Bird Monitoring at Three Tree Encroachment Reduction Projects in the Chilcotin Grassland Benchmark

Implementation Report

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Prepared for:
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Executive Summary

The removal of forest encroachment onto grasslands has recently been initiated in the Cariboo-Chilcotin by the Ecosystem Restoration Team, Cariboo-Chilcotin Range Branch, Ministry of Forests and Range, following decades of fire suppresion. Monitoring for changes in biodiversity following restoration activities is an important phase of adaptive management. A songbird (Order *Passeriformes*) and woodpecker (Family *Picidae*) monitoring project was initiated in June, 2008 in three sites where cutting of encroachment has begun. These groups of birds can be effectively monitored using the point count method of inventorying for estimating relative abundance and population trends over time. Baseline indices of relative abundance have been generated for the treatment areas as a basis for long-term effectiveness monitoring.

Fifty point count stations over three study areas were surveyed once in 2008. A total of 758 bird detections of 46 species were made during surveys and an additional five species were incidentally observed. Filtering for elligible songbirds and woodpeckers, 40 species and 712 individuals were encountered. Songbird and woodpecker species richness was similar between the three areas. Three sets of indices of relative abundance were calculated for each study area and management implications are discussed.

Cover Photo: Long-billed Curlew on territory at Chilcotin Road Area 1 (Iron Wood Springs)

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INTRODUCTION

The removal of forest encroachment onto grasslands has recently been initiated in the Cariboo-Chilcotin by the Ecosystem Restoration Team, Cariboo-Chilcotin Range Branch, Ministry of Forests and Range. Forest encroachment has been occurring in the region since the early 1900s when permanent settlement increased and the "cool" fires that normally occurred every 7-20 years were regularly suppressed. The Cariboo-Chilcotin Grassland Strategy established a "Grassland Benchmark" based on aerial photographs dated between 1962 and 1974. Areas mapped as open range during this first systematic forest inventory are considered benchmark and are to be managed, and in many cases restored, as native grassland (Cariboo-Chilcotin Grasslands Strategy Working Group, 2001).

Monitoring for changes in biodiversity following restoration activities is an important phase of adaptive management. Many birds exhibit high degrees of habitat affinity and are sensitive to change. Methods have been developed to use birds as ecological indicators. As such, a songbird (Order *Passeriformes*) and woodpecker (Family *Picidae*) monitoring project was initiated in June, 2008 in three sites where cutting of encroachment has begun. These groups of birds can be effectively monitored using the point count method of inventorying for estimating relative abundance and population trends over time. Baseline indices of relative abundance have been generated for the treatment areas as a basis for long-term effectiveness monitoring.

STUDY AREAS

Three study areas were surveyed on the west-central side of British Columbia's Fraser River (regionally known as the Chilcotin). Appendices A and B contain coordinates and maps of study areas and point count stations. All areas fall within the Grassland Benchmark Area (Cariboo-Chilcotin Grasslands Strategy Working Group, 2001) and occur in the Interior Douglas-fir Very Dry Mild (IDFxm) biogeoclimatic subzone. The Meldrum Creek Road area (~150 ha) is west of Meldrum Creek Road, three km north of Highway 20 (Fig.1). Cutting of encroachment on the most of the area was scheduled to occur during the summer of 2008 (the southern portion had already been cut recently). The Iron Wood Springs section of Chilcotin District Area 1 (~145 ha) is 26 km west of Alexis Creek, south of the confluence of the Chilko and Chilcotin Rivers (Fig. 2). Crews were in the process of cutting encroachment down at the time of this survey and were approximately three-quarters completed. Chilcotin District Area 2 (Deer Creek) is west of the Chilko River and accessed via the Hanceville crossing and Stone Reserve (20 km from Lee's Corner) (Fig. 3). Resources in 2008 permitted surveying only in part of the north-west portion (~125 ha) of this ~1230 ha restoration area. Cutting of encroachment had recently been completed. The Meldrum Creek Road and Chilcotin District Area 1 areas were mosaics of existing grassland, treated and yet to be treated encroached grassland, trembling aspen copses and Douglas-fir forest edges. The Chilcotin District Area 2 site, where surveyed, was a string of relatively small openings surrounded by forest, with some aspen content.

Fig. 1: Meldrum Creek Road Area

Fig. 2: Chilcotin District Area 1

Fig. 3: Chilcotin District Area 2

METHODS

Point Count Stations

Point count station centres were selected by placement of a 250 m grid over the study area map and selecting points that fell within the existing grassland and encroachment removal treatment areas. The first point was randomly placed such that it was at least 100 m from the grassland/ forest interface and the orientation of the grid was such that it allowed for the maximum number of points to occur in the grassland and treatment areas. Due to the heterogeneous nature of IDF forest and adjacent grassland openings, some stations contained treed components. This was considered suitable to the study layout considering the small size of some of the grassy openings and treatment sites and the convoluted nature of openings and forest interfaces. Point count stations were 200 m in diameter with a 50 m buffer in between.

Station centres were located in the field using a Global Positioning System and map-derived Universal Transverse Mercator (UTM) coordinates (±10 m). They were marked with tall pig-tail stakes and labelled "MOFR Bird Point #" with pink flagging tape (Fig. 4). At the Meldrum Creek Road area, 50 m and 100 m distances were flagged so as to assist with distance judgement in the initial round of surveys. In total, 50 stations were installed over the three areas (18 Meldrum Creek Road, 17 Chilcotin District Area 1, 15 Chilcotin District Area 2).

Fig. 4: Point count station plot centre and environs (Chilcotin District Area 2, Deer Creek #12)

Point Count Surveys

Point count surveys were conducted according to RIC (1999) and Ralph *et al.* (1995). Surveys were conducted once during breeding seasons from 0.5 hours before official sunrise up to five hours following sunrise on June 6, 19 and 20, 2008. Surveys lasted five minutes with demarcation between the 0-3 minute interval and the 3-5 minute interval so as to be compatible

with Breeding Bird Survey protocol if the data were to be utilized by other researchers. Standard 4-letter species codes were used (RIC 2002) (See Appendix C). All species seen and heard calling or singing were identified and categorized according to distance codes (1=0-50 m, 2=51-100 m, 3= >100 m). Gender and relative age (adult, immature) were recorded if observations allowed. Birds flying over the station but not using the habitat directly were identified as "fly-overs". The RIC Animal Observation Form- Songbird Point Count (1998) data sheet was used for field data collection. Collected at the beginning of each count were start times and environmental conditions including cloud cover (1 = clear; 2 = scattered clouds (<50%); 3 = scattered clouds (>50%); 4 = unbroken clouds), wind speed (Beaufort scale), precipitation (N = None; F = Fog; M = Misty drizzle; D = Drizzle), temperature and general habitat description. Generally, counts in central British Columbia should be conducted in temperatures above 3 degrees Celsius, winds less than Beaufort 3 and precipitation less than light rain (RIC, 1999). So as to take into account the unsheltered conditions and cooler Chilcotin climate, standards were modified so as to include Beaufort 3 winds and temperatures above freezing. Comments and additional information useful to the Breeding Bird Atlas, including nest observations, were additionally collected. Surveys were conducted by a competent observer of birds by both sight and sound (the author). Stations were accessible by a combination of 4x4 pick-up truck and walking.

Data Analysis

Data were entered into a standard Ministry of Environment Wildlife Species Inventory MS Excel template, modified to reflect this project. Species that were not songbirds or woodpeckers were culled from the dataset before analysis of relative abundance as they are not suitably detectable using the point count survey method. They have been included in Appendix C, however, as have species encountered incidentally. Fly-overs not associated with station habitat use (e.g. not aerially foraging) were also culled.

As this study is not generating estimates of absolute density or comparing density between species, an analysis of relative detectability was not necessary (Hutto *et al.*, 1985). So as to allow for comparisons of the same area over time, bird detections from within fixed, 100 m radius stations were used to generate indices of relative abundance. They include:

1) Mean number of birds by species per station within 100 m radius.
2) Proportion of fixed radius stations within which a species was detected.
3) Proportion of unlimited radius stations within which a species was detected.

Determinations of the proportion of species detected in an unlimited radius (inclusive of all distance classes, including >100 m) assist with assessing whether certain species are detected more commonly at further distances from the observer or from adjacent habitats. This index is limited, however, as the >100 m class lacks complete independence between surveys (there is a possibility that individuals can be double-counted).

RESULTS

Fifty point count stations over three study areas were surveyed once in 2008. A total of 758

bird detections of 46 species were made during surveys and an additional five species were incidentally observed. Filtering for eligible songbirds and woodpeckers, 40 species and 712 individuals were encountered. Songbird and woodpecker species richness was similar between the three areas with Chilcotin District Area 1 having 32 species, Meldrum Creek Road 30 species and Chilcotin District Area 2 28 species respectively. On average, 14.3 ± 0.35 songbirds and woodpeckers were detected per station with very little difference between study areas (Table 1).

Table 1: Species richness and percent total species of all birds detected in three study areas, June 2008.

Study Area	# Point Count Stations	Total Detections Over 5-min. survey		Species Richness		% Total Species[c]		Mean # Detections/ Station	
		All Spp.[a]	Song/ Wood[b]	All Spp.	Song/ Wood	All Spp.	Song/ Wood	All Spp.[d]	Song/ Wood[e]
Meldrum Creek Road	18	269	257	35	30	76	75	15.3	14.1
Chilcotin District Area 1 (Iron Wood Springs)	17	260	243	34	32	74	80	15.3	14.1
Chilcotin District Area 2 (Deer Creek)	15	229	223	31	28	67	70	15.0	14.7
Total	50	758	712	46	40	100	100	-	-
Mean +/- SE	-	-	-	33 +/- 2	30 +/- 2	75 +/- 5	75 +/- 5	15.2 +/- 0.19	14.3 +/- 0.35

[a] Number of all bird species detected during surveys in study area, including fly-overs.
[b] Number of songbird and woodpecker species in study area taking into account culled data.
[c] Percent of species detected in study area as a proportion of total species detected in entire project area.

Table 2 summarizes the three indices of relative abundance for the songbirds and woodpeckers encountered in point count surveys. The most numerous species (mean number of birds by species per station within 100 m radius) were Chipping Sparrow (1.0-2.12/ station), Dusky Flycatcher (0.7-1.18/station), Vesper Sparrow (0.61-1.18/station), Yellow-rumped Warbler (0.24-1.17/station), Dark-eyed Junco (0.39-1.06/station) and American Robin (0.33-1.06/station) (Table 2). Also encountered in numbers (>0.2/station at least one study area) were Warbling Vireo, Mountain Chickadee, Brown-headed Cowbird, Pine Siskin, Mountain Bluebird, Hermit Thrush, Western Tanager, Ruby-crowned Kinglet and Western Tanager.

The most common species (i.e. those that occurred at the greatest proportion of 100 m fixed-radius stations) were Chipping Sparrow (80-94% stations), Dusky Flycatcher (73-88% stations), Vesper Sparrow (13-82% stations), and Yellow-rumped Warbler (24-67% stations). In at least 50% of at least one of the study areas were Warbling Vireo, Dark-eyed Junco, American Robin, Mountain Chickadee and Brown-headed Cowbird.

Vesper Sparrow, Warbling Vireo and Yellow-rumped Warbler were commonly detected both within the 100 m fixed radius, as well as beyond 100 m (also occurred in a high proportion

of stations of unlimited radius). Several species, however, occurred in proportionately more unlimited radius stations than fixed area stations. While habitat monitoring within the study areas was beyond the scope of this project, it is expected that habitat adjacency influenced these results. Much of the study areas have experienced forest encroachment and, as such, are largely surrounded by forest. The former open range that set the boundary for the CCLUP Grassland Benchmark was convoluted in shape, had openings ranging from small to large and was bounded and intermixed with Douglas-fir forest, trembling aspen copses and wetlands. Many birds have habitat affinities during the breeding season and can be expected in certain habitats. Species detected beyond the 100 m fixed radius only in at least one study area were American Crow, MacGillavray's Warbler, Olive-sided Flycatcher and Pileated Woodpecker. Cassin's Vireo, Hermit Thrush, Olive-sided Flycatcher, Red-breasted Nuthatch, Ruby-crowned Kinglet, Pileated Woodpecker, Swainson's Thrush, Townsend's Solitaire, Western Tanager and Western Wood-pewee, all woodland dwelling birds (Campbell *et al.* 1997), were more often detected at greater distances from station centres. The presence of Common Raven and American Crow also on this list is perhaps influenced by their loud, obvious and wide-ranging natures. Also having loud and distinctive songs but more typical of open habitats are Linclon's Sparrow and Western Meadowlark. The habit of Tree Swallows to aerially forage in open spaces likewise makes them easily detectable over long ranges.

Open-habitat bird species encountered in the study areas include Vesper Sparrow, Mountain Bluebird, Western Meadowlark, Savannah Sparrow, Lincoln's Sparrow, Brewer's Blackbird, Brown-headed Cowbird, Eastern Kingbird, Black-billed Magpie, Mourning Dove, Red-tailed Hawk, Common Nighthawk, Killdeer and Long-billed Curlew. The nighthawk, not a songbird, was observed aerially foraging in suitable nesting habitat. Killdeer were seen with young while Long-billed Curlews, blue listed in British Columbia, were encountered at both Chilcotin District Areas 1 and 2. A territorial pair were even within plot #14 at Chilcotin District Area 1.

Additional forest nesting birds observed during the project include Downy and Hairy Woodpecker, Red-naped Sapsucker, Hammond's Flycatcher, Cedar Waxwing, Townsend's Warbler Ruffed Grouse and seed-eating finches like Pine Siskin, Evening Grosbeak, White-winged Crossbill and Cassin's Finch.

Table 2: Relative indices of songbird and woodpecker abundance from point counts conducted in June 2008. The most commonly detected species are in bold.

Species [a]	Mean#birds by species/station within 100 m radius			Proportion of stations in which species was detected within 100 m			Proportion of stations in which species detected in an unlimited radius		
	Meldrum[b]	CD1[c]	CD2[d]	Meldrum	CD1	CD2	Meldrum	CD1	CD2
AMCR	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00
AMRO	0.61	1.06	0.33	0.39	0.71	0.33	0.61	0.82	0.53
BHCO	0.78	0.00	0.27	0.61	0.00	0.13	0.61	0.00	0.13
BRBL	0.00	0.00	0.13	0.00	0.00	0.07	0.00	0.00	0.07
CAVI	0.06	0.06	0.13	0.06	0.06	0.07	0.11	0.12	0.13
CHSP	1.00	2.12	1.87	0.89	0.94	0.80	0.89	0.94	0.80
CORA	0.00	0.00	0.13	0.00	0.00	0.13	0.11	0.29	0.73
DEJU	0.39	1.06	0.60	0.28	0.65	0.53	0.28	0.65	0.53
DOWO	0.00	0.00	0.13	0.00	0.00	0.13	0.00	0.00	0.13
DUFL	1.11	1.18	0.73	0.83	0.88	0.73	0.89	0.88	0.73
EAKI	0.00	0.06	0.00	0.00	0.06	0.00	0.00	0.06	0.00
EVGR	0.00	0.12	0.00	0.00	0.12	0.00	0.00	0.12	0.07
HAFL	0.00	0.06	0.00	0.00	0.06	0.00	0.00	0.06	0.00
HAWO	0.06	0.06	0.07	0.06	0.06	0.07	0.06	0.06	0.07
HETH	0.22	0.29	0.27	0.22	0.29	0.27	0.39	0.29	0.47
LEFL	0.17	0.00	0.00	0.11	0.00	0.00	0.17	0.00	0.00
LISP	0.06	0.06	0.07	0.06	0.06	0.07	0.22	0.06	0.20
MACW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00
MOBL	0.33	0.24	0.13	0.33	0.24	0.13	0.39	0.24	0.13
MOCH	0.78	0.41	0.27	0.56	0.29	0.27	0.61	0.35	0.33
NOFL	0.11	0.18	0.07	0.11	0.18	0.07	0.11	0.18	0.07
OCWA	0.11	0.06	0.00	0.06	0.06	0.00	0.11	0.06	0.00
OSFL	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00
PISI	0.22	0.24	0.60	0.22	0.12	0.40	0.22	0.12	0.47
PIWO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.27
RBNU	0.17	0.06	0.20	0.17	0.06	0.13	0.39	0.29	0.27
RCKI	0.17	0.24	0.20	0.17	0.24	0.20	0.44	0.29	0.47
RNSA	0.00	0.06	0.00	0.00	0.06	0.00	0.00	0.06	0.00
SAVS	0.06	0.00	0.00	0.06	0.00	0.00	0.06	0.00	0.00
SWTH	0.06	0.12	0.47	0.06	0.12	0.40	0.06	0.35	0.73
TOSO	0.00	0.00	0.07	0.00	0.00	0.07	0.00	0.00	0.07
TOWA	0.06	0.00	0.00	0.06	0.00	0.00	0.06	0.00	0.00
TRES	0.28	0.12	0.13	0.22	0.06	0.07	0.28	0.65	0.13
VESP	0.61	1.18	0.67	0.61	0.82	0.13	0.78	0.88	0.73
WAVI	0.39	0.71	0.73	0.44	0.59	0.60	0.72	0.71	0.73
WEME	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00
WETA	0.28	0.29	0.13	0.17	0.24	0.13	0.22	0.47	0.60
WIWA	0.00	0.06	0.00	0.00	0.06	0.00	0.00	0.06	0.00
WWPE	0.11	0.18	0.33	0.11	0.18	0.33	0.11	0.29	0.40
YRWA	1.17	0.24	0.87	0.67	0.24	0.67	0.78	0.35	0.73

[a]Includes songbirds and woodpeckers only. Species codes are from RIC 2002.
[b]Meldrum Creek Road Study Area
[c]Chilcotin District Area 1 Study Area
[d]Chilcotin District Area 2 Study Area

DISCUSSION

The three study areas had similar levels of species richness for songbirds and woodpeckers. Of the species encountered in the highest numbers and at largest proportion of stations, Vesper Sparrow is the only one that breeds solely in grasslands and open spaces. Chilcotin District Area 1 had both the highest numbers and highest proportion of stations containing this species. While habitat was not quantified in this study, this area did have the largest of the existing openings in the three sites and this may have contributed to the commonness of Vesper Sparrow. Compared with Chilcotin District Area 2 where opening sizes are quite a bit smaller and the relative proportion of forest edge greater, this species has only limited distribution across the survey stations. Chipping Sparrow, Dark-eyed Junco and American Robin are ubiquitous species that are capable of utilizing a range of habitats from forest to grasslands (Campbell *et al.* 1997). The varied habitat composition typical to the study area is likely conducive to the needs of these species during the breeding season. Dusky Flycatcher, also numerous and common across the areas, nests in deciduous trees or shrubs and were invariably associated with aspen copses bordered by grassland.

Aspen copses in IDF forests and grasslands are known to be cavity nester hot-spots (Aitkin and Martin, 2004; Martin *et al.* 2004). This study encountered cavity nesting species in aspen stands such as Mountain Bluebird, Mountain Chickadee, Northern Flicker, Tree Swallow and Bufflehead, all of which utilize adjacent openings (or wetlands in the case of Bufflehead) for foraging. Western Wood-pewee, Warbling Vireo, Orange-crowned Warbler and Least Flycatchers were also associated with aspen copses and Hermit Thrushes tended to favour stands leading with this tree. Mountain bluebirds were almost always observed using individual conifer encroachment trees, both live and dead, as perches from which to sing and watch over the grassland for insects to feed on. Vesper and Savannah Sparrows, both grassland species, also exhibited this behaviour.

In terms of operational planning for the removal of forest encroachment in Grassland Benchmark areas, the maintenance of aspen copses should be of paramount importance. Not only is it important in terms of biodiversity to retain existing cavity trees (that tend to be in dead and dying aspen), but to ensure an on-going supply of them in the form of younger and more healthy trees. As the reintroduction of fire is planned as a means of processing the cut encroachment trees, it will also be important to avoid burning through the residual aspen stands where there is greater fuel loading and higher risk of loss.

It is interesting to note that while several cavity nests were found in aspen copses (Mountain Bluebird, Northern Flicker, Tree Swallow), other nests were found within the encroachment itself. An active Yellow-rumped Warbler nest was 1 m off the ground in a live, 2 m Douglas-fir at Meldrum Creek Road while two American Robins (Fig. 5) and a Dark-eyed Junco were nesting on and under slash at Chilcotin District Area 1. This use, along with the observed use of scattered live and dead trees within existing grassland opening suggests that retention of some of this tree structure is actually desirable. Especially in places where the resultant fuel loading from encroachment slash is high (e.g. parts of Iron Wood Springs in Chilcotin District Area 1), it might be worth considering not burning at all. Fires in such areas can be expected to burn hotter than grassland fires usually experience and soil scorching and invasive plant infestation might ensue.

Grasses and herbs would still grow and the slash eventually break down. With regard to standing tree retention, the occasional live sapling or pole would likely be beneficial to bird communities, especially where there is little existing structure. In those places where bark beetle-killed pine were left uncut in treated areas, they were certainly used for foraging, perching and singing by a variety of birds. Considering the objectives of grassland restoration efforts, these trees, having no foliage, are not expected to impede grass growth below.

The fact that nesting occurs within and around trees encroaching on grasslands also points to the timing of restoration activities. Migratory birds, including most of the species encountered in this project, are protected under the federal Migratory Birds Convention Act (1917, amended 1994). It is unlawful to harm or destroy migratory birds or their active nests. As such, cutting and burning of encroachment trees would best be done outside of the main breeding season of May through August.

Special consideration should be taken to prevent disturbance of blue listed Long-billed Curlews nesting in grasslands undergoing ecosystem restoration. Efforts should focus on retaining the habitat conditions currently in place within known nesting territories. Burning should not occur when curlews are establishing territories, courting and nesting. These birds begin appearing in the Chilcotin from mid- to late April and remain through August.

Fig. 5: American Robin nest with eggs built on slashed tree encroachment at Chilcotin Road Area 1.

Key Operational Recommendations

1. Maintain aspen copses of as wide a range of ages and conditions as possible from both cutting and burning with particular focus on retaining stands with dead and dying trees.
2. Retain some tree structure where encroachment is being removed. Both living and dead trees provide feeding, perching and nesting habitat to bird communities.
3. Where the risk of soil scorching is high, it may be preferable to let cut debris rot and grassland plants reestablish around it instead, while at the same time retaining considerable bird nesting habitat.
4. Timing of tree encroachment cutting and burning should not coincide with bird breeding season.

CONCLUSION

Effectiveness monitoring is an integral phase of ecosystem restoration projects now underway in the Cariboo-Chilcotin Grassland Benchmark. It evaluates treatment effects and contributes to adaptive management decisions over time. By nature, monitoring must occur over a period of time that adequately allows for ecosystem processes. The base-line indices of relative abundance of songbirds and woodpeckers in these three restoration areas should serve as a reference to future point count surveys. To accommodate variation due to differences between weather between surveys from year to year, as well as annual bird population fluctuations not related directly to breeding habitat conditions, a collection of several years worth of survey data will be the most useful (Sauer *et al.* 2004). It is recommended that surveys be repeated annually over at least the next 3-5 years at which time the monitoring frequency for ensuing years can be re-assessed.

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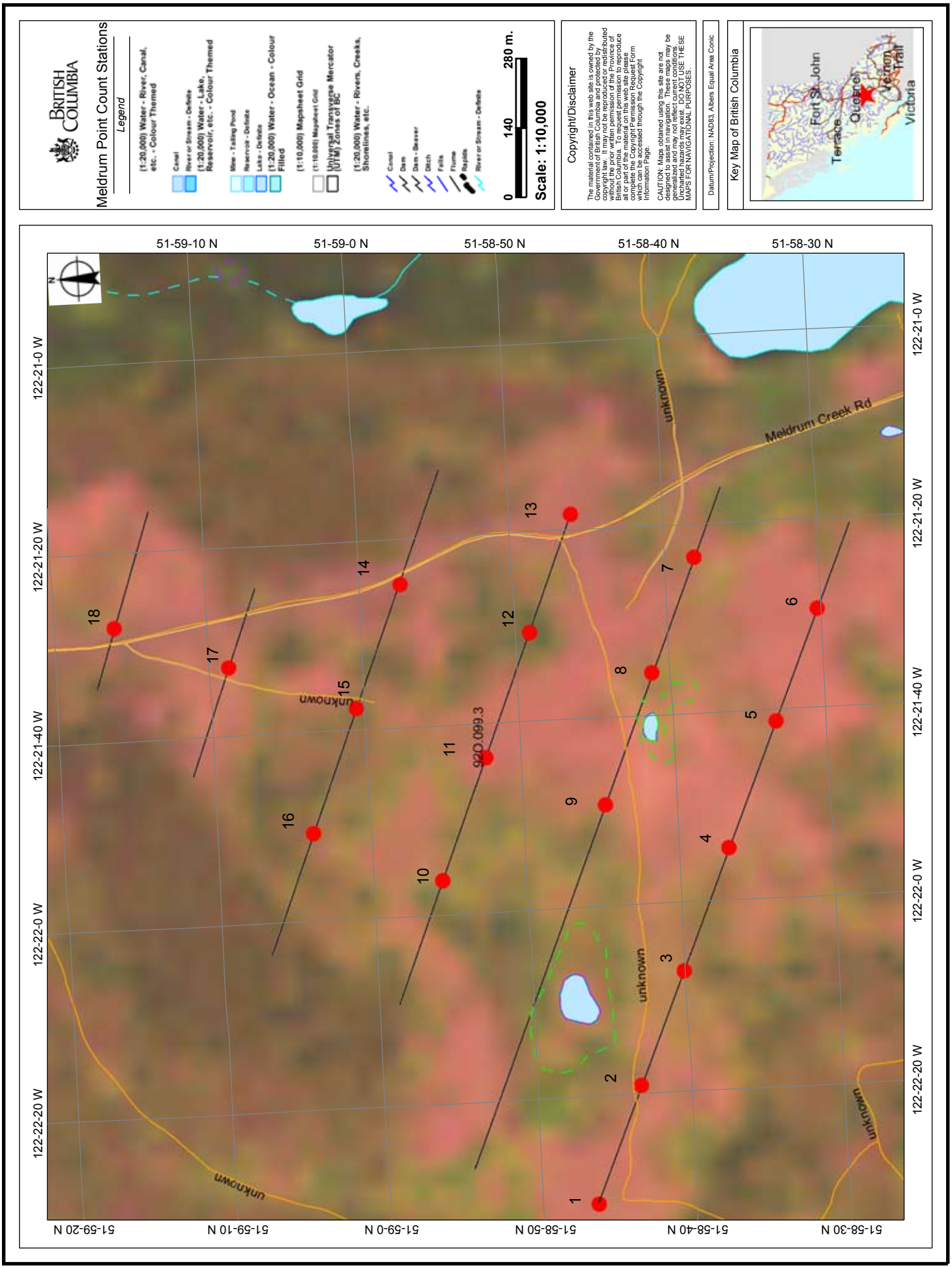
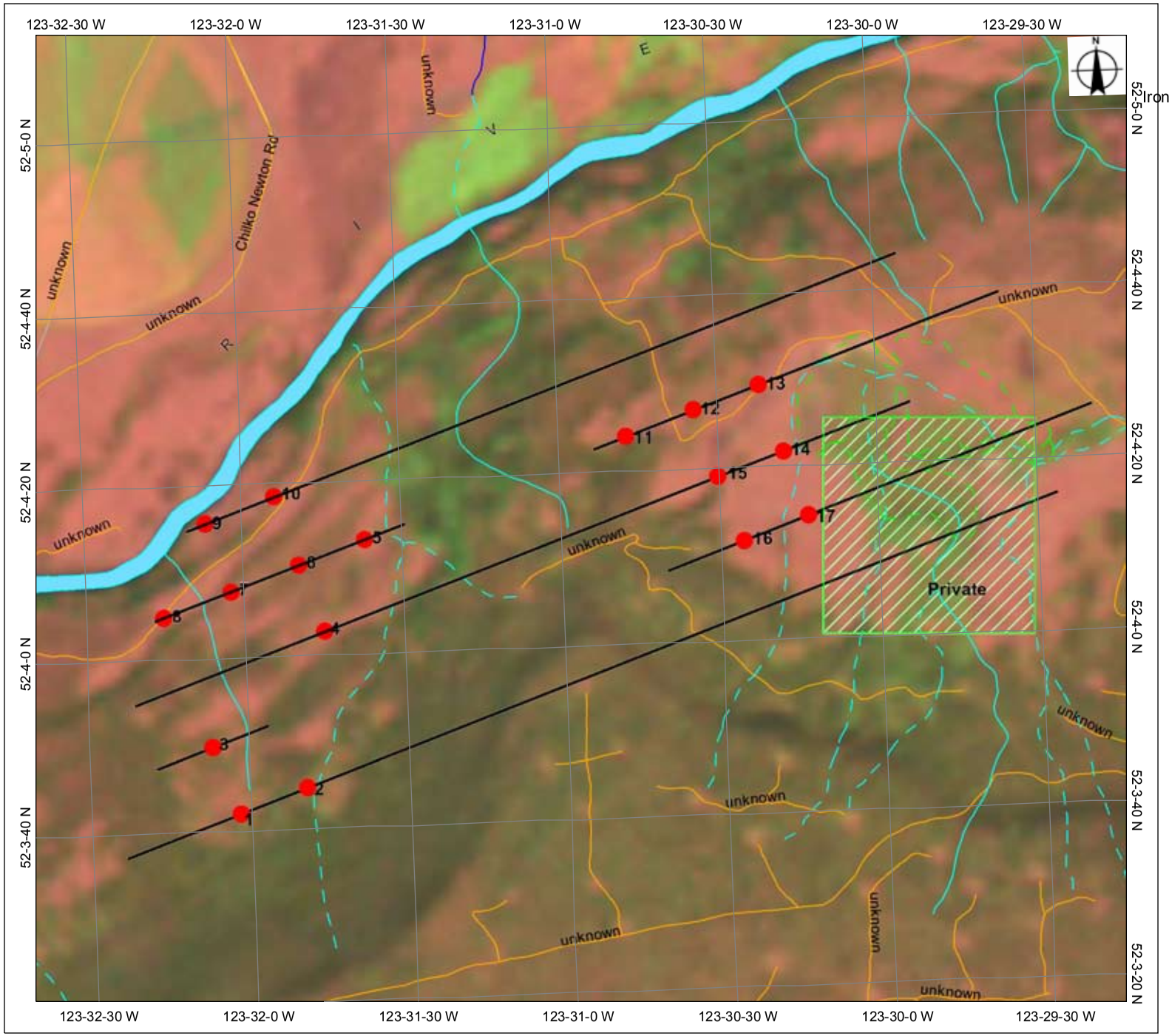
Appendix A: UTM coordinates of point count stations at three study areas (NAD 83 datum, grid 10U)

Meldrum Creek Road			Chilcotin District Area 1 (Iron Wood Springs)			Chilcotin District Area 2 (Deer Creek)		
Plot	**Easting**	**Northing**	**Plot**	**Easting**	**Northing**	**Plot**	**Easting**	**Northing**
1	542898	5758952	1	463398	5768034	1	481315	5764824
2	543133	5758855	2	463636	5768119	2	481461	5764615
3	543361	5758761	3	463306	5768274	3	482294	5763376
4	543606	5758658	4	463723	5768676	4	482426	5763177
5	543859	5758554	5	463880	5768995	5	482561	5762976
6	544082	5758460	6	463639	5768914	6	482697	5762775
7	544195	5758705	7	463393	5768825	7	482969	5762372
8	543962	5758797	8	463152	5768744	8	484094	5760701
9	543704	5758901	9	463311	5769074	9	484510	5760085
10	543564	5759236	10	463562	5769160	10	485216	5759029
11	543808	5759141	11	464829	5769322	11	485364	5758812
12	544058	5759041	12	465073	5769406	12	485505	5758601
13	544292	5758948	13	465311	5769488	13	485650	5758387
14	544154	5759306	14	465390	5769247	14	485796	5758168
15	543918	5759397	15	465153	5769165	15	485943	5757954
16	543671	5759493	16	465238	5768933			
17	544012	5759649	17	465470	5769015			
18	544101	5759877						

Appendix B: Maps of point count station locations in three study areas (from iMapBC).





Iron Wood Springs Point Count Stations

Legend

(1:20,000) Water - River, Canal, etc. - Colour Themed

- Canal
- River or Stream - Definite

(1:20,000) Water - Lake, Reservoir, etc. - Colour Themed

- Mine - Tailing Pond
- Reservoir - Definite
- Lake - Definite

(1:20,000) Water - Rivers, Creeks, Shorelines, etc.

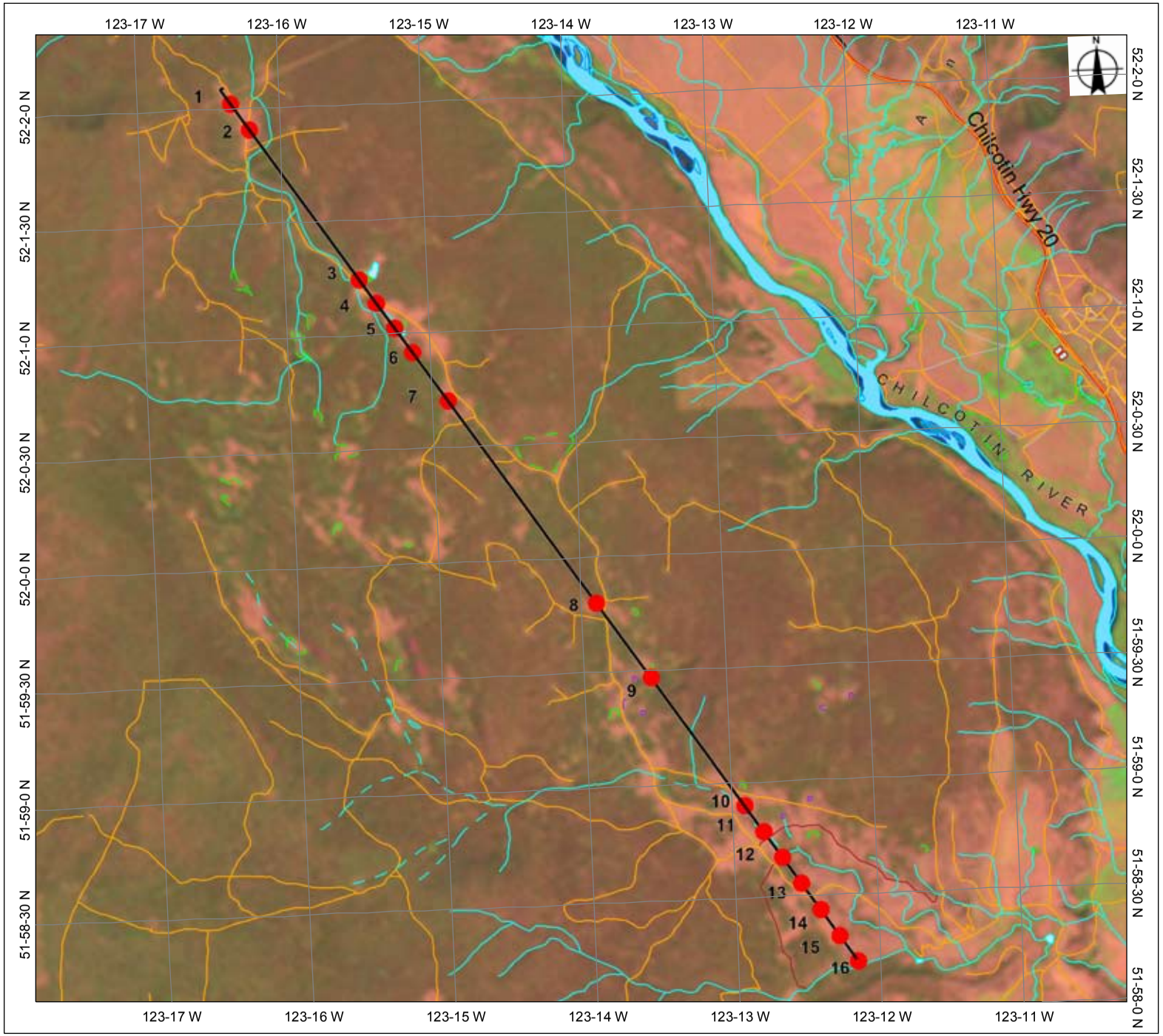
- Canal
- Dam
- Dam - Beaver
- Ditch
- Falls
- Flume
- Rapids
- River or Stream - Definite
- River or Stream - Dry
- River or Stream - Indefinite
- River or Stream - Left Bank
- River or Stream - Right Bank
- Dam - section Base
- Flooded Land - Inundated
- Lake - Definite

0 275 550 m.

Scale: 1:20,000

Datum/Projection: NAD83, Albers Equal Area Conic

Key Map of British Columbia



BRITISH COLUMBIA

Deer Creek Point Count Stations

Legend

(1:20,000) Water - River, Canal, etc. - Colour Themed

- Canal
- River or Stream - Definite

(1:20,000) Water - Lake, Reservoir, etc. - Colour Themed

- Mine - Tailing Pond
- Reservoir - Definite
- Lake - Definite

(1:20,000) Water - Rivers, Creeks, Shorelines, etc.

- Canal
- Dam
- Dam - Beaver
- Ditch
- Falls
- Flume
- Rapids
- River or Stream - Definite
- River or Stream - Dry
- River or Stream - Indefinite
- River or Stream - Left Bank
- River or Stream - Right Bank
- Dam - section Base
- Flooded Land - Inundated
- Lake - Definite

0 650 1300 m.

Scale: 1:45,000

Datum/Projection: NAD83, Albers Equal Area Conic

Key Map of British Columbia

Appendix C: Species codes of all birds encountered defined by common and scientific names

Code	Common Name	Scientific Name
AMCR	American Crow	*Corvus brachyrhynchos*
AMRO	American Robin	*Turdus migratorius*
BBMA**	Black-billed Magpie	*Pica hudsonia*
BHCO	Brown-headed Cowbird	*Molothrus ater*
BRBL	Brewer's Blackbird	*Euphagus cyanocephalus*
BUFF*	Bufflehead	*Bucephala albeola*
CAFI**	Cassin's Finch	*Carpodacus cassinii*
CAVI	Cassin's Vireo	*Vireo cassinii*
CEWA**	Cedar Waxwing	*Bombycilla cedrorum*
CHSP	Chipping Sparrow	*Spizella passerina*
CONI*	Common NIghthawk	*Chordeiles minor*
CORA	Common Raven	*Corvus corax*
DEJU	Dark-eyed Junco	*Junco hyemalis*
DOWO	Downy Woodpecker	*Picoides pubescens*
DUFL	Dusky Flycatcher	*Empidonax oberholseri*
EAKI	Eastern Kingbird	*Tyrannus tyrannus*
EVGR	Evening Grosbeak	*Coccothraustes vespertinus*
HAFL	Hammond's Flycatcher	*Empidonax hammondii*
HAWO	Hairy Woodpecker	*Picoides villosus*
HETH	Hermit Thrush	*Catharus guttatus*
KILL*	Killdeer	*Charadrius vociferus*
LBCU*	Long-billed Curlew	*Numenius americanus*
LEFL	Least Flycatcher	*Empidonax minimus*
LISP	Lincoln's Sparrow	*Melospiza lincolnii*
MACW	MacGillavray's Warbler	*Oporornis tolmiei*
MOBL	Mountain Bluebird	*Sialia currucoides*
MOCH	Mountain Chickadee	*Poecile gambeli*
MODO**	Mourning Dove	*Zenaida macroura*
NOFL	Northern Flicker	*Colaptes auratus*
OCWA	Orange-crowned Warbler	*Vermivora celata*
OSFL	Olive-side Flycatcher	*Contopus cooperi*
PISI	Pine Siskin	*Carduelis pinus*
PIWO	Pileated Woodpecker	*Dryocopus pileatus*
RBNU	Red-breasted Nuthatch	*Sitta canadensis*
RCKI	Ruby-crowned Kinglet	*Regulus calendula*
RNSA	Red-naped Sapsucker	*Sphyrapicus nuchalis*
RTHA*	Red-tailed Hawk	*Buteo jamaicensis*
RUGR*	Ruffed Grouse	*Bonasa umbellus*
SAVS	Savannah Sparrow	*Passerculus sandwichensis*
SWTH	Swainson's Thrush	*Catharus ustulatus*

Code	Common Name	Scientific Name
TOSO	Townsend's Solitaire	*Myadestes townsendi*
TOWA	Townsend's Warbler	*Dendroica townsendi*
TRSW	Tree Swallow	*Tachycineta bicolor*
VESP	Vesper Sparrow	*Pooecetes gramineus*
WAVI	Warbling Vireo	*Vireo gilvus*
WEME	Western Meadowlark	*Sturnella neglecta*
WETA	Western Tanager	*Piranga ludoviciana*
WIWA	Wilson's Warbler	*Wilsonia pusilla*
WWCR**	White-winged Crossbill	*Loxia leucoptera*
WWPE	Western Wood-pewee	*Contopus sordidulus*
YRWA	Yellow-rumped Warbler	*Dendroica coronata*

***** Non-songbird species encountered during surveys but not included in relative abundance indices.

****** Species encountered in study areas but not during surveys.