questions, it is recommended that the bat sampling methodology get incorporated into the study design with increased scope and effort in future years.

Birds were not previously identified as a focal taxon for this study. The diversity of species, general abundance, and responses to landscape features make them an ideal focal species. Bird surveys have been successfully used in other studies of the drawdown zone (e.g., CBLMON-11B1), and metrics of richness and abundance of certain species (e.g., insectivores) can be correlated to insect biomass which is already being collected. Most birds in 2013 were detected in reference areas and outside of treatment and control transects. However, sampling effort was low (especially at Canoe Reach where high waters prevented surveys at several transects), and it is again recommended that bird surveys be incorporated into future years of this study.

Given the revegetation failure, several recommendations are made regarding the revegetation program, including clarifying long-term goals, focusing effort where successes have been noted, consideration of the development of physical works in the drawdown zone of Kinbasket Reservoir to benefit wildlife (i.e., analogous to CLBWORKS-29B implemented in Arrow Lakes Reservoir; Hawkes and Howard 2012), and exploring the potential of woody debris removal to promote vegetation development (Hawkes et al. 2013). This study can be adapted to test the effectiveness of on-going reservoir management activities. Specifically, woody debris removal offers an unique opportunity to document changes in wildlife utilization of sites from a baseline state. Continuing the status quo is unlikely to reveal any unequivocal benefits to wildlife from revegetation prescriptions, given the high levels of vegetation mortality so far witnessed.

6.1 Management Questions

The current status of our ability to answer each of the four management questions associated with CLBMON-11A is summarized below.

6.1.1 How effective is the revegetation program at enhancing and increasing the utilization of habitat in the drawdown zone by wildlife such as amphibians, birds, small mammals, and ungulates?

The revegetation prescriptions applied were never considered relevant nor beneficial to amphibians, and they were not implemented explicitly to benefit most wildlife species. The revegetation program itself has been largely unsuccessful to date at increasing the percent cover or diversity of vegetation relative to untreated (control) locations (Hawkes et al. 2013). Hawkes et al. (2013) found that four to five-years post-planting, sedge plug survivorship was <5% and no deciduous shrub (willow, alder and cottonwood) stakes survived. These results held regardless of community type, elevation, geographic region, or prescription type. The revegetation prescriptions themselves are also typically small, in some cases likely being smaller than the home range size of species that may utilize them (e.g., Savannah Sparrow can have breeding territories >1 ha [Wheelwright and Rising 2008]). The varying sizes of the revegetation prescriptions, lack of replication and adequately stratified treatments, lack of revegetation success, and other inconsistencies in the CLBWORKS-1 planting methodology make it difficult to achieve more than speculation in regards to the program's effect on animal utilization of those habitats.

This study did not specifically sample amphibians, reptiles, or birds (prior to 2013). Other studies have found that the revegetation prescriptions applied in the drawdown zone have been largely ineffective at benefiting amphibians or reptiles (i.e., CLBMON-58: Hawkes et al. 2014). Benefits for other groups are inconsistent across time and reach, but given the widespread mortality of most revegetated areas, it is believed that the revegetation program has been ineffective at enhancing and increasing the utilization of habitat in the drawdown zone by wildlife.

The presence of a greater number of pellet groups in treatments vs. control transects is interesting, but it's not clear if this is simply a coincidence or if the treated areas were selected by ungulates. The frequency of observation that is currently associated with CMLBMON-11A is not sufficient to adequately address use of the treatment and control areas by ungulates and a more intensive sampling regime would be required to do so.

6.1.2 To what extent does revegetation increase the availability of invertebrate prey (e.g. arthropods) in the food chain for birds, amphibians and small mammals?

This study does not attempt to investigate the dietary preferences of birds, amphibians or small mammals (nor do the other CLBMON studies currently in effect). Insectivorous mammals (i.e., shrews and bats) are not targeted by the small mammal methods used and it is not known what effect revegetation might have on habitat utilization of insectivorous mammals. While the biomass of insects can be correlated to songbird presence (e.g., Hawkes et al. 2012 [CLBMON-11B1]), songbirds were not a focal taxa of this study (though a pilot program to add songbirds as a focal group was added in 2013). Nonetheless, a general increase in invertebrates in treatment vs. control areas could translate into a greater availability of those speculated prey for any insectivorous species.

The biomass of arthropods (as a proxy for invertebrate prey availability) was not different between control and treatment transects sampled in the drawdown zone. If there were differences, it would not be indicative of a revegetation treatment effect (because the treatments have been ineffective at increasing vegetation cover and abundance). The fact that some groups (e.g., spiders) were found in treatment and not control transects is inexplicable using existing data, but could be related to habitat preferences. More work is required to determine if this is the case.

The small mammal trapping methods used to date target granivorous small mammals, not insectivores (shrews) and the availability of insects will not influence the relative abundance of seed-eating species such as Deer Mouse and Meadow Vole. It would be more appropriate to correlate the productivity of seed-producing plants with the relative abundance of the small mammal species targeted by the monitoring program. However, it is unlikely that any of the plans selected for the revegetation program were selected to benefit seed-eating small mammals. Moreover, the methods used to date do not assess plant productivity (through assessments of seed production) so it is not possible to determine whether the revegetation program would influence the availability of food for seed-eating small mammals. Furthermore, the lack of success associated with the revegetation program suggests that this has not been the case. It is the opinion of the authors that the revegetation program has had no influence on the productivity of invertebrate prey.

6.1.3 Are revegetation efforts negatively impacting wildlife in the drawdown zone? For example, does revegetation increase the incidence of nest mortality in birds or create sink habitat for amphibians?

This study does not address any negative impacts to wildlife in the drawdown zone. The determination of nest mortality or sink habitats requires specific studies, with hypotheses not addressed under this study. Based on other studies of nest mortality (CLBMON-36) and impacts on amphibians and reptiles (CLBMON-58), it is not known if revegetation has any negative impacts, but none are suspected thus far.

6.1.4 Which methods of revegetation are most effective at enhancing and increasing the utilization of wildlife habitat in the drawdown zone?

Based on the results obtained thus far for CLBMON-11A, it appears that all methods of revegetation are ineffective at enhancing and increasing the utilization of wildlife habitat in the drawdown zone. As found in CLBMON-9 (based on four years of results), only the sedge plug revegetation treatment had any establishment success, but even then only in very limited areas (Hawkes et al. 2013). No treatments were effective at increasing the quality or quantity of vegetation in the drawdown zone of Kinbasket Reservoir.

6.2 Management Questions - Summary

Our ability to address each of the management questions is summarized below (Table 6-1). The methods applied to date (small mammal live-trapping, ungulate surveys, and arthropod sampling) are not well-suited to answering the management questions associated with CLBMON-11A. The wrong species of small mammal are being targeted, the productivity (i.e., seed load) of plants that would be consumed by granivorous small mammals has not been assessed, songbirds have not been considered a focal taxa for CLBMON-11A, and the size of the revegetation prescriptions applied in the drawdown zone are likely of little benefit to ungulates given the proximity and spatial extent of suitable habitat adjacent to the drawdown zone. Overall, there does not appear to have been a connection made between the types of plants used in the revegetation program and how the use of those species would benefit wildlife using the drawdown zone of Kinbasket Reservoir.

Despite the overall assessment of ineffectiveness and issues associated with the current focal taxa, there are opportunities to modify CLBMON-11A to assess the use of the drawdown zone by wildlife and to evaluate whether physical works programs, such as the woody-debris removal program (CLBWORKS-16), can effectively enhance wildlife habitat in the drawdown zone. Further, consideration of physical works designed to protect specific habitats in the drawdown zone would likely be beneficial in Kinbasket Reservoir. The implementation of physical works in the drawdown zone has a high likelihood of enhancing the drawdown zone for wildlife by providing opportunities for the establishment and development of vegetation communities, which would subsequently be used by wildlife. Areas treated under CLBWORKS-1 in 2013 (KM 88) should be monitored. The area treated is larger than other areas treated previously, the sedge plugs used were larger, and the density of planting was higher.

Table 6-1: Relationships between management questions (MQs), methods and results, sources of Uncertainty, and the future of project CLBMON-11A

MQ	Able to Address MQ?	Scope		Sources of Uncertainty
		Current supporting results	Suggested modifications to methods where applicable	
1	Partially	Generally, diversity and relative abundance of indicator taxa is greater in non-drawdown habitat compared to drawdown. Few differences were apparent between treatment and control transects within the drawdown, with the exception of spiders that were absent from most control transects.	• Increased frequency of sampling (i.e., annually) • Add additional focal groups (i.e., birds and bats) • Add other sites as physical works are implemented (e.g., woody debris removal) • Consider the development of physical works prescriptions (e.g., analogous to CLBMWORKS-29B for Arrow Lakes Reservoir)	• Lack of appropriate baseline (sampling did not occur prior to the application of the revegetation prescriptions) • Natural annual population variation • Variable reservoir operations • Widespread revegetation failure • Bi-annual sampling
2	Partially	General arthropod richness, relative abundance and biomass did not appear different between treatment and control transects. However spiders were notably absent from control transects, while present on the majority of treatment transects. No difference between control and treatment transects were noted for beetles. Arthropod communities in the drawdown zone (i.e., on both control and treatment transects) tend to be similar but are different compared to non-drawdown communities. General arthropod richness and biomass were significantly higher in non-drawdown. There was a clear trend of greater spider family and species-level diversity above the drawdown zone than within it.	• Sample insectivorous mammals (e.g., bats, shrews) • Annual sampling for all groups • Add other sites as physical works are implemented (e.g., woody debris removal) • Consider the development of physical works prescriptions (e.g., analogous to CLBMWORKS-29B for Arrow Lakes Reservoir)	• Lack of appropriate baseline (sampling did not occur prior to the application of the revegetation prescriptions) • Natural annual population variation • Unknown dietary preferences or intake rates for species in the drawdown zone • Variable reservoir operations • Bi-annual sampling

MQ	Able to Address MQ?	Scope		Sources of Uncertainty
		Current supporting results	Suggested modifications to methods where applicable	
3	No	No negative impacts detected. Some (very moderate) suggestions of localized benefits, e.g., high elk pellet counts found on treatment transect at Goodfellow Creek.	• Management question is suited for other current studies in the region, not well stated to be addressed in this program.	• Lack of appropriate baseline (sampling did not occur prior to the application of the revegetation prescriptions) • Natural annual population variation • Widespread revegetation failure • Lack of knowledge regarding the use of the drawdown zone in the winter • Variable reservoir operations
4	No	None	• Focus on any successfully revegetated areas • Modify study to evaluate success of woody debris removal programs. •	• Lack of appropriate baseline (sampling did not occur prior to the application of the revegetation prescriptions) • Widespread revegetation failure • Lack of sufficient study design (i.e., appropriate size, replicates, controls) to address wildlife questions • Variable reservoir operations

7.0 RECOMMENDATIONS

1. **Modify the indicator taxa** to focus on spiders, beetles, ungulates (pellet plots), and grass/ground-nesting birds. These taxa are more likely to exhibit a measureable response to habitat change in the drawdown zone. Ungulate pellet plots are recommended to continue to document the use of the drawdown zone by ungulates. Small mammals should not be monitored as they do not contribute data necessary to answering the management questions. Bats are suitable indicators of habitat quality. If woody debris removal (see point 4, below) is considered, then bats should be sampled to assess whether the removal of woody debris influences the use of the drawdown zone by bats.

2. **Monitor KM 88** to assess wildlife use of the areas treated in 2013, which represent a different prescription (larger sedge plugs, larger area, and higher density of planting).

3. **Consider the development of physical works prescriptions for the drawdown zone of Kinbasket Reservoir.** Developing prescriptions to protect or enhance high quality habitats that exist in the drawdown zone (e.g., Ptarmigan Creek, Bush Arm Causeway, Ponds in the Valemount Peatland) would contribute to an overall improvement in wildlife habitat suitability (if the physical works are built).

4. **Explore the potential of woody debris removal for facilitating natural colonization and/or regeneration processes.** The original terms of reference for CLBWORKS-1 did not consider the potential role that could be filled by natural colonization and regeneration processes, particularly seed bank germination and regeneration of remnant individuals, in helping achieve reclamation objectives. Based on revegetation results to date, we believe that facilitating natural colonization processes through targeted physical works may be a more efficient approach than site stocking for achieving vegetation remediation objectives in the long term.

   Anecdotal evidence suggests that reducing woody debris accumulation on sites with dormant seed and/or rhizome banks can stimulate rapid regrowth, possibly providing a more cost-effective route to site remediation over the long term than site stocking. In lieu of more costly physical works, we recommend that woody debris be removed from selected sites in the drawdown zone, and that CLBMON-11A evaluate the effectiveness of targeted woody debris removal in enhancing colonization and regeneration processes, which will ultimately results in increased wildlife habitat suitability. This approach aligns with the proposed approach for CLBMON-9 (Hawkes et al. 2013).

   Because a reservoir-wide woody debris management program, CLBWORKS-16, is already in place on the Kinbasket Reservoir, it would be a relatively simple and inexpensive matter to redirect some of the resources for this program onto clearing debris from sites that demonstrate strong potential for natural regeneration. A profile of regeneration potentials for sites around the reservoir could be developed using woody debris accumulation data (to identify areas of high, moderate, low, and nil accumulation), soil seed bank profiles, soil fertility assays, evidence of nascent vegetation establishment (as indicated by seedling crops), and recent land use history. A study design together with treatment (debris removal) prescriptions could then be developed for target sites, including the identification of suitable control sites, which would allow for formal effectiveness monitoring.

5. **Pre-treatment sampling.** If implementing recommendation 4, sample prior to woody debris removal. One of the limitations of this program is the lack of pre-treatment data,

which makes it difficult to determine if any observed changes are treatment effects or related to pre-existing phenomena.

6. **Consider modifying the sampling program of CLBMON-11A to occur annually:** Collecting ecological data on an annual basis would provide a better indication of the annual variability associated with those species groups and their use of the drawdown zone (with particular emphasis on the use of control and treatment sites).
7. **Reconsider the frequency of aerial surveys for ungulates**. Aerial surveys may only need to be conducted every 5 years, during the winter, to assess the distribution and occurrence of ungulates (and other winter-active animals like wolves and wolverines) relative to the drawdown zone.
8. **Consider increasing the total area revegetated** in the drawdown zone (i.e., expand existing treatment areas) or add additional treatment areas of the same prescriptions applied previously to increase the number of replicates.
9. **Future revegetation.** If future revegetation is to occur, consider the species of wildlife that are likely to benefit from the revegetation to ensure the appropriate mix of plants is used, that the total area planted is likely to influence wildlife use of the drawdown zone, and that the revegetation prescriptions be applied in a replicated manner with sufficient stratification.

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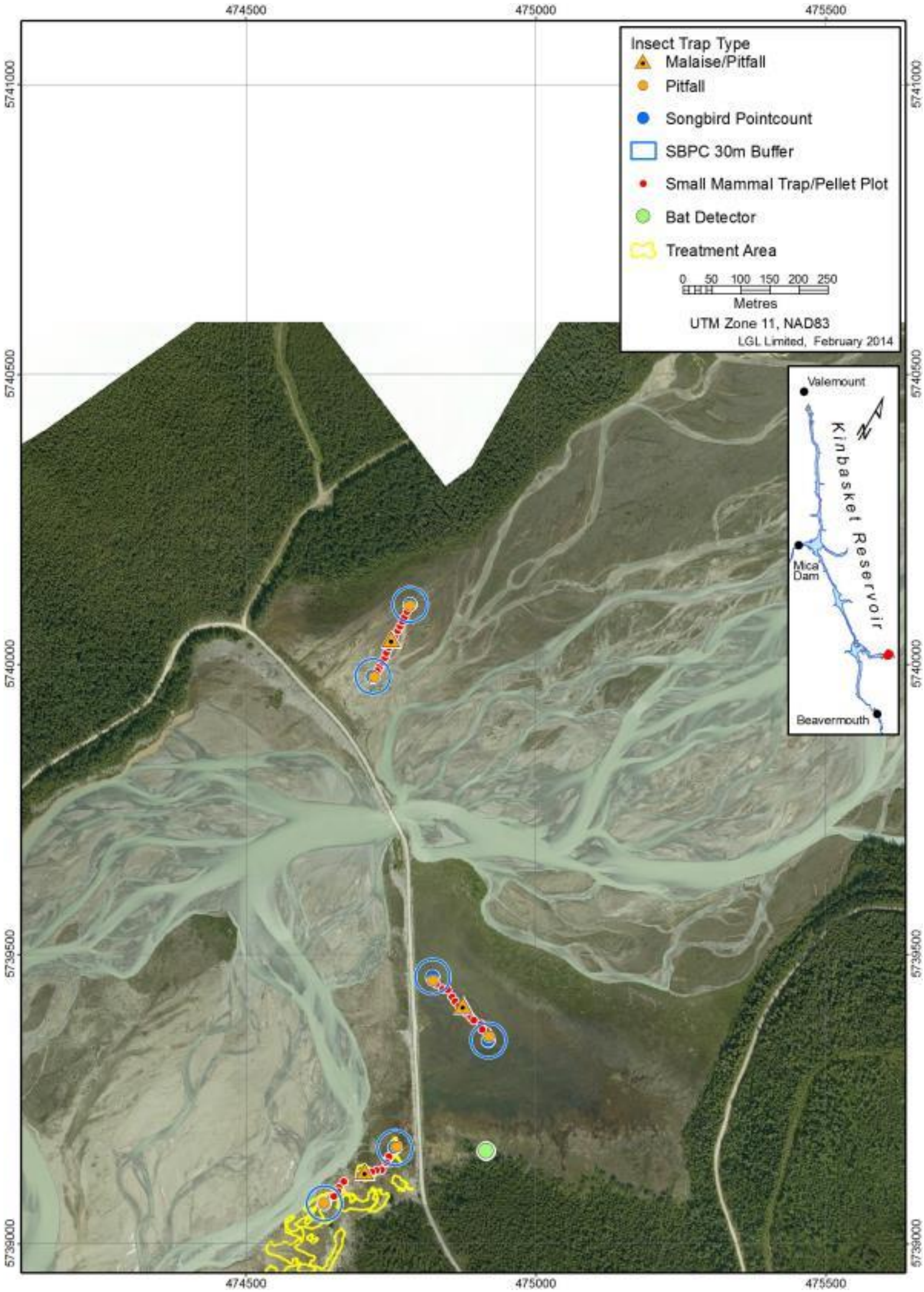
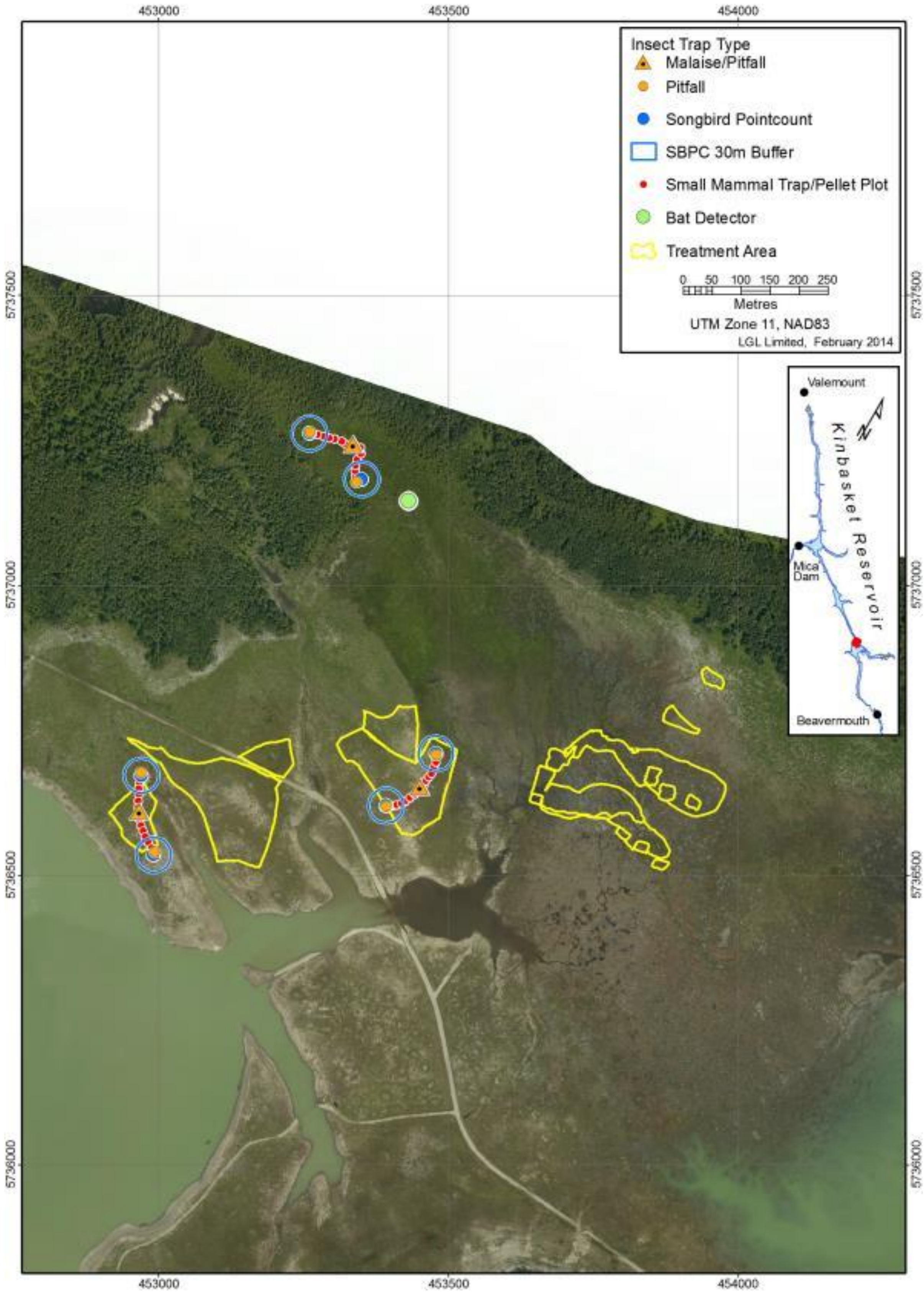
9.0 APPENDICES

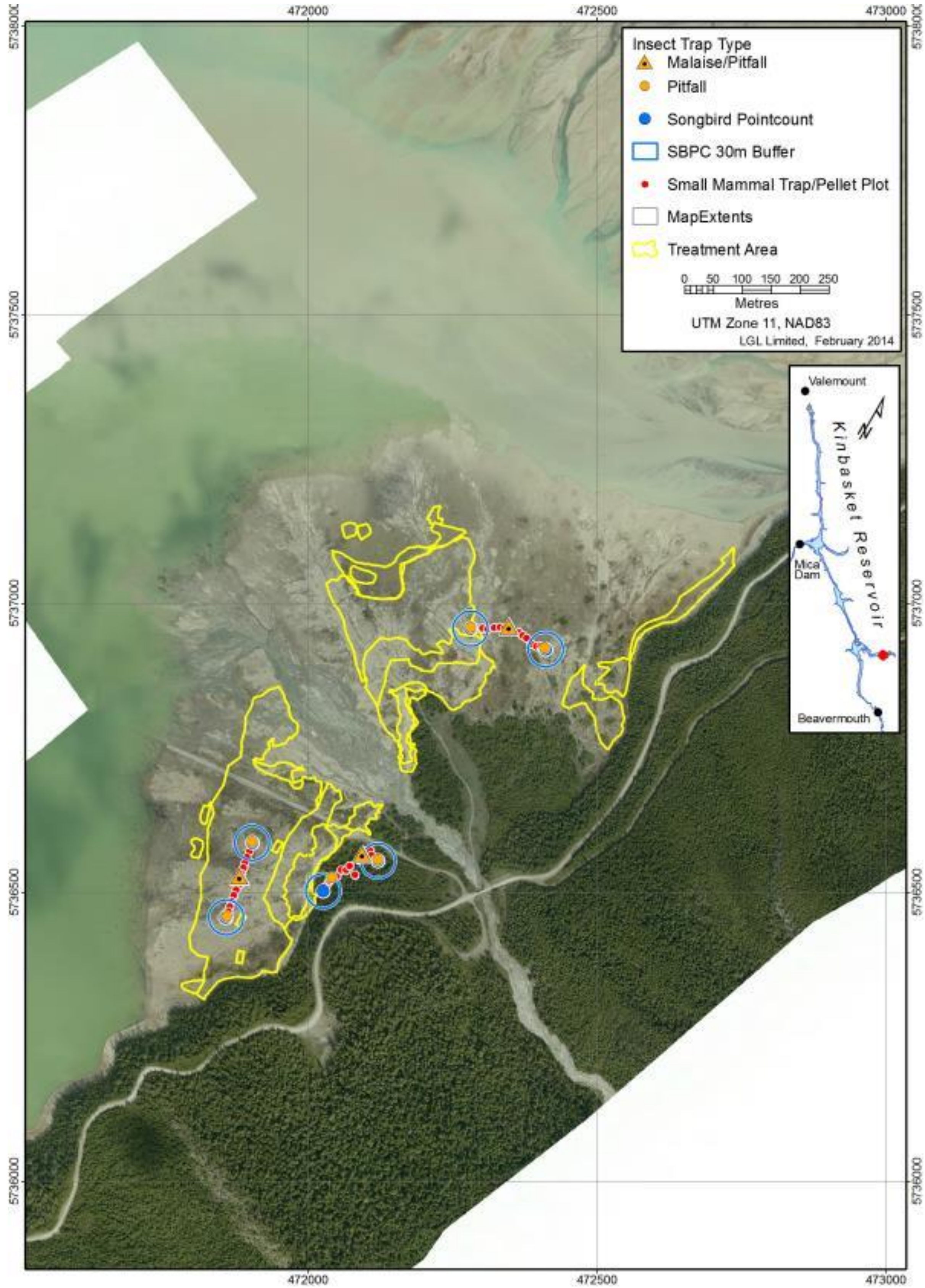
9.1 Appendix 9-A: Maps depicting Malaise and pitfall trapping locations for all reaches sampled in 2013



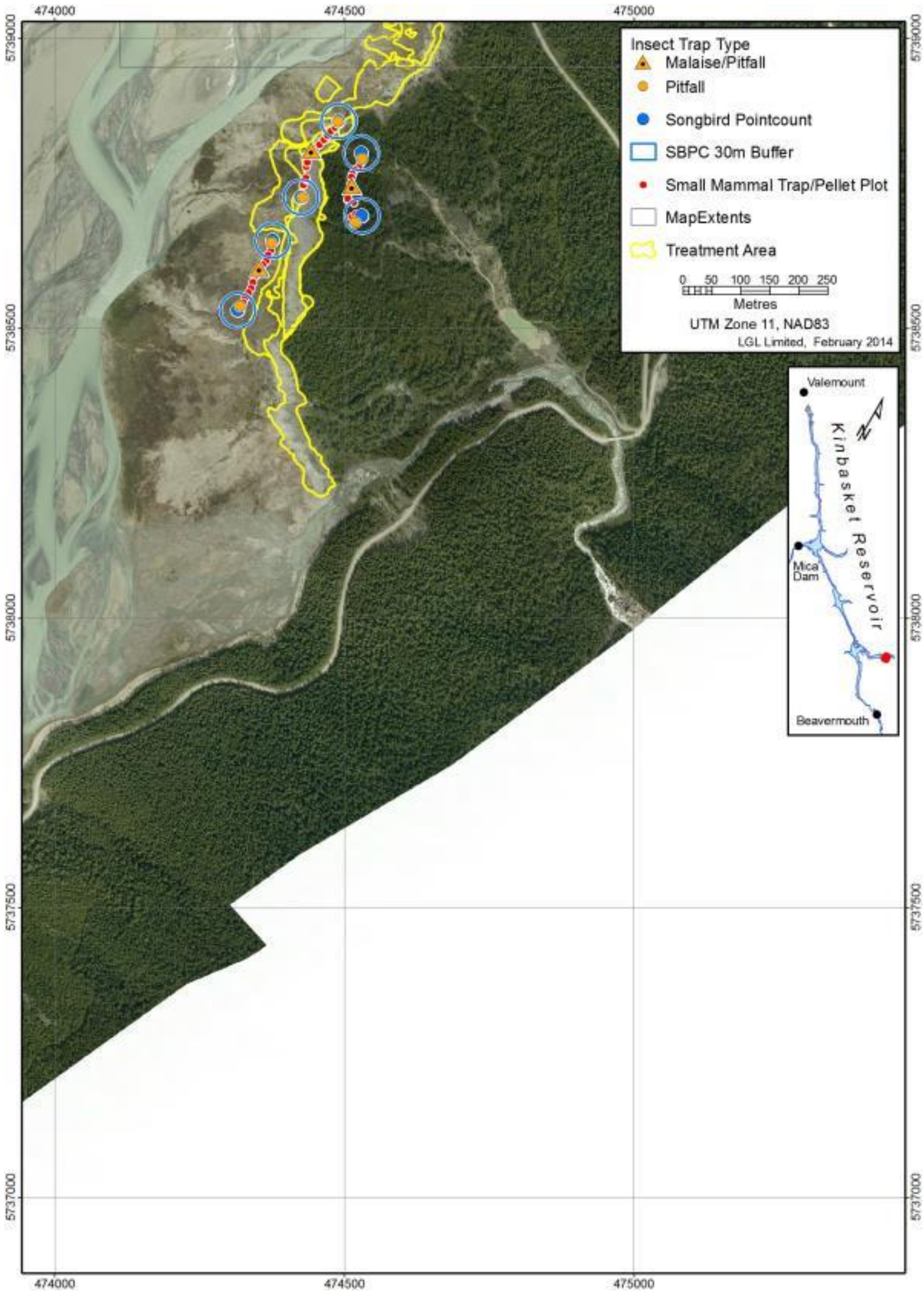
Map 9-1. Sampling locations at the Bush Arm Causeway, 2013.



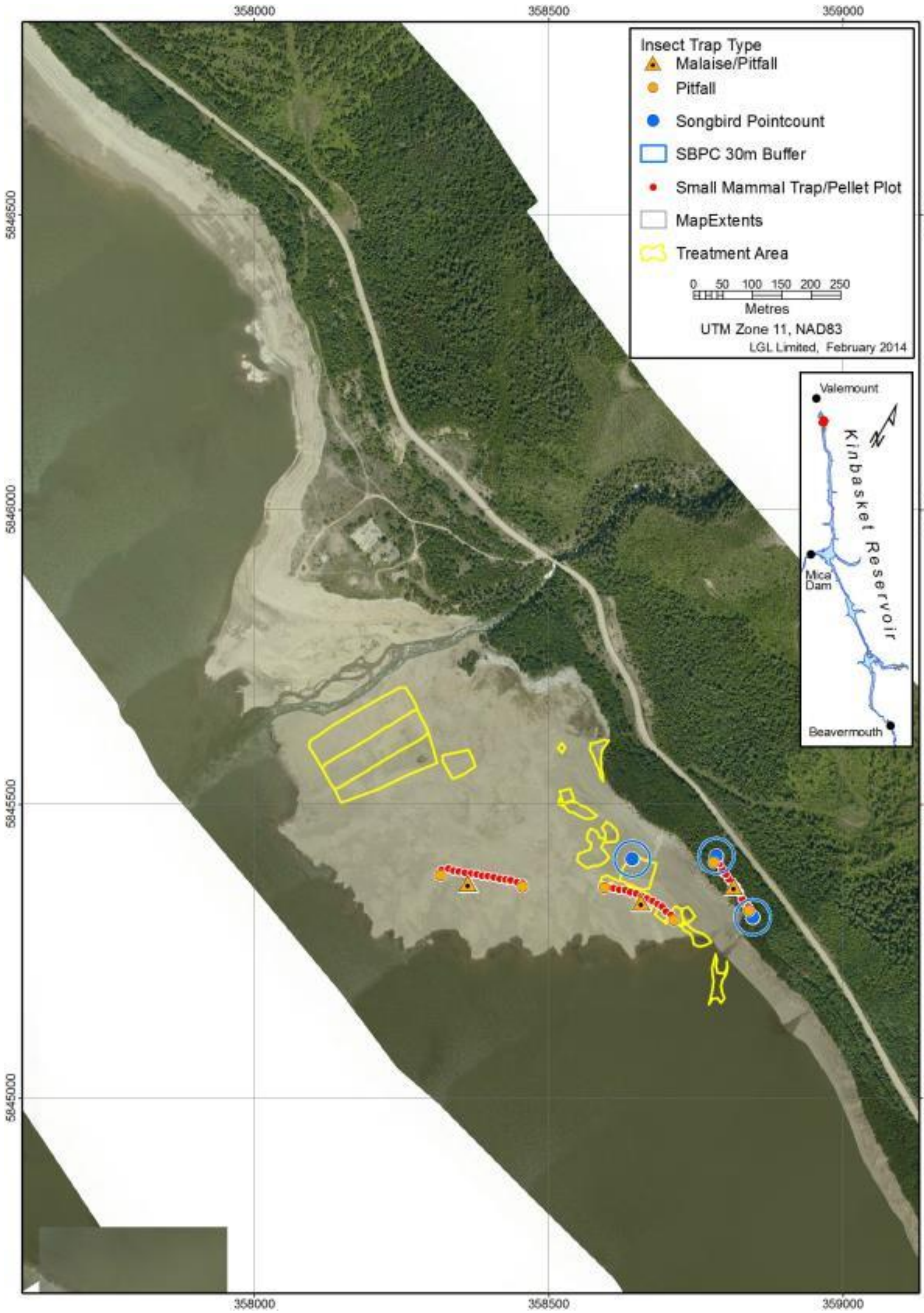
Map 9-2. Sampling locations at KM 88, Bush Arm, 2013.



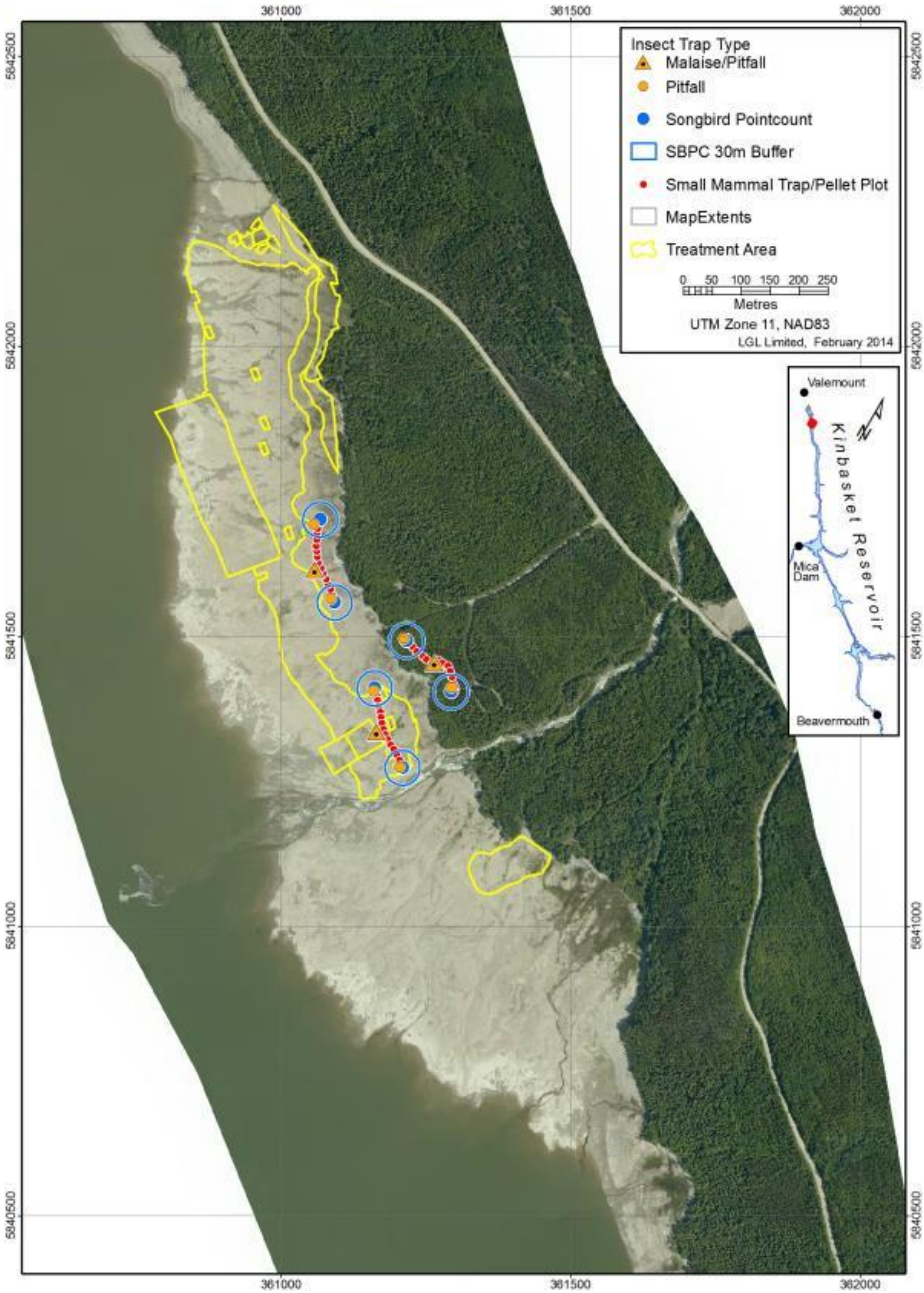
Map 9-3. Sampling locations at Hope Creek, 2013.



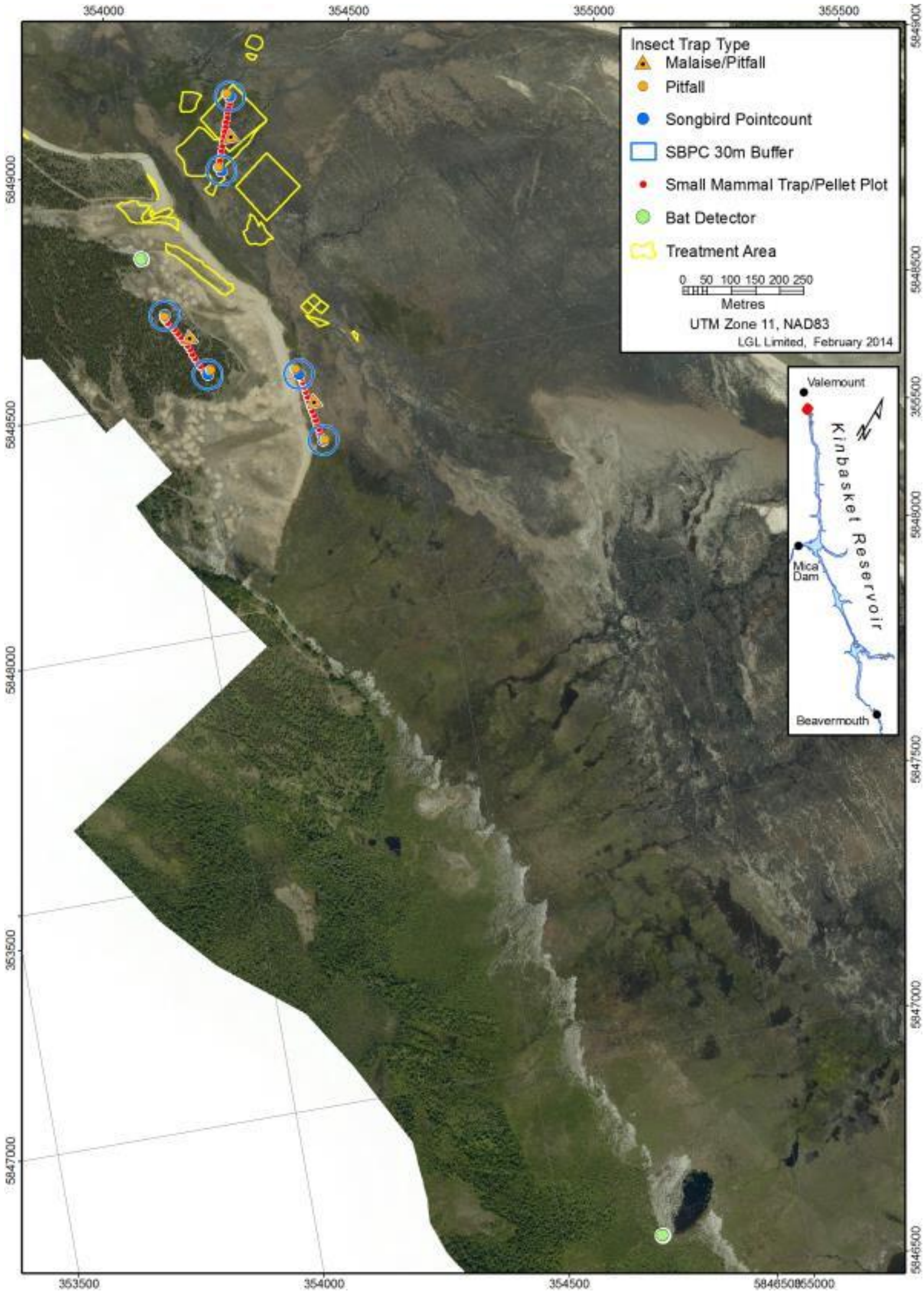
Map 9-4. **Sampling locations at Goodfellow Creek, 2013.**



Map 9-5. Sampling locations at Dave Henry Creek, 2013.



Map 9-6. Sampling locations at Yellowjacket Creek, 2013.



Map 9-7. Sampling locations at the Valemount Peatland, 2013.

9.2 Appendix 9-B: Location of ungulate pellet plots (PP), small mammal traps (SMT), vegetation plots (VP), songbird point counts (SBPC) and Malaise traps (MAL) along each transect in Bush Arm and Canoe Reach, Kinbasket Reservoir

REACH	SITE_NAME	SITE #	TRANS	STATION	UTM_E	UTM_N	ELEV	PP	SMT	SBPC	MAL	PT	WORKS1	TRT_YR	TREAT
Bush Arm	Causeway	121	RFTA	121RFTA01	474721	5739975	753.8	Y	Y	Y		Y			Reference A
Bush Arm	Causeway	121	RFTA	121RFTA02	474724	5739984	753.7	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA03	474729	5739993	753.7	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA04	474732	5740002	753.8	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA05	474737	5740011	753.6	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA06	474740	5740021	753.7	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA07	474746	5740030	753.8	Y	Y		Y	Y			Reference A
Bush Arm	Causeway	121	RFTA	121RFTA08	474750	5740039	754.1	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA09	474754	5740048	754.0	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA10	474758	5740057	753.8	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA11	474762	5740067	753.8	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA12	474766	5740076	753.7	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA13	474771	5740085	753.8	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA14	474775	5740094	753.9	Y	Y						Reference A
Bush Arm	Causeway	121	RFTA	121RFTA15	474780	5740103	753.9	Y	Y	Y		Y			Reference A
Bush Arm	Causeway	121	RFTB	121RFTB01	474824	5739457	752.4	Y	Y	Y		Y			Reference B
Bush Arm	Causeway	121	RFTB	121RFTB02	474832	5739450	752.3	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB03	474839	5739442	752.3	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB04	474847	5739435	752.2	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB05	474853	5739428	752.3	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB06	474861	5739421	752.2	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB07	474867	5739413	752.3	Y	Y		Y	Y			Reference B
Bush Arm	Causeway	121	RFTB	121RFTB08	474874	5739406	752.3	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB09	474881	5739399	752.2	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB10	474888	5739392	752.1	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB11	474895	5739385	752.2	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB12	474901	5739378	752.2	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB13	474908	5739370	752.0	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB14	474915	5739363	752.0	Y	Y						Reference B
Bush Arm	Causeway	121	RFTB	121RFTB15	474921	5739356	752.0	Y	Y	Y		Y			Reference B
Bush Arm	Good Fellow Creek	88	COT	88COT01	474312	5738528		Y	Y	Y		Y			Control
Bush Arm	Good Fellow Creek	88	COT	88COT02	474317	5738537		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT03	474322	5738546		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT04	474327	5738554		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT05	474332	5738563		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT06	474336	5738572		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT07	474341	5738581		Y	Y		Y	Y			Control
Bush Arm	Good Fellow Creek	88	COT	88COT08	474346	5738589		Y	Y						Control

REACH	SITE_NAME	SITE #	TRANS	STATION	UTM_E	UTM_N	ELEV	PP	SMT	SBPC	MAL	PT	WORKS1	TRT_YR	TREAT
Bush Arm	Good Fellow Creek	88	COT	88COT09	474351	5738598		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT10	474356	5738607		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT11	474361	5738615		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT12	474366	5738624		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT13	474371	5738633		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT14	474376	5738642		Y	Y						Control
Bush Arm	Good Fellow Creek	88	COT	88COT15	474381	5738650		Y	Y	Y		Y			Control
Bush Arm	Good Fellow Creek	88	LRT	88LRT01	474529	5738816	755.3	Y	Y	Y		Y			Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT02	474533	5738806	755.3	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT03	474532	5738797	755.4	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT04	474527	5738790	755.3	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT05	474518	5738781	755.4	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT06	474512	5738774	755.3	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT07	474505	5738763	755.1	Y	Y		Y	y			Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT08	474506	5738752	755.0	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT09	474506	5738750	754.7	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT10	474499	5738737	754.7	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT11	474498	5738729	754.6	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT12	474504	5738715	754.6	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT13	474509	5738707	754.7	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT14	474515	5738699	754.9	Y	Y						Local Reference
Bush Arm	Good Fellow Creek	88	LRT	88LRT15	474521	5738686	755.6	Y	Y	Y		Y			Local Reference
Bush Arm	Good Fellow Creek	88	TRT	88TRT15	474424	5738727	753.1	Y	Y	Y		Y	LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT14	474426	5738738	753.2	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT13	474427	5738748	753.1	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT12	474427	5738757	753.0	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT11	474428	5738767	753.0	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT10	474430	5738778	753.2	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT09	474430	5738788	753.5	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT08	474432	5738797	753.9	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT07	474437	5738806	753.9	Y	Y		Y	Y	LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT06	474444	5738813	753.2	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT05	474451	5738821	753.2	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT04	474459	5738827	753.3	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT03	474465	5738834	753.2	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT02	474472	5738841	753.4	Y	Y				LS	2009, 2010	Treatment
Bush Arm	Good Fellow Creek	88	TRT	88TRT01	474479	5738848	753.4	Y	Y	Y		Y	LS	2009, 2010	Treatment
Bush Arm	Hope Creek	87	COT	87COT01	472320	5736982		Y	Y	Y		Y			Control
Bush Arm	Hope Creek	87	COT	87COT02	472329	5736984		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT03	472339	5736985		Y	Y						Control

REACH	SITE_NAME	SITE #	TRANS	STATION	UTM_E	UTM_N	ELEV	PP	SMT	SBPC	MAL	PT	WORKS1	TRT_YR	TREAT
Bush Arm	Hope Creek	87	COT	87COT04	472349	5736986		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT05	472357	5736988		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT06	472367	5736987		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT07	472378	5736987		Y	Y		Y	Y			Control
Bush Arm	Hope Creek	87	COT	87COT08	472388	5736987		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT09	472397	5736988		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT10	472408	5736989		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT11	472418	5736990		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT12	472429	5736991		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT13	472439	5736989		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT14	472450	5736989		Y	Y						Control
Bush Arm	Hope Creek	87	COT	87COT15	472460	5736990		Y	Y	Y		Y			Control
Bush Arm	Hope Creek	87	LRT	87LRT15	472012	5736484	756.4	Y	Y	Y		Y			Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT14	472021	5736495	756.6	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT13	472023	5736495	756.4	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT12	472020	5736506	755.9	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT11	472029	5736511	756.3	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT10	472042	5736517	756.3	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT09	472049	5736519	756.3	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT08	472056	5736520	756.1	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT07	472072	5736526	755.9	Y	Y		Y	Y			Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT06	472077	5736536	755.9	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT05	472083	5736544	756.1	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT04	472084	5736551	755.4	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT03	472090	5736564	755.4	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT02	472089	5736578	755.1	Y	Y						Local Reference
Bush Arm	Hope Creek	87	LRT	87LRT01	472087	5736588	755.0	Y	Y	Y		Y			Local Reference
Bush Arm	Hope Creek	87	TRTB	87TRTB15	471857	5736458	748.1	Y	Y	Y		Y	PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB14	471860	5736468	747.9	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB13	471863	5736477	747.9	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB12	471866	5736487	748.5	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB11	471870	5736496	748.8	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB10	471873	5736505	748.4	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB09	471876	5736514	748.6	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB08	471879	5736523	748.4	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB07	471882	5736533	748.0	Y	Y		Y	Y	PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB06	471886	5736542	748.3	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB05	471889	5736551	748.1	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB04	471892	5736561	748.1	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB03	471895	5736570	748.2	Y	Y				PS	2010	Treatment

REACH	SITE_NAME	SITE #	TRANS	STATION	UTM_E	UTM_N	ELEV	PP	SMT	SBPC	MAL	PT	WORKS1	TRT_YR	TREAT
Bush Arm	Hope Creek	87	TRTB	87TRTB02	471898	5736580	748.7	Y	Y				PS	2010	Treatment
Bush Arm	Hope Creek	87	TRTB	87TRTB01	471901	5736589	748.8	Y	Y	Y		Y	PS	2010	Treatment
Bush Arm	KM 88	80	TRT	80TRT01	453110	5736549		Y	Y	Y		Y	PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT02	453115	5736557		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT03	453121	5736566		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT04	453127	5736574		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT05	453132	5736582		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT06	453138	5736591		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT07	453143	5736600		Y	Y		Y	Y	PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT08	453147	5736608		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT09	453152	5736617		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT10	453157	5736625		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT11	453162	5736634		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT12	453168	5736642		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT13	453174	5736650		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT14	453180	5736658		Y	Y				PS	2012	Treatment
Bush Arm	KM 88	80	TRT	80TRT15	453186	5736666		Y	Y	Y		Y	PS	2012	Treatment
Bush Arm	KM 88	80	COT	80COT01	453280	5736788		Y	Y	Y		Y			Control
Bush Arm	KM 88	80	COT	80COT02	453285	5736796		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT03	453291	5736804		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT04	453297	5736812		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT05	453302	5736821		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT06	453308	5736829		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT07	453312	5736838		Y	Y		Y	Y			Control
Bush Arm	KM 88	80	COT	80COT08	453317	5736847		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT09	453322	5736856		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT10	453327	5736864		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT11	453332	5736873		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT12	453338	5736881		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT13	453344	5736889		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT14	453351	5736896		Y	Y						Control
Bush Arm	KM 88	80	COT	80COT15	453357	5736904		Y	Y	Y		Y			Control
Bush Arm	KM 88	80	LRT	80LRT01	453049	5736900		Y	Y	Y		Y			Local Reference
Bush Arm	KM 88	80	LRT	80LRT02	453054	5736908		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT03	453060	5736916		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT04	453065	5736925		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT05	453070	5736933		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT06	453076	5736941		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT07	453081	5736950		Y	Y		Y	Y			Local Reference
Bush Arm	KM 88	80	LRT	80LRT08	453085	5736959		Y	Y						Local Reference

REACH	SITE_NAME	SITE #	TRANS	STATION	UTM_E	UTM_N	ELEV	PP	SMT	SBPC	MAL	PT	WORKS1	TRT_YR	TREAT
Bush Arm	KM 88	80	LRT	80LRT09	453090	5736968		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT10	453095	5736977		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT11	453100	5736985		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT12	453106	5736993		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT13	453113	5737001		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT14	453119	5737008		Y	Y						Local Reference
Bush Arm	KM 88	80	LRT	80LRT15	453126	5737016		Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	COT	12COT15	358318	5845389	743.4	Y	Y	Y		Y			Control
Canoe Reach	Dave Henry Creek	12	COT	12COT14	358330	5845391	743.4	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT13	358338	5845387	743.2	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT12	358348	5845386	743.1	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT11	358358	5845384	743.4	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT10	358368	5845382	743.8	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT09	358378	5845381	743.7	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT08	358387	5845379	743.7	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT07	358397	5845378	743.8	Y	Y		Y	Y			Control
Canoe Reach	Dave Henry Creek	12	COT	12COT06	358407	5845376	744.0	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT05	358417	5845374	744.2	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT04	358427	5845372	744.1	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT03	358436	5845371	743.6	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT02	358447	5845368	743.3	Y	Y						Control
Canoe Reach	Dave Henry Creek	12	COT	12COT01	358456	5845366	743.4	Y	Y	Y		Y			Control
Canoe Reach	Dave Henry Creek	12	LRT	12LRT01	358848	5845309	756.8	Y	Y	Y		Y			Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT02	358845	5845313	756.8	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT03	358839	5845326	756.7	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT04	358835	5845331	756.6	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT05	358828	5845340	756.9	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT06	358824	5845351	756.8	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT07	358819	5845360	756.8	Y	Y		Y	Y			Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT08	358811	5845366	756.8	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT09	358806	5845373	756.8	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT10	358801	5845381	757.0	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT11	358796	5845385	757.0	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT12	358795	5845390	757.0	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT13	358790	5845399	757.0	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT14	358787	5845402	757.0	Y	Y						Local Reference
Canoe Reach	Dave Henry Creek	12	LRT	12LRT15	358783	5845407	757.0	Y	Y	Y		Y			Local Reference
Canoe Reach	Dave Henry Creek	12	TRT	12TRT15	358591	5845362	743.3	Y	Y	Y		Y	PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT14	358600	5845360	743.0	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT13	358610	5845358	743.1	Y	Y				PS	2009	Treatment

REACH	SITE_NAME	SITE #	TRANS	STATION	UTM_E	UTM_N	ELEV	PP	SMT	SBPC	MAL	PT	WORKS1	TRT_YR	TREAT
Canoe Reach	Dave Henry Creek	12	TRT	12TRT12	358620	5845355	743.2	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT11	358630	5845354	743.3	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT10	358639	5845351	742.9	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT09	358649	5845348	742.7	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT08	358658	5845344	742.8	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT07	358667	5845340	742.2	Y	Y		Y	Y	PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT06	358677	5845336	742.2	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT05	358685	5845331	741.8	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT04	358693	5845326	741.7	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT03	358700	5845318	741.4	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT02	358708	5845312	741.3	Y	Y				PS	2009	Treatment
Canoe Reach	Dave Henry Creek	12	TRT	12TRT01	358715	5845305	741.3	Y	Y	Y		Y	PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	COT	08COT01	354296	5848365	750.3	Y	Y	Y		Y			Control
Canoe Reach	Valemount Peatland	08	COT	08COT02	354294	5848375	750.6	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT03	354292	5848385	750.6	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT04	354290	5848395	750.4	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT05	354289	5848405	750.4	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT06	354287	5848415	750.3	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT07	354285	5848425	750.4	Y	Y		Y	Y			Control
Canoe Reach	Valemount Peatland	08	COT	08COT08	354283	5848436	750.5	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT09	354281	5848446	750.4	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT10	354280	5848456	750.4	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT11	354279	5848466	750.3	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT12	354278	5848476	750.3	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT13	354276	5848486	750.1	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT14	354275	5848495	750.2	Y	Y						Control
Canoe Reach	Valemount Peatland	08	COT	08COT15	354274	5848505	750.2	Y	Y	Y		Y			Control
Canoe Reach	Valemount Peatland	08	LRT	08LRT15	354086	5848537	755.3	Y	Y	Y		Y			Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT14	354079	5848546	755.5	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT13	354073	5848556	755.6	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT12	354069	5848565	755.6	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT11	354065	5848574	755.5	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT10	354061	5848583	756.0	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT09	354058	5848594	755.9	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT08	354054	5848603	755.8	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT07	354048	5848612	755.8	Y	Y		Y	Y			Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT06	354043	5848622	755.9	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT05	354039	5848631	755.9	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT04	354033	5848640	755.9	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT03	354028	5848648	756.0	Y	Y						Local Reference

REACH	SITE_NAME	SITE #	TRANS	STATION	UTM_E	UTM_N	ELEV	PP	SMT	SBPC	MAL	PT	WORKS1	TRT_YR	TREAT
Canoe Reach	Valemount Peatland	08	LRT	08LRT02	354022	5848656	755.7	Y	Y						Local Reference
Canoe Reach	Valemount Peatland	08	LRT	08LRT01	354017	5848664	755.6	Y	Y	Y		Y			Local Reference
Canoe Reach	Valemount Peatland	08	TRT	08TRT15	354231	5849090	748.1	Y	Y	Y		Y	HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT14	354227	5849081	748.1	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT13	354223	5849071	748.2	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT12	354220	5849062	748.2	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT11	354217	5849052	748.3	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT10	354213	5849043	748.6	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT09	354210	5849033	748.3	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT08	354207	5849024	748.4	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT07	354203	5849015	748.6	Y	Y		Y	Y	HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT06	354200	5849005	748.7	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT05	354197	5848996	748.8	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT04	354193	5848986	749.0	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT03	354190	5848977	749.0	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT02	354187	5848967	748.9	Y	Y				HS/PS	2009	Treatment
Canoe Reach	Valemount Peatland	08	TRT	08TRT01	354184	5848958	749.2	Y	Y	Y		Y	HS/PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT01	361216	5841496	757.0	Y	Y	Y		Y			Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT02	361221	5841489	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT03	361228	5841481	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT04	361235	5841474	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT05	361246	5841465	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT06	361252	5841460	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT07	361261	5841453	757.0	Y	Y		Y	Y			Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT08	361272	5841459	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT09	361279	5841454	756.4	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT10	361289	5841449	756.5	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT11	361292	5841440	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT12	361296	5841430	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT13	361298	5841417	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT14	361297	5841403	757.0	Y	Y						Local Reference
Canoe Reach	Yellowjacket Creek	15	LRT	15LRT15	361302	5841412	757.0	Y	Y	Y		Y			Local Reference
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA01	361163	5841410	750.9	Y	Y	Y		Y	PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA02	361166	5841400	751.0	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA03	361167	5841390	750.8	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA04	361169	5841380	750.8	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA05	361172	5841370	749.9	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA06	361173	5841360	749.5	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA07	361175	5841350	749.0	Y	Y		Y	Y	PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA08	361177	5841340	749.0	Y	Y				PS	2009	Treatment

REACH	SITE_NAME	SITE #	TRANS	STATION	UTM_E	UTM_N	ELEV	PP	SMT	SBPC	MAL	PT	WORKS1	TRT_YR	TREAT
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA09	361181	5841331	748.8	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA10	361185	5841322	748.8	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA11	361190	5841313	749.9	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA12	361195	5841305	750.1	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA13	361200	5841296	750.8	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA14	361205	5841287	751.3	Y	Y				PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	TRTA	15TRTA15	361209	5841277	751.3	Y	Y	Y		Y	PS	2009	Treatment
Canoe Reach	Yellowjacket Creek	15	COT	15COT01	361093	5841562	752.5	Y	Y	Y		Y			Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT02	361089	5841571	752.5	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT03	361086	5841581	752.5	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT04	361082	5841590	752.0	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT05	361078	5841599	752.6	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT06	361073	5841608	752.7	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT07	361070	5841618	752.5	Y	Y		Y	Y			Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT08	361065	5841627	752.6	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT09	361063	5841637	752.9	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT10	361062	5841647	752.8	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT11	361061	5841656	752.3	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT12	361062	5841667	751.7	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT13	361062	5841677	751.5	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT14	361064	5841686	751.7	Y	Y						Control
Canoe Reach	Yellowjacket Creek	15	COT	15COT15	361065	5841696	752.3	Y	Y	Y		Y			Control

9.3 Appendix 9-C: Songbird species (4-letter codes1) and number of individuals detected at each transect type within each site.

Counts for each site/transect type combination were pooled across that transect's two point count stations. Only songbirds detected within 75 m are shown. Dashes indicate no sampling, zeroes in total column indicate no songbirds detected within 75 m of point count centres, despite sampling.

Reach	Site	Transect Type	Species																
			ALFL	AMRE	CHSP	COYE	DEJU	DUFL	GCKI	HAFL	LISP	MACW	MOBL	SAVS	SWTH	WAVI	WETA	YRWA	Total
Bush Arm	Causeway	Treatment																	0
	Causeway	RFTA												1					1
	Causeway	RFTB												3					3
	Goodfellow Creek	Control			1									1					2
	Goodfellow Creek	Treatment			1								2						3
	Goodfellow Creek	Reference		1	1			1	2	1						1	1	1	9
	Hope Creek	Control																	0
	Hope Creek	Treatment																	0
	Hope Creek	Reference		1	1		1			1					1				5
	KM 88	Control												1					1
	KM 88	Treatment												2					2
	KM 88	Reference	1	1	1	2					1	1			1				8
Canoe Reach	Dave Henry Creek	Control																	0
	Dave Henry Creek	Treatment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Dave Henry Creek	Reference					1		2						1			1	5
	Valemount Peatland	Control												2					2
	Valemount Peatland	Treatment																	0
	Valemount Peatland	Reference			2		3											1	6
	Yellowjacket Creek	Control																	0
	Yellowjacket Creek	Treatment																	0
	Yellowjacket Creek	Reference																2	2

[1]Species codes: ALFL= Alder Flycatcher; AMRE = American Redstart; CHSP = Chipping Sparrow; DEJU = Dark-eyed Junco; DUFL = Dusky Flycatcher; GCKI = Golden-crowned Kinglet; HAFL = Hammond's Flycatcher; LISP = Lincoln's Sparrow; MACW = MacGillivray's Warbler; MOBL = Mountain Bluebird; SVAS = Savannah Sparrow; SWTH = Swainson's Thrush; WAVI = Warbling Vireo; WETA = Western Tanager; YRWA = Yellow-rumped Warbler

9.4 Appendix 9-D: Incidental sightings shown by site with the numbers of individuals recorded. No incidental observations were noted for Goodfellow Creek (Site 88).

Common Name	Scientific Name	Reach						Total
		Bush Arm			Canoe Reach			
		Causeway (Site 121)	Hope Creek (Site 87)	KM 88 (Site 80)	Dave Henry Creek (Site 12)	Valemount Peatland (Site 08)	Yellowjacket Creek (Site 15)	
Amphibians and Reptiles								
Western Toad	*Anaxyrus boreas*					2		2
Western Toad Tadpoles	*Anaxyrus boreas*					5,010		5,010
Birds								
American Robin	*Turdus migratorius*			1		1		2
Black Swift	*Cypseloides niger*	12						12
Canada Goose	*Branta canadensis*				4			4
Cedar Waxwing	*Bombycilla cedrorum*		1	12				13
Chipping Sparrow	*Spizella passerine*		1	2				3
Common Yellowthroat	*Geothlypis trichas*			3				3
Great Blue Heron	*Ardea herodias*	1		1		2		4
Killdeer	*Charadrius vociferus*			2		2		4
Mountain Bluebird	*Sialia currucoides*			2				2
Northern Flicker	*Colaptes auratus*			3				3
Northern Harrier	*Circus cyaneus*					1		1
Osprey	*Pandion haliaetus*			3		2	2	7
Pine Grosbeak	*Pinicola enucleator*		1					1
Ruffed Grouse	*Bonasa umbellus*				1		4	5
Rufous Hummingbird	*Selasphorus rufus*			1				1
Savannah Sparrow	*Passerculus sandwichensis*			4		4		8
Solitary Sandpiper	*Tringa solitaria*			1				1
Song Sparrow	*Melospiza melodia*			1		1		2
Western Wood-Pewee	*Contopus sordidulus*					1		1
Wilson's Snipe	*Gallinago delicata*			1		1		2
Mammals								
American Mink	*Neovison vison*					1		1
Black Bear	*Ursus americanus*			1	1			2
Deer Sp.	*Odocoileus* sp.				2			2
Meadow Vole	*Microtus pennsylvanicus*					1		1
Red Squirrel	*Tamiasciurus hudsonicus*					1		1
River Otter	*Lontra canadensis*			1				1
Snowshoe Hare	*Lepus americanus*				1			1
White-tailed Deer	*Odocoileus virginianus*			1				1
Wolf/Coyote	*Canis lupus / Canis latrans*						1	1
Wolf	*Canis lupus*					1		1
	Total	13	3	40	9	21 (plus 5,010)	7	93 (plus 5,010)