Columbia River Project Water Use Plan

Kinbasket and Arrow Lakes Reservoir Revegetation Management Plan

Wildlife Effectiveness Monitoring and Enhancement Area Identification for the Lower and Mid Arrow Lakes Reservoir

Implementation Year 5

Reference: CLBMON-11B1

Ungulate Pellet Plots: 2014 Progress Report

Study Period: 2014

Okanagan Nation Alliance, Westbank, BC

and

LGL Limited environmental research associates Sidney, BC

February 25, 2015

EA3451

KINBASKET AND ARROW LAKES RESERVOIRS

Monitoring Program No. CLBMON-11B1
Wildlife Effectiveness Monitoring and Enhancement Area Identification for Lower and Mid- Arrow Lakes Reservoir




2014 Report

Prepared for

BC Hydro Generation
Water Licence Requirements
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February 25, 2015

Suggested Citation:

Adama, D.B. and V.C. Hawkes. 2015. CLBMON-11B1. Wildlife Effectiveness Monitoring for Lower and Mid- Arrow Lakes Reservoir. 2014. 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 Unpublished report by Okanagan Nation Alliance, Westbank, B.C. and LGL Limited environmental research associates, Sidney, B.C., for BC Hydro Generation, Water Licence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. 13 pp. + Appendices.

Cover photos:

From left to right: Cottonwood stakes at Edgewood South; Cottonwood stakes at Lower Inonoaklin; A planted *Carex lenticularis* meadow at Burton Flats; Dixon Terbasket conducting a pellet plot count survey © Doug Adama, LGL Limited.

EXECUTIVE SUMMARY

CLBMON-11B1 is a long-term wildlife monitoring project to assess the efficacy of revegetation and wildlife physical works at enhancing the wildlife habitats in the drawdown zone of Arrow Lakes Reservoir. Focal species groups selected for this study include songbirds, arthropods and ungulates (BC Hydro 2005, BC Hydro 2009); the response of other taxa (i.e., amphibian, reptiles, western painted turtles, shorebirds, and waterbirds) to revegetation and wildlife physical works are being assessed under other studies. Sampling for the focal taxa varies annually and in 2014 only ungulates pellet plot surveys were conducted.

The relevant management hypothesis in CLBMON-11B1 for ungulates is:

HA_{1C}: Revegetation does not change the utilization of the drawdown zone by ungulates as measured by indices of use (e.g., pellet counts, browse, tracks and occupancy).

In 2014, 34 pellet counts stations from 6 transects (3 treatment and 3 control) were sampled at three study sites: Lower Inonoaklin, Edgewood, and Burton Flats. Only three pellet groups were counted in all treatment plots, all of which occurred at the Lower Inonoaklin and all were Deer spp. Overall, fewer pellet groups were observed in the treatment areas than in control areas; however, this was not significant across 2013 and 2014.

An assessment of the sample sizes at each of the three study sites indicates that the number of pellet plots is currently insufficient to answer the management questions. Using pellet densities observed in 2013 and 2014, sample size estimates were calculated to detect an effect size of 0.50 difference between the means. Sample size estimates ranged from 98 to 395 plots required per site whereas only 10 (Lower Inonoaklin) or 12 plots (Burton and Edgewood) have been established at each site.

In assessing the pellet count data collected to date, it is clear that pellet group component of CLBMON-11B1 needs to be reassessed. In doing so, it must first be determined whether ungulate use of the treatment sites is an appropriate metric for assessing the success of revegetation and wildlife physical works prescriptions. To date, none of the CLBWORKS-02 or CLBWORKS-30 prescriptions have been developed with the objective of enhancing ungulate habitat and the size of the treatment areas are likely too small at most locations to influence the use of the drawdown one by ungulates. Furthermore, as pellet deposition in the drawdown zone of the three study sites was low, the number of pellet count plots required to detect a response is very high. Consequently, we recommend discontinuing this component of CLBMON-11B1 unless future physical works or revegetation prescriptions are designed specifically to enhance ungulate habitat.

ACKNOWELDGEMENTS

The authors express their appreciation to the following individuals for their assistance in coordinating and conducting this study: James Pepper, Alan Peatt, Dixon Terbasket (Okanagan Nation Alliance) and Phillip Bradshaw (BC Hydro).

Key Words: Arrow Lakes Reservoir, ungulates, revegetation, effectiveness monitoring, drawdown zone, BC hydro

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1.0 INTRODUCTION

The Columbia River Water Use Plan (WUP) was developed to balance environmental values, recreation, power generation, cultural and heritage values, navigation and flood control on the Columbia River (BC Hydro 2005). Pursuant to the recommendations of the WUP, BC Hydro implemented a reservoir wide planting program (CLBWORKS-2) in Arrow Lakes Reservoir to benefit littoral productivity, wildlife habitat, shoreline erosion, archaeological site protection, and shoreline aesthetics. Wildlife physical works projects (CLBWORKS-29A & 29B) were identified to help mitigate the impact of Arrow Lakes Reservoir operations on wildlife and wildlife habitat.

To assess the efficacy of these programs, an 11-year wildlife-monitoring program (CLBMON-11B1) was implemented in 2009. Focal taxa include songbirds, arthropods and ungulates (BC Hydro 2005, BC Hydro 2009) and the response of other taxa (i.e., amphibian, reptiles, western painted turtles, shorebirds, and waterbirds) to revegetation and wildlife physical works are being assessed under other studies. A thorough description of the CLBMON-11B1 study design is provided in Hawkes (2009). In 2014, only ungulate pellet plot surveys were conducted; these results are summarized in this report.

2.0 OBJECTIVES

The overall scope of CLBMON-11B1 is to collect baseline and post-treatment data of the revegetation treatments and wildlife physical works to assess their effectiveness at enhancing wildlife habitat. The specific objectives of the study are to:

1. Monitor the appropriate biological indicators and response variables to assess the effectiveness of the revegetation and wildlife physical works in enhancing wildlife habitat in Arrow Lakes Reservoir.
2. Provide recommendations on the effectiveness of the revegetation program and wildlife physical works projects on improving habitat for wildlife in the drawdown zone.
3. Provide recommendations for improving wildlife habitat prescriptions in Arrow Lakes Reservoir.
4. Identify high-value habitat in Arrow Lakes Reservoir for protection and enhancement.

2.1 Management Questions and Hypothesis

To achieve these objectives, BC Hydro formulated the following management questions to be addressed by the study:

1. Are the revegetation and wildlife physical works projects effective at enhancing wildlife habitat in the drawdown zone of Arrow Reservoir and if so to what extent?
2. Are some methods or techniques more effective than others at enhancing wildlife habitat in drawdown zone?

The relevant management hypothesis specific to the ungulate pellet data collect in 2014 is:

HA_{1C}: Revegetation does not change the utilization of the drawdown zone by ungulates as measured by indices of use (e.g., pellet counts, browse, tracks and occupancy).

A complete list of the management hypotheses for CLBMON-11B1 is provided in BC Hydro (2009).

2.2 Key Water Use Decisions Affected

Results from this study will aid in more informed decision making with respect to the need to balance the requirements of wildlife dependent on wetland and riparian habitats with other values such as recreational opportunities, flood control and power generation.

The key water use planning decisions affected by the results of this monitoring program is whether revegetation and wildlife physical works are effective at enhancing wildlife habitat. Results from this study will also assist in refining the approaches and methods for enhancing wildlife habitat through adaptive management.

3.0 METHODS

3.1 Study Area

The Arrow Lakes Reservoir was created in 1968 with the construction of Hugh Keenleyside Dam and the impoundment of the Columbia River and the Upper and Lower Arrow Lakes (Figure 3-1). Extending 230 km from Castlegar to Revelstoke, BC, the reservoir has a north-south orientation, and is set in the valley between the Monashee Mountains in the west and Selkirk Mountains in the east. Two biogeoclimatic zones occur within the study area: the Interior Cedar Hemlock (ICH) and the Interior Douglas-fir (IDF).

BC Hydro is authorized by Water Licence No. 27066 to store 7.1 MAF of water in the reservoir for power generation and flood control. The normal operating range of the reservoir is between 419.99 and 440.14 m (1377.92 and 1444.03 ft.). BC Hydro can obtained permission from the Comptroller of Water Rights (CWR) to store an additional 0.262 MAF of water at Arrow Lakes Reservoir between elevations 440.14 and 440.75 m (1444.03 and 1446.03 ft.) for flood control.

3.2 Study Sites

Pellet plots stations were established at three sites in the mid-Arrow: Burton Flats, Lower Inonoaklin Rd., and at Edgewood South (Figure 3-1; Appendix 7.1). Burton Flats occurs in the ICH mw 2 biogeoclimatic subzone variant and comprises an alluvial fan located 2 km south of Burton and just south of confluence of Caribou and Snowy Creeks. The Lower Inonoaklin Rd. site is located 1 km south of the Needles ferry terminal. The Edgewood South (Eagle Creek) site is located on an alluvial fan at Edgewood on the south side of Eagle Creek. Both the Edgewood South and Lower Inonoaklin Rd. sites occur in the ICH dw1 biogeoclimatic subzone/variant.

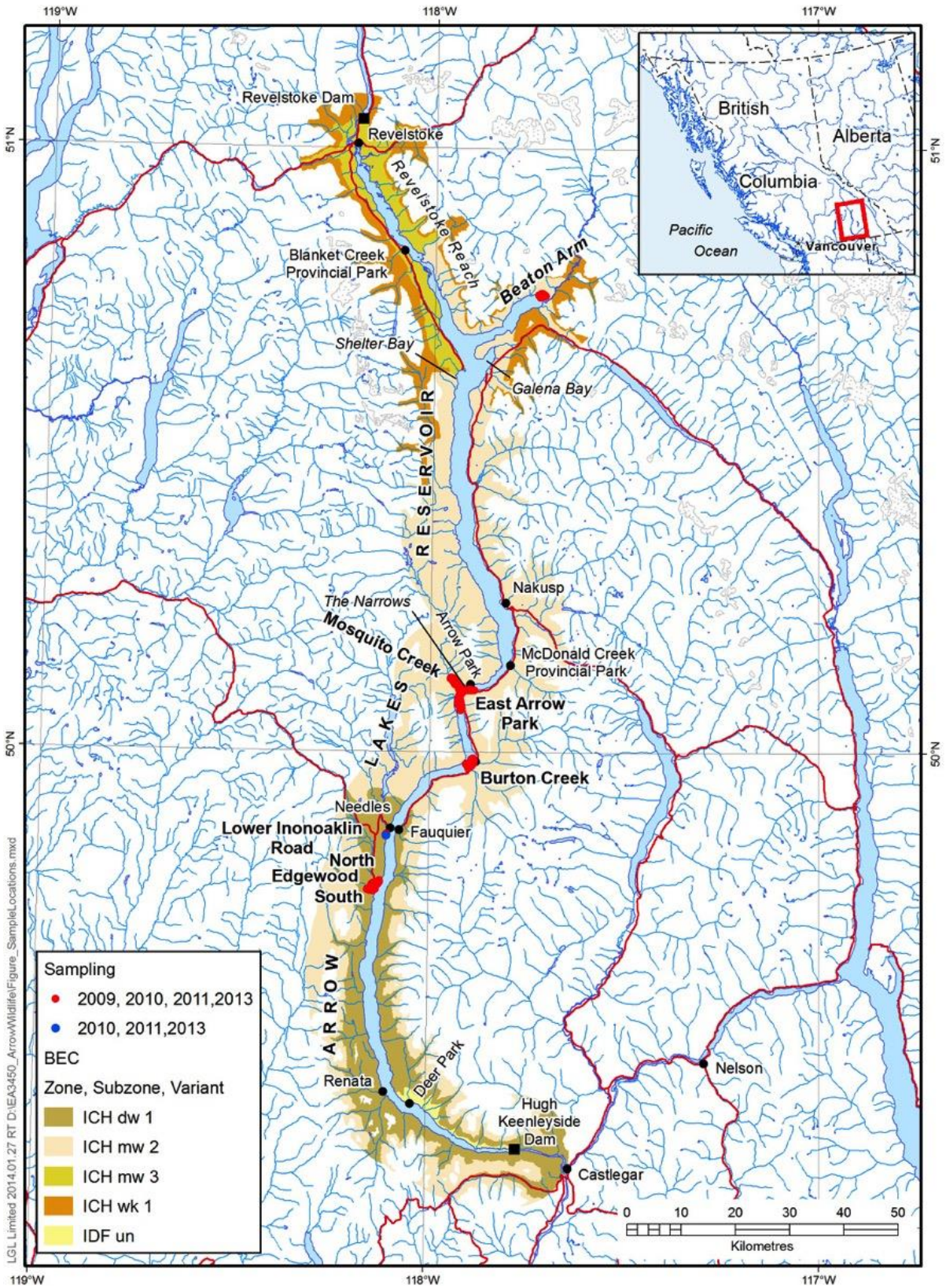

Figure 3-1: Location of the 2014 samples in Arrow Lakes Reservoir, B.C. Biogeoclimatic subzone variants shaded

From 2008 and 2011, several revegetation treatments were applied to the three sites (Table 1-1). The predominant treatment techniques included the planting of Black Cottonwood (*Populus balsamifer ssp. trichocarpa)* live stakes either by hand or with the aid of an excavator, and sedge plugs (*Carex lenticularis* and C. *aperta*) planted by experienced tree planters (Keefer et al 2009, 2010, 2011, 2012). Other treatments included fertilizer trails (2008 only) and the planting of willow (*Salix* species*)* seedlings, red-osier dogwood (C*ornus stolonifera*) seedlings and woolgrass (*Scirpus atrocinctus*), small-fruited bulrush (*S. microcarpus*) and bluejoint reedgrass (*Calamagrostis canadensis*).

Table 3-1: Summary of treatment history at the three survey sites. (Keefer et al 2009, 2010, 2011, 2012)

Site/UTM	Year	Treatment	Area Planted (ha) *
Burton Flats	2008	Fertilization and Sedge Plug	1.9
	2009	Live stakes and Seedling Plugs	6.2
Total Area = 30 ha	2010	Seedling Plugs	2.1
UTM: 435584 E, 5536706 N	2011	Cottonwood Live stakes	7.7
		Total	***17.8***
Lower Inonoaklin Rd	2009	Live stakes and Seedling Plugs	2.4
	2011	Cottonwood Live stakes	4.6
Total area = 10 ha			
UTM: 420302 E, 5524021 N		***Total***	***7.0***
Edgewood South	2009	Cottonwood Live stakes	1.1
UTM: 417826 E, 5513851N		***Total***	***1.1***
Total area = 5 ha			

* As treatment polygons may have been replanted, the total area of ground treated may be lower than reported.

3.3 Sampling Design

Pellet count stations were established and cleared in 2011 (Hawkes et al 2011). Plot centres were marked with spikes and flat washers and the coordinates of each station were recorded using sub-meter resolution GPS (SX Blue II). Plot centres were positioned 30 m apart and stations were stratified across treatment and control sites. Treatment sites included areas within the reservoir that were planted with native gramminoids, shrubs, or trees (Table 1-1). Control sites were established within the reservoir immediately adjacent treatments sites but designated as leave areas (i.e., no planting). A single transect was established in each treatment and control site and five or six sample stations were located along each transect (Table 3-2; Appendix 7.1). Sampling did not occur in 2012 but plots were counted and cleared again in 2013.

Table 3-2: The distribution of pellet plots stations by elevation, treatment, and location. Stations were originally established in 2011

Location/Treatment	Mean Elevation (m)	Number of Stations
Burton		
Control	**438.39**	6
Treatment	**439.21**	6
Edgewood South		
Control	**437.87**	6
Treatment	**437.72**	6
Lower Inonoaklin		
Control	**439.77**	5
Treatment	**438.58**	5
	Total	**34**

3.4 Pellet Group Sampling

Circular plots (10m^2) were searched for animal scat and other sign using a 1.77 m rope attached to a centre stake (Figure 1-2). Pellet groups were recorded when 10 or more pellets occurred close together. Single pellets or scattering of pellets were noted but were not recorded as a group.

Each pellet group was identified to species and all pellets were cleared from the plot after enumerating. Because White-Tailed Deer and Mule Deer pellets cannot be distinguished from each other reliably, deer pellets were not keyed to species (Shackleton 1999). Scat and tracks from other species were also recorded.

Figure 3-2: Dixon Terbasket (ONA) searching for ungulate pellets at Burton Flats

3.5 Data Analyses

3.5.1 Data Summary

Total pellet group counts were summarized by site and treatment to identify differential use of the treatment and control polygons. Densities of pellet groups (per ha) were calculated for comparison across years, treatments, and sites. As values for 2013 represent two years of pellet accumulation they were halved to provide an average across the two-year period. To identify patterns in the data, non-parametric (Mann-Whitney U and Kruskal-Wallis) tests were performed to compare the pellet group numbers across treatment types, years, and sites independently. Two-way ANOVA were performed to test the interactions between site and year and treatment type and year. All test were performed with α = 0.10.

3.5.2 Sample Size Estimation

Using pellet densities observed in 2013 and 2014, sample size estimates were calculated to detect an effect size of 0.50 difference between the means. Control and treatment transects were pooled at each site. Calculations followed White and Eberhardt (1980) where:

$n = \{_{\alpha}^{2} [1 + (m/ k)]/d^2 m$

n = number of plots

$\mathcal{Z}$ = is the value of the standard normal distribution with upper and lower tail areas of α/2. $\mathcal{Z}$ = 1.96 at α 0.05

k = negative binomial coefficient

m =mean number of pellet groups per plot

$d = w/ m \sqrt{2}$

d = confidence interval of the mean = w/m√2

w = difference between the means to be detected (effect size)

$k = D_{pg}^{2} / (S^2 - D_{pg})$, where

S^2 = variance in the number of pellet groups per plot.
D_{pg} = average density of pellet groups per plot

Ungulate pellet count data is known to fit a binomial distribution (White and Eberhardt 1980). In addition to being sensitive to variance (S^2), sample size estimates are also sensitive to pellet densities; consequently, the requisite sampling intensity varies inversely with pellet-group density (Neff 1966).

4.0 RESULTS

4.1 Reservoir Conditions

Between the 2013 and 2014 sampling sessions, the reservoir filled and discharged more quickly than the historic mean. Arrow Lakes Reservoir reached a maximum elevation of 439.91 m ASL on July 4, 2013 inundating the sample stations (all located above 436.8 m ASL) for 52 days or less. After the 2014 sampling, the plot stations were inundated for a maximum of 49 days (Figure 4-1). Despite filling quickly, reservoir levels did not impede our sampling in 2014.

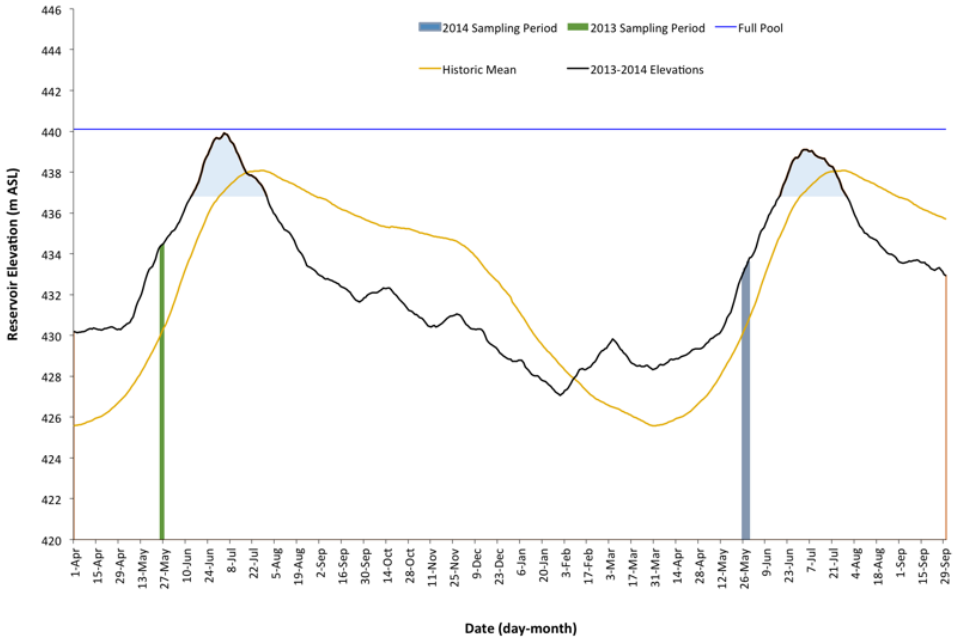

Figure 4-1: **Arrow Lakes Reservoir elevations for 2013 and 2014.** The inundation period of the study areas is shown with light blue shading. 2013 and 2014 sampling periods and corresponding reservoir levels are show by green and blue columns

4.2 Ungulate Pellets and other wildlife sign

Thirty-four stations from 6 transects (3 treatment and 3 control) were sampled on May 27 and 28, 2014. Only three pellet groups were counted in all treatment plots, all of which occurred at the Lower Inonoaklin and all were Deer spp. (Table 4-1). Two of the three pellet groups were located in the control area and the third group was located in the treatment area.

Overall (2013 and 2014 data combined), fewer pellet groups were observed in the treatment plots than in control plots (Mann-Whitney U test; $p = 0.04$); however, the results were not significant across years (Two-way ANOVA; $p = 0.240$). Despite the apparent difference in pellet group numbers observed in 2013 and 2014 (21 and 3 in 2013 and 2013, respectively), the difference was not statistically significant (Mann-Whitney U test; $p = 0.11$). Pellet group counts differed significantly across the three sites (2013 and 2014 data pooled; Kruskal-Wallis; $p = 0.01$); however, the interaction between year and site was not significant (Two-way ANOVA; $p = 0.46$).

Table 4-1: Total pellet groups by location and treatment recorded in 2103 and 2014. Data for 2013 represents two years of pellet group accumulation.

Location Treatment Type	Deer Pellet Groups 2013	Deer Pellet Groups 2014	Total
Burton			
Control	10	0	10
Treatment	0	0	0
Edgewood South			
Control	9	0	9
Treatment	0	0	0
Lower Innonoaklin			
Control	1	2	3
Treatment	1	1	2
Total	**21**	**3**	**24**
Control	20	2	22
Treatment	1	1	2

Two sets of Deer tracks were observed in the treatment site at Edgewood South and three sets of deer tracks were observed in the control site at Lower Inonoaklin. One set of Coyote tracks were observed at the treatment site at Edgewood South and one at the control site at Lower Inonoaklin.

Deer were the only ungulate species identified through tracks and pellet counts in in both 2013 and 2014, which is not unexpected. During winter aerial ungulate surveys in 2011 and 2012, deer comprised 92 and 85 per cent of the known ungulates identified in the mid-Arrow Lakes Reservoir, respectively (data Hawkes et al 2012 and 2013). Of the deer observations identified to species, almost all were White-Tailed deer (96 per cent in 2011 and 100 per cent in 2012).

4.3 Sample size

The sample size estimates ranged from 98 to 395 plots required per site (Table 4-2) whereas only 10 (Lower Innonoaklin) or 12 plots (Burton and Edgewood) were established at each site. The high number of plots required reflects the low pellet group density and variance within and across transects. Despite being larger in area, Burton appears to require the smallest sample size (based on the 2013 data only). However, given the paucity of data at the sites and across years, these results should be considered preliminary.

Table 4-2: Sample size estimates (plots/site) and associated parameters.

Parameter	Burton Flats	Lower Inonoaklin	Edgewood South
Area (ha)	30	10	5
n	**98**	**395**	**150**
Z	3.84	3.84	3.84
m	0.54	0.30	0.42
k	0.22	0.04	0.14
d^2	0.50	0.50	0.50

5.0 DISCUSSION

CLBWORKS-02 and CLBWORKS-30 are two programs under the Columbia WUP with objectives to benefit wildlife through habitat enhancement and restoration in the upper elevations of Arrow Lakes Reservoir. To date, over 100 hectares has been planted in an effort to maximize vegetation growth and one physical works project was implemented near Revelstoke, B.C. CLBMON-11B1 is a long-term wildlife monitoring program to assess the efficacy of these programs at enhancing wildlife habitat in Arrow Reservoir. Focal species groups selected for this study include songbirds, arthropods and ungulates (BC Hydro 2005, BC Hydro 2009). Only the ungulate component (ungulate pellet plot surveys) were conducted in 2014 under CLBMON-11B1.

Only three pellet groups were observed in the 34 sample plots in 2014, which was lower than in 2013. This was confounded by the absence of sampling in 2012 resulting in the accumulation of two years of pellet groups in 2013. The distribution of pellet groups differed across years; however, little can be made of this be given the small sample size. Overall, pellet groups were observed more frequently in control sites than in treatment sites, although this difference was not significant across years. In reviewing the position of the pellet plot arrays on the landscape, control plots tended to be located upslope of the treatment plots (i.e., Lower Innonoaklin Rd and Edgewood South) and closer to the forest edge (all sites). Ungulates select habitats based on forage availability, predation risk, thermal cover and snow depth and deer in particular are often associated with forest edges (Kie et al 2003). Thus it is not surprising that control areas may yield higher abundances of ungulate pellets and this was overlooked when developing the initial sampling design.

From the pellet data collected in 2013 and 2014, it is clear that the pellet surveys under CLBMON-11B1 need to be reassessed. In doing so, consideration should be given to whether ungulate use is an appropriate response variable for past and future habitat enhancement/restoration in the reservoir. To date, none of the CLBWORKS-02 or CLBWORKS-30 prescriptions have been developed with the objective of enhancing ungulate habitat (Keefer et al 2008, 2009, 2010; and KES 2011 and 2012; Golder 2009; Hawkes and Howard 2011). Furthermore, with the possible exception of Burton flats, the size of the revegetation and wildlife physical works projects (implemented or proposed to date) in the lower and mid-Arrow are likely too small to influence ungulate use of the drawdown zone. Finally, as pellet deposition in the drawdown zone of the three study sites was low, the number of pellet count plots required to detect a response is very high. Using pellet densities observed in 2013 and 2014, sample size estimates were determined to detect an effect size of 0.50 difference between the means. Sample sizes ranged from 98 to 395 plots required per site whereas only 10 (Lower Inonoaklin) or 12 plots (Burton and Edgewood) have been established at each site. In considering the uncertainty regarding the benefits that the revegetation and wildlife physical works program will have on ungulates and the sample size limitations, we recommend discontinuing this component of CLBMON-11B1 unless future physical works or revegetation prescriptions are specifically designed to enhance ungulate habitat.

6.0 RECOMMENDATIONS

Unless future physical works or revegetation prescriptions are developed specifically to enhance ungulate habitat in the drawdown zone of Arrow Lakes Reservoir, we recommend discontinuing this component of CLBMON-11B1.

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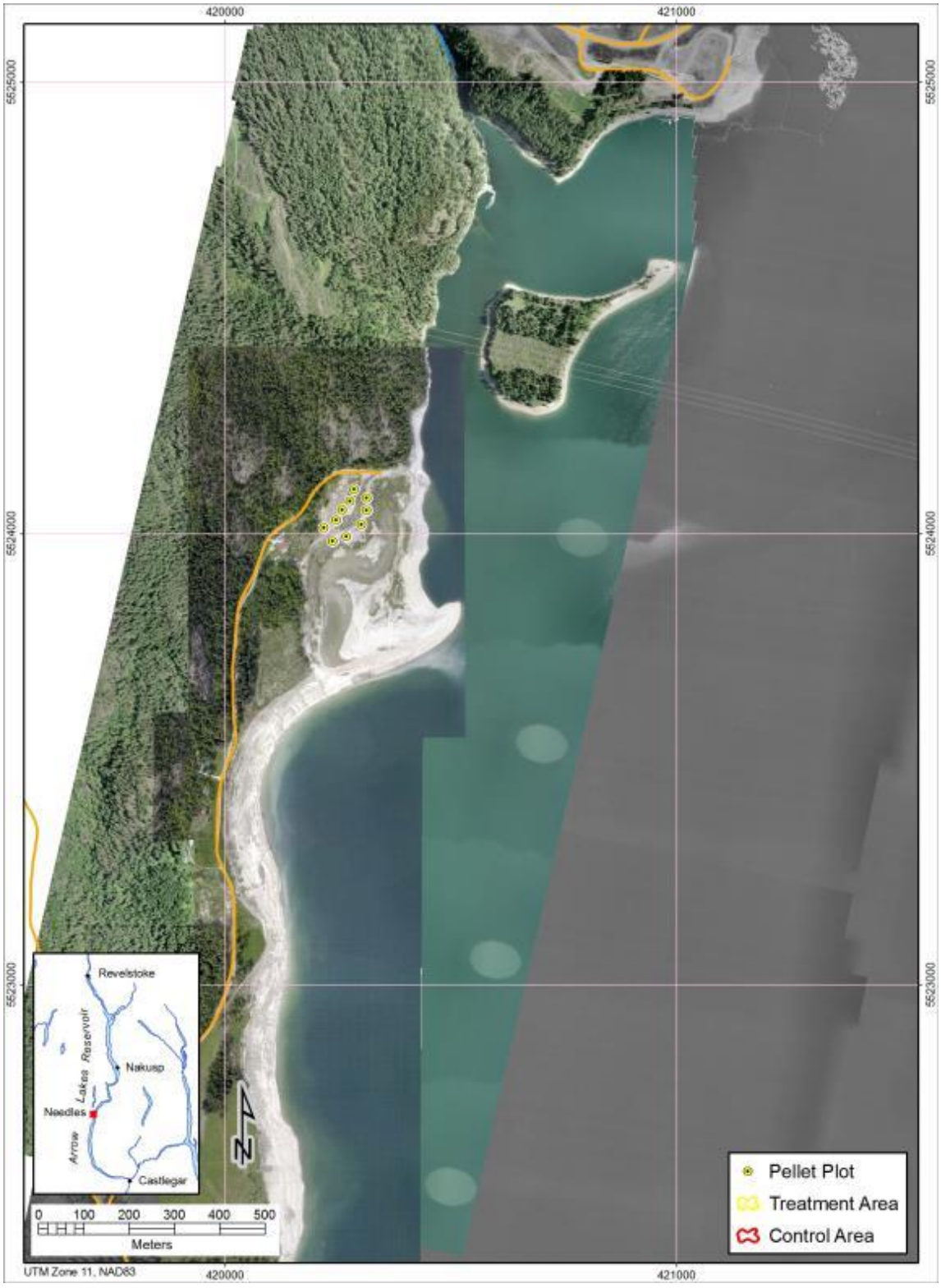
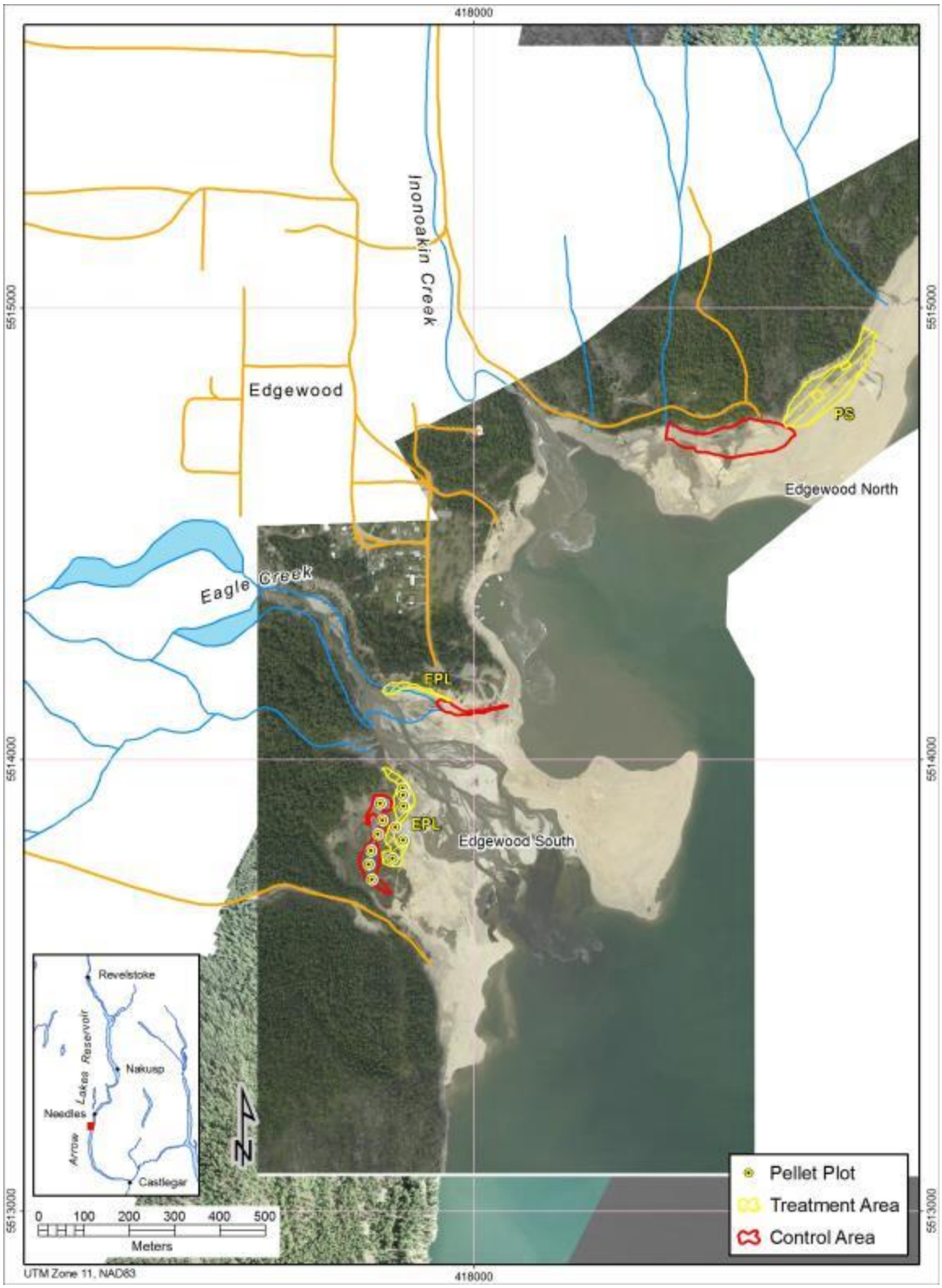
8.0 APPENDICES

8.1 Appendix 8-A: Maps of pellet plots sites

Map 8-1: Distribution of pellet plots sampled at Burton Flats



Map 8-2: Distribution of pellet plots sampled at Lower Inonoaklin Road



Map 8-3: Distribution of pellet plots sampled at Edgewood South