FREP

REPORT #36

November 2013

FOREST AND RANGE EVALUATION PROGRAM

Cover Requirements and Habitat Needs of Grassland-nesting Birds in the Cariboo-Chilcotin

Prepared by:
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Photo: C. Haddow

Habitat Conservation Trust Fund

FREP Forest & Range Evaluation Program

British Columbia

Sustainability of Forest and Range Resources Through Science and Stewardship

MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
FOREST AND RANGE EVALUATION PROGRAM

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This report will be updated periodically—if you have any edits, corrections, or other feedback, please email Peter Bradford **Peter.Bradford@gov.bc.ca**

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Management of forest and range resources is a complex process that often involves the balancing of ecological, social, and economic considerations. This evaluation report represents one facet of this process. Based on monitoring data and analysis, the authors offer the following recommendations to those who develop and implement forest and range management policy, plans, and practices.

Citation:
Haddow, C., Bings, B. and Wallich, E., Cover Requirements and Habitat Needs of Grassland-nesting Birds in the Cariboo-Chilcotin. Ministry of Forests, Lands and Natural Resource Operations, Resource Practices Br., Victoria BC FREP Report 36.
http://www.for.gov.bc.ca/hfp/frep/publications/index.htm

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EXECUTIVE SUMMARY

Over the last 30 years, habitat loss, fragmentation, and habitat degradation has resulted in a marked decline in British Columbia's grassland-nesting birds, many of which are now endangered, threatened, or of special concern. These declines are notable in the province's Cariboo-Chilcotin region, where forest ingrowth or encroachment, livestock grazing, and the introduction of domestic forage grasses has led to significant changes in native grasslands.

Grassland birds depend on adequate herbaceous cover for protection from predators during nesting and foraging; however, few studies exist relating native rangeland grass species composition and structure to nest cover. A previous Forest and Range Evaluation Program study used digital photography to monitor grassland bird nest cover. Building on this work, the project reported here:

- developed methods to accurately evaluate available native grass cover at nest sites of four grassland bird species (Sharp-tailed Grouse, Western Meadowlark, Vesper Sparrow, and Savannah Sparrow);
- simulated grazing by clipping grasses to different heights;
- determined vegetation heights required to retain nest cover for each bird species; and
- established how grazing intensity affects quality and availability of nesting habitat.

Three locations in the Cariboo-Chilcotin grasslands were chosen for this study. The Junction Sheep Range Provincial Park transects are in the very dry, warm Bunchgrass biogeoclimatic zone, where the climax vegetation is dominated by bluebunch wheatgrass. The Becher's Prairie and OK Ranch transects are both in the very dry, mild Interior Douglas-fir zone, with bluebunch wheatgrass on the drier, south-facing slopes and short-awned porcupinegrass and spreading needlegrass on the gentle slopes and level areas. At all three study sites, the non-native Kentucky bluegrass replaces the taller bunchgrasses in areas of more intensive livestock grazing.

The four species of grassland-nesting birds studied exhibited non-random nest site selection and chose areas where native bluebunch wheatgrass and needlegrass provided cover that usually exceeded 90% at the nest site. Study results indicate that maintaining high levels of residual cover before nesting, as well as high cover during the nesting period, would benefit grassland-nesting birds. In addition, grazing practices that result in an increase in density of bluebunch wheatgrass would also improve nesting opportunity.

Measures of stubble height are usually averaged across pastures where livestock have typically grazed plants to variable heights. A pasture meeting a stubble height requirement of 15 cm may retain patches of taller grasses, which could provide some suitable nest sites for the smaller Vesper Sparrow; however, 15 cm is not sufficient to provide adequate nest cover for the larger Western Meadowlark and Sharp-tailed Grouse. As the average stubble height of grazed grasslands approaches the preferred height of vegetation at the nest (generally 20 cm for Vesper Sparrow and greater than 25–30 cm for Sharp-tailed Grouse and Western Meadowlark), the density of potential suitable nest sites should increase.

Heavy grazing affects plant communities. As grazers remove the preferred plant species and these are replaced with less preferred non-native species, available grassland-nesting cover and grassland productivity declines.

Improving range condition and health has benefits for grassland-nesting birds and also enhances the quality and production of native grasses, which has benefits for livestock producers. Based on this research, recommended practices that would maintain or improve grassland-nesting bird habitat include:

- Restoring native bluebunch wheatgrass ecosystems
- Maintaining adequate stubble height of native bunchgrass species
- Planning the timing of livestock use
- Managing livestock use near Sharp-tailed Grouse lek sites
- Limiting browse use on shrubs
- Restoring fire-maintained grassland ecosystems

1.0 INTRODUCTION

Over the last 30 years, populations of grassland-nesting birds have markedly declined and many are now red- or blue-listed[1] in British Columbia (Sauer et al. 2012). The most probable causes of decline are permanent loss and fragmentation of habitat as well as habitat degradation (Brennan and Kuvlesky 2005). Habitat is most commonly lost to urbanization, expansion of intensive cultivation, industrialization, and road construction. Many bird species are intolerant of small areas of suitable habitat and will abandon a patchwork landscape (U.S. Geological Survey 2006). Moreover, fragmentation amplifies risk for ground-nesters by increasing the amount of grassland in proximity to edges, thereby increasing the incidence of predation (Brennan and Kuvlesky 2005).

Grassland birds are highly dependent on adequate herbaceous cover for protection from predators during nesting and foraging; therefore, changes in vegetation composition and structure can have a significant impact on breeding populations (Wildlife Habitat Council 1999). Changes in vegetation are of special concern in British Columbia's Cariboo-Chilcotin region, where forest ingrowth or encroachment, livestock grazing, and the introduction of domestic forage grasses has led to significant changes in native grasslands (Hooper and Pitt 1995). For example, fire suppression at Becher's Prairie has resulted in more than 35% of grasslands being replaced by trees between 1962 and 1995 (Ross 1997). Grazing livestock can affect vegetation cover for ground-nesting birds by reducing average grass height and altering the grass community composition. Native bunchgrass, such as bluebunch wheatgrass (*Pseudoroegneria spicata*), is particularly susceptible to grazing during spring and early summer. This palatable grass species is preferentially selected by grazers, but it is not well adapted to defoliation given its elevated growing points, which are readily removed by grazers (Miller et al. 1986; Fraser 2003b). Grazing also slows tillering (or the production of new grass shoots), reduces current photosynthate production that supports new growth, and slows root growth, making the grass more susceptible to drought (Burkhardt and Sanders 2010). Intensive grazing can precipitate the gradual replacement of perennial bunchgrasses with rhizomatous and sod-forming grasses, such as Kentucky bluegrass (*Poa pratensis*). These invader species are more resistant to grazing but are shorter and less dense than native bunchgrass and may not provide sufficient cover for security and nesting purposes (Fraser 2003b).

In the Cariboo-Chilcotin, grassland birds that require tall or dense vegetation for nesting include the Sharp-tailed Grouse *columbianus* subspecies (*Tympanuchus phasianellus columbianus*) referred to in this report as "Sharp-tailed Grouse"; Western Meadowlark (*Sturnella neglecta*); Vesper Sparrow (*Pooecetes gramineus*); and Savannah Sparrow (*Passerculus sandwichensis*). The Sharp-tailed Grouse has been extirpated from much of its former range in British Columbia (Leupin 2003) and is now a blue-listed species in the province (B.C. Conservation Data Centre 2012). It is relatively widespread in larger cutblock areas of the Cariboo-Chilcotin; however, breeding populations in permanent native grassland habitats are considered at risk (Ritcey 1995). The Western Meadowlark, Vesper Sparrow, and Savannah Sparrow remain common migrants in the area; however, breeding populations of these species are declining in British Columbia and throughout their range (Sauer et al. 2012).

Grasslands of the Cariboo-Chilcotin are dominated by bluebunch wheatgrass, short-awned porcupinegrass (*Hesperostipa curtiseta*), spreading needlegrass (*Achnatherum richardsonii*), and Rocky Mountain fescue (*Festuca saximontana*) (Steen and Coupé 1997). Few studies exist relating native rangeland grass species composition and structure to nest cover for various bird species. In our preliminary study of nest cover within the Cariboo-Chilcotin grasslands, we concluded that cover at the nest often exceeded 90%, while the average cover of grazed grasslands was generally less than the preferred nest cover (Haddow and Bings 2010).

To build on our former study, this project:

- develops methods to accurately measure available vegetative cover for Sharp-tailed Grouse, Western Meadowlark, Vesper Sparrow, and Savannah Sparrow, and uses these methods to evaluate percent cover provided by native grasses at nest sites;
- simulates grazing by clipping grasses to different heights and measures the changes in vegetation cover;
- compares preferred nest cover to cover available at variable clipped heights to determine the vegetation heights that retain nest cover for each bird species; and

1 Red-listed species include any indigenous species or subspecies that have, or are candidates for, "Extirpated," "Endangered," or "Threatened" status in British Columbia; blue-listed species and ecological communities are of "Special Concern" (formerly Vulnerable); and yellow-listed species and ecological communities are "Secure" (B.C. Conservation Data Centre 2012).

- measures the bird cover variability in grassland pastures exposed to various levels of grazing to determine how grazing intensity affects quality and availability of nesting habitat.

We then integrated our results with current knowledge to develop guidance for range and livestock managers in maintaining or improving grassland-nesting habitat.[2]

2.0 PREFERRED HABITAT OF GRASSLAND-NESTING BIRDS

2.1 *Sharp-tailed Grouse*

Figure 1. Male Sharp-tailed Grouse displaying at lek site (Rick Howie photo).

Sharp-tailed Grouse occupy two types of grassland habitats in British Columiba: (1) permanent native grasslands of the Ponderosa Pine, Bunchgrass, and Interior Douglas-fir biogeoclimatic zones; and (2) temporary grassy openings created by fire and logging in lower-elevation lodgepole pine forests of the Interior Douglas-fir, Sub-Boreal Pine–Spruce, and Sub-Boreal Spruce zones (Ritcey 1995). Sharp-tailed Grouse prefer gentle grassland topography (Ritcey 1995) where they feed on forbs, grasses, and insects in spring and summer, enhanced with berries in the fall. In winter, Sharp-tailed Grouse gather in loose flocks under cover of Douglas-fir, aspen, or spruce-cottonwood forests and often adjacent to riparian areas with willow, water birch, chokecherry, common snowberry, saskatoon, red-osier dogwood, and prickly rose thickets (Giesen and Connelley 1993; Ritcey 1995; Leupin and Chutter 2007). Sharp-tailed Grouse seek shelter in these areas and feed primarily on buds and catkins of deciduous trees and shrubs. In early April, males gather to attract female partners in "dancing grounds," or leks, which are usually

Figure 2. Female Sharp-tailed Grouse (Jared Hobbs photo).

located on open, dry, elevated sites in bunchgrass habitats with areas of reduced or moderate grass cover (Ritcey 1995; Figure 1). Females nest soon after mating, usually between April and June (Leupin and Chutter 2007; Figure 2).

In the permanent native grasslands, Sharp-tailed Grouse nest within 2 km of their leks, or traditional breeding grounds (Leupin 2003). This species nests under dense vegetation within open grassy areas and shows a strong preference for residual cover from the previous years' growth. Reduced availability of suitable nesting sites may be a limiting factor to the success of this species (Leupin 2003).

2.2 *Western Meadowlark*

Figure 3. Western Meadowlark singing (Ralph Ritcey photo).

2 Data used in this report was collected between 2005 and 2011.

Western Meadowlarks arrive in the Cariboo-Chilcotin during the last week of February, with the main migration occurring in late-March and continuing to early May (Campbell et al. 2001; Figure 3). Western Meadowlarks are most common on low-elevation, south-facing slopes of the Cariboo-Chilcotin (Hooper and Pitt 1996). They prefer treeless areas, with patchy vegetation and a high coverage of grass, forbs, and litter (Hooper and Pitt 1996) where they forage on the ground for small invertebrates, grains, and seeds (B.C. Conservation Data Centre 2012). Some shrub or tree cover is important for providing elevated song perches (B.C. Conservation Data Centre 2012). Breeding occurs from about mid-April to late July and nests are situated on dry ground and well hidden in grass clumps (Campbell et al. 2001; B.C. Conservation Data Centre 2012).

2.3 *Vesper Sparrow*

Figure 4. Vesper Sparrow (Jared Hobbs photo).

Vesper Sparrows are one of the most abundant breeding birds in the Cariboo-Chilcotin grasslands (Campbell et al. 2001; Figure 4). They arrive in late-April to early May (Campbell et al. 2001) and are often found in the transition between grasslands and treed areas (Dechant et al. 2000). In the Chilcotin, they are common on south-facing slopes and in areas with complex vegetation structure, such as a mix of shrubs, grasses, and tall, dense vegetation (Hooper and Pitt 1996). The breeding season starts soon after arrival in early May and broods mature as late as mid-August (Campbell et al. 2001). Vesper Sparrows build their well-concealed nests on the ground at the base of plants or under dead stems (Dechant et al. 2000; Campbell et al. 2001), and they forage on the ground for seeds and insects (B.C. Conservation Data Centre 2012).

2.4 *Savannah Sparrow*

Savannah Sparrows are common migrants that arrive in the Cariboo-Chilcotin between late April and mid-May

Figure 5. Savannah Sparrow (Rick Howie photo).

(Campbell et al. 2001; Figure 5). They can be found in a variety of open habitats, from dry grassland to marshy areas, but prefer areas with a well-developed litter layer and vegetation that varies from short to intermediate in height (Swanson 1998). In the Chilcotin, they are commonly associated with dense vegetation (Hooper and Pitt 1996). Savannah Sparrows breed from mid-April to the end of July (Campbell et al. 2001) and carefully conceal their nests in dense ground cover and below overhanging grasses, forbs, and sedges (Hooper and Pitt 1996).

3.0 STUDY AREAS

The study area included three locations in the Cariboo Chilcotin grasslands: Becher's Prairie and the Junction Sheep Range Provincial Park, both southwest of Williams Lake (see Figure 6), and the OK Ranch, located northwest of Clinton (see Figure 7). As well, nest cover for six Vesper Sparrow nests located in Lac du Bois (North Kamloops) was recorded and incorporated into the analyses. The Junction Sheep Range Provincial Park is in the very dry, warm Bunchgrass biogeoclimatic zone (BGxw2), where the climax or potential natural community vegetation is dominated by bluebunch wheatgrass. Junegrass (*Koeleria macrantha*) and needle-and-thread grass (*Hesperostipa comata*) increase on grazed grasslands in this zone (Wikeem and Wikeem 2004). Becher's Prairie and the OK Ranch are both in the very dry, mild Interior Douglas-fir zone (IDFxm), with bluebunch wheatgrass on the drier, south-facing slopes and short-awned porcupinegrass on the gentle slopes and level areas. Spreading needlegrass dominates areas close to the forest edge and areas with higher moisture (Steen

and Coupé 1997). At all three study sites, the non-native Kentucky bluegrass replaces the taller bunchgrasses in areas of more intensive livestock grazing.

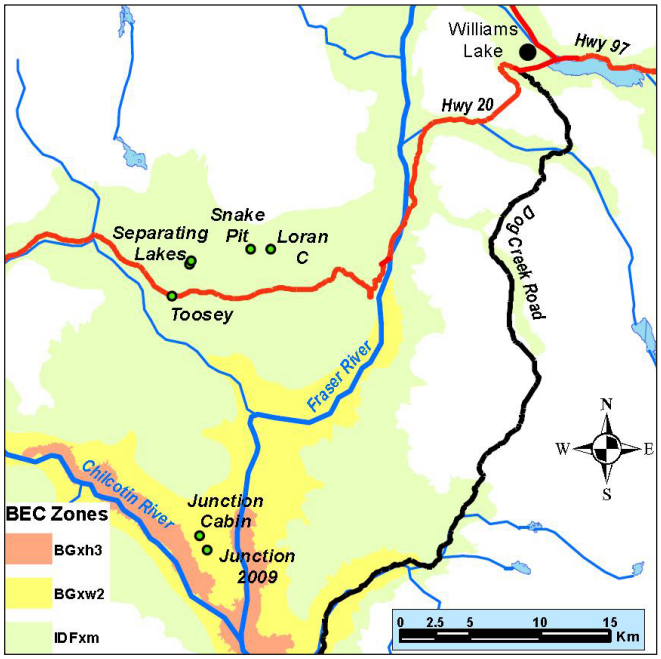

Figure 6. ***Study transects (green dots) located southwest of Williams Lake on the Junction Sheep Range Provincial Park (BGxw2) and Becher's Prairie (IDFxm).***

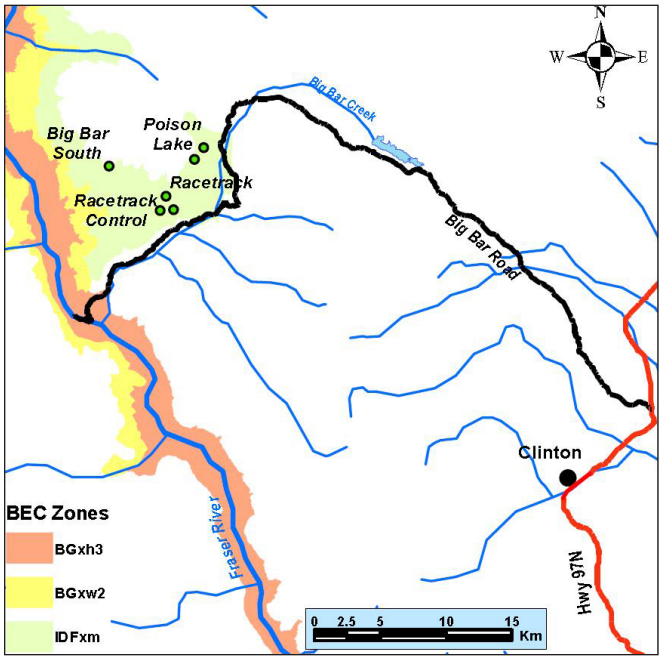

Figure 7. ***Study transects (green dots) located at the OK Ranch in the IDFxm northwest of Clinton.***

4.0 METHODOLOGY

4.1 *Nest Cover*

Sharp-tailed Grouse, Western Meadowlark, and Vesper and Savannah sparrow nests were located in the Cariboo-Chilocotin grasslands at the Junction Sheep Range Provincial Park, Becher's Prairie, and the OK Ranch. Nests were located annually during May and June from 2007 to 2011. Each nest was identified with UTM co-ordinates, using a handheld GPS device, and visited several times during the nesting period to observe and record productivity and fledgling success. In July, once nestlings had fledged, the following measurements were obtained at all nest sites:

- dominant grass species,
- nest depth and width,
- vegetation cover based on two Robel pole[3] measurements on opposite sides of each nest, and
- percent cover as estimated by digital photography.

For the latter measurement, fluorescent orange, life-sized silhouettes of the bird species were attached to cover boards and these silhouettes were photographed from either side of a nest. Grouse silhouettes were 36 cm (length from beak to tail) x 13 cm (height); meadowlark silhouettes were 22 x 11 cm; and sparrow silhouettes were 13 x 9 cm. Because Vesper and Savannah sparrows are of a similar size, no differentiation was made between the silhouettes for these two species. The silhouette was centred relative to the nest and the cover board was pushed down to ground level. Digital photos were taken from a distance of 4 m at 1 m height (similar to Robel pole methodology) and computer software (GNU Image Manipulation Program [GIMP]) was used to calculate the percentage of the silhouette obscured by vegetation. The cover boards provided a consistent, unbiased approach for measurement of cover at the nest compared to cover generally available in grazed and ungrazed areas. This method did not attempt to measure behavioural and camouflage response of grassland-nesting birds to predators.

3 A Robel pole is a round pole with evenly spaced and calibrated bands marked on the pole. The pole has been used to measure vegetation screening and density as it relates to avian habitat (Robel et al. 1969). In this experiment, the Robel pole was calibrated with bands every 2.5 cm. The pole was placed in the centre of the nest and an observer recorded the height of the most visible band not obscured by vegetation from a distance of 4 m away from the pole and at 1 m in height.

4.2 *Effect of Clipping to Various Heights on Nest Cover*

To assess the variation in vegetation cover from clipping, or simulated grazing, 50 m straight-line transects were established in 2005 and 2006 on four sites with no livestock grazing (Figure 6; Table 1). The Junction Cabin transect was at the Junction Sheep Range Provincial Park, where grasses were exposed to grazing by bighorn sheep but not domestic livestock. The other three transects at Becher's Prairie were located within fenced exclosures; typically, these are 1 ha in size, protected from domestic grazers, and used by range managers and researchers to assess plant community responses to grazing and rest from grazing.

Table 1. ***Transects used to assess the effect of clipping height on nest cover***

Dominant grass type	Transect	Study area	Year
Bluebunch wheatgrass	Toosey	Becher's Prairie	2005
Bluebunch wheatgrass	Junction Cabin	Junction Sheep Range Provincial Park	2006
Mixed needlegrass	Loran C	Becher's Prairie	2005
Mixed needlegrass	Snake Pit	Becher's Prairie	2005

Twenty-five plots, measuring 0.5 x 0.5 m, were established along each transect. Two dominant grass species represented on the site were identified. Within each plot, the height of the vegetative portion of the plant (stubble height) was measured for each of the dominant grass species found closest to the plot centre. In addition, each bird species silhouette was placed on the far side of the plot relative to the camera and photographed from a distance of 4 m and 1 m height before and after clipping the vegetation in the plots to heights of 25, 20, 15, 10, and 5 cm (Figure 8). Cover was estimated at each clipped height for each bird species silhouette using the GIMP software described in Section 4.1. Cover at nest sites was then compared to cover of clipped and unclipped plots of transects in similar locations and grass types. For example, the cover at a nest found in bluebunch wheatgrass at the Junction Sheep Range Provincial Park was compared to the cover of the Junction Cabin transect.

4.3 *Effect of Grazing on Nest Cover*

Between 2005 and 2011, bird silhouette cover was assessed along eleven 50-m transects at Becher's Prairie,

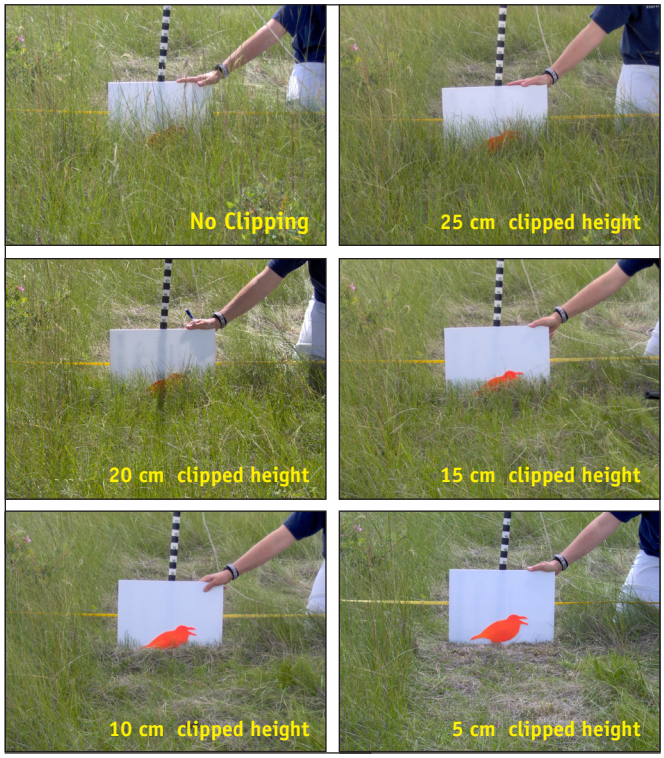

Figure 8. ***Using cover boards to determine the effect of clipping height on percent cover for nesting birds.***

the Junction Sheep Range, and the OK Ranch within pastures exposed to variable levels of livestock grazing (Figures 6–7, Table 2). Some transects were sampled once and others had repeat measurements for multiple years. Cover data, collected from unclipped plots for the same four transects used in the clipping assessment (i.e., Junction Cabin, Toosey, Loran C, and Snake Pit), are included for comparative purposes. Photos of six of the eleven transects are shown in Figure 9.

5.0 DATA SUMMARY AND ASSESSMENTS

5.1 *Nest Cover*

Ten Sharp-tailed Grouse nests were found concealed under the previous year's growth of bluebunch wheatgrass; one nest was in spreading needlegrass. Western Meadowlark nests were usually well hidden under overhanging bluebunch wheatgrass and mixed needlegrass bunches and litter. Forty-eight of 63 Vesper Sparrow nests were concealed at the base of tall overhanging bluebunch wheatgrass, and nests were usually woven from bluebunch wheatgrass leaves. Other Vesper Sparrow nests were found in spreading needlegrass, short-awned porcupinegrass, and

Table 2. ***Cover transects with variable grazing level***

Grass type	Transect name	Location	Grazing level	Year
Bluebunch wheatgrass	Toosey	Becher's Prairie	Exclosure; no grazing	2005
Bluebunch wheatgrass	Racetrack Control	OK Ranch	No grazing	2008, 2010, 2011
Bluebunch wheatgrass	Junction Cabin	Junction Sheep Range Provincial Park	Light grazing; wild sheep	2006
Bluebunch wheatgrass	Junction 2009	Junction Sheep Range Provincial Park	Light grazing; wild sheep	2009
Bluebunch wheatgrass	Separating Lake lek	Becher's Prairie	Moderate; horses in winter	2009, 2010, 2011
Bluebunch wheatgrass	Big Bar South	OK Ranch	Moderate grazing	2008, 2010, 2011
Mixed needlegrass	Loran C	Becher's Prairie	Exclosure; no grazing	2005
Mixed needlegrass	Snake Pit	Becher's Prairie	Exclosure; no grazing	2005
Mixed needlegrass	Sep Lake (north of fence)	Becher's Prairie	Light to moderate grazing	2010, 2011
Mixed needlegrass	Racetrack	OK Ranch	Moderate to heavy	2008, 2010, 2011
Mixed needlegrass	Poison Lake	OK Ranch	Heavy	2008, 2010, 2011

Figure 9. ***Six of the eleven cover transects representing different grazing intensities.***

Kentucky bluegrass. Savannah Sparrow nests in this study were found adjacent to riparian areas, beneath rushes, sedges, and riparian grasses. Table 3 provides a summary of nests by bird species, location, and grass species, and Figure 10 shows photos of some typical nests.

Table 3. ***Nest summary***

Bird species	Nest location	No. nests by nest grass species composition: Bluebunch wheatgrass	No. nests by nest grass species composition: Mixed needlegrass
Sharp-tailed Grouse	Becher's Prairie	2	
	Junction	4	1[a]
	OK Ranch	4	
	Total	**10**	
Western Meadowlark	Junction	1	
	OK Ranch	4	3
	Total	**5**	**3**
Vesper Sparrow	Becher's Prairie	19	11
	Junction	1	
	OK Ranch	22	4
	Kamloops Lac du Bois	6	
	Total	**48**	**15**
Savannah Sparrow	Becher's Prairie	1	
	OK Ranch	2	
	Total	**3**	

[a] Sharp-tailed Grouse nest found in *A. richardsonii* but not included in this analysis.

Repeated short-interval burns (i.e., prescribed burns, escaped prescribed burns, and wildfires) in parts of Becher's Prairie significantly reduced grass cover for a number of years, limiting nesting use by all bird species; consequently, few to no nests were found in recently burned areas.

Figure 10. ***Vegetation cover for Sharp-tailed Grouse, Western Meadowlark, and Vesper Sparrow nests with nestlings.***

The majority of birds, regardless of species, exhibited non-random nest-site selection and preferred nest sites in bluebunch wheatgrass and needlegrass that provided 90–100% cover (Figure 11). Minimum cover for nest selection was 85, 67, and 62% for Sharp-tailed Grouse, Western Meadowlark, and Vesper/Savannah sparrows, respectively.

5.2 *Effect of Clipping to Various Heights on Nest Cover*

The Junction Cabin transect was dominated by bluebunch wheatgrass and junegrass. The Toosey transect was dominated by bluebunch wheatgrass, junegrass, and Rocky Mountain fescue. The Loran C and the Snake Pit transects both had a mix of short-awned porcupinegrass, Kentucky bluegrass, and spreading needlegrass. With the exception of the Junction Cabin transect, unclipped grasses provided good nesting cover, with average cover greater than 90% for Sharp-tailed Grouse, Western Meadowlark, and Vesper/Savannah sparrows (Table 4). The average height of unclipped grass at the four transects was 34–42 cm. Unclipped grasses were slightly shorter along the Junction Cabin transect, but the most striking aspect of this site was the high variability in percent cover for all the bird species silhouettes. The average cover at the Junction Cabin was less than the average cover for the other three transects.

Analysis of variance (ANOVA) results showed a significant effect of clipped height and transect location on percent cover of Sharp-tailed Grouse, Western Meadowlark, and Vesper/Savannah sparrow silhouettes (Table 5). Interaction between clipped height and transect location

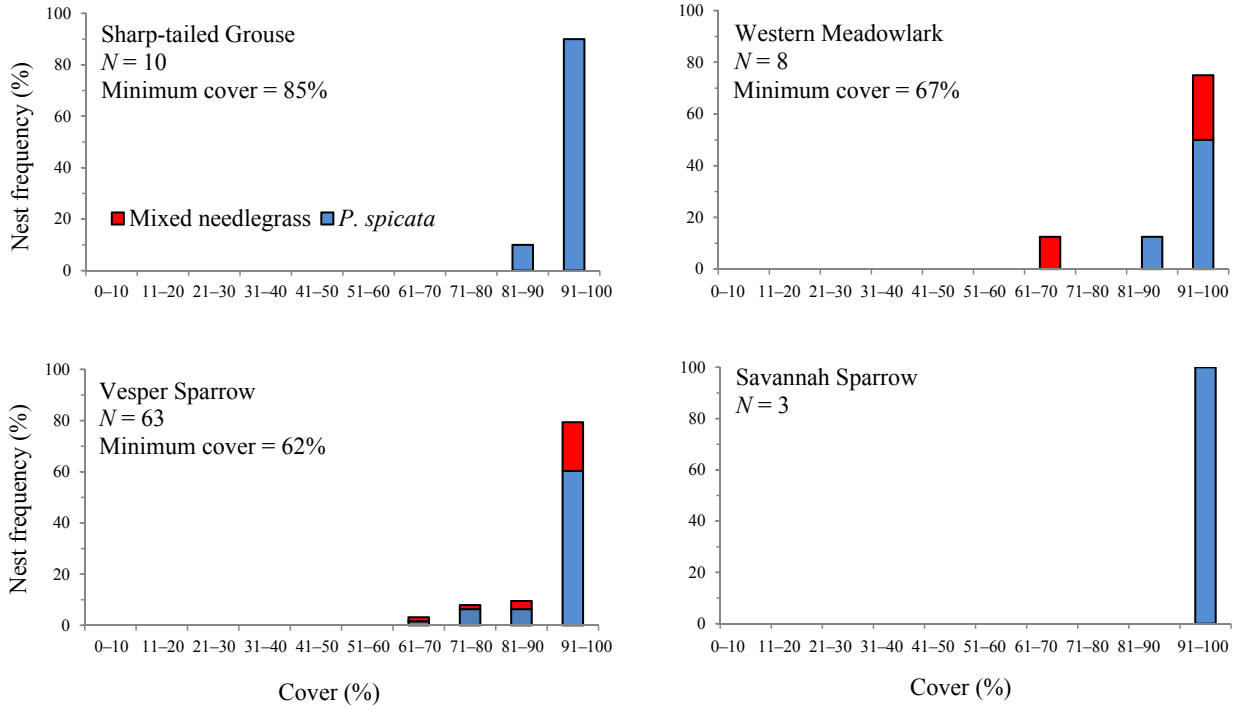

Figure 11. ***Frequency distributions for percent nest cover by bird species and dominant grass species.***

Table 4. *Dominant native grass species, average unclipped grass height, and average percent cover for the various bird species silhouettes*

Transect	Dominant grass species	Average height (cm) unclipped	Average cover (%) (± 95% CI)		
			Sharp-tailed Grouse	Western Meadowlark	Sparrow
Junction Cabin	Bluebunch wheatgrass	34	74 (9)	77 (10)	83 (8)
Toosey	Bluebunch wheatgrass	37	96 (2)	97 (1)	99 (1)
Loran C	Mixed needlegrass	39	91 (3)	94 (3)	98 (1)
Snake Pit	Mixed needlegrass	42	92 (2)	93 (2)	98 (1)

Table 5. *ANOVA results for clipped height and transect location*

	Source of variation	Sum of squares	df	*F*	*P*-value
Sharp-tailed Grouse	Clipped Height	265609	4	472.86	> 0.0001
	Transects	24678	3	58.58	> 0.0001
	Clipped Height x Transect	4271	12	2.53	0.003
	Within[a]	67404	480		
Western Meadowlark	Clipped Height	318213	4	423.70	> 0.0001
	Transects	17610	3	31.26	> 0.0001
	Clipped Height x Transect	6146	12	2.73	0.0014
	Within[a]	90125	480		
Sparrow	Clipped Height	255413	4	309.23	>0.0001
	Transects	36098	3	58.27	>0.0001
	Clipped Height x Transect	2132	12	0.86	0.5877
	Within[a]	99114	480		

[a] There is substantial variation that cannot be explained by either clipped height or transect location. This variation might be related to differences in vegetation and litter between each plot.

Table 6. *Correlation coefficient between clipped grass height and percent cover for the various bird species silhouettes*

Transect	Correlation coefficient (*r*)		
	Sharp-tailed Grouse	Western Meadowlark	Sparrow
Junction Cabin	0.74	0.70	0.68
Toosey	0.92	0.92	0.89
Loran C	0.92	0.93	0.94
Snake Pit	0.95	0.93	0.92

was significant for Sharp-tailed Grouse and Western Meadowlark cover. The correlation coefficients were moderate to very strong (r > 0.68) between clipped grass height and percent cover, and showed that cover improved with increasing grass height (Table 6). At most clipped heights, cover was significantly greater at the Toosey, Loran C, and Snake Pit transects compared to Junction Cabin (Table 7), although for Sharp-tailed Grouse and Western Meadowlark cover, the significant interaction between the two main effects showed these differences were less predictable at intermediate clipped heights. Since average cover was similar at the Toosey, Loran C, and Snake Pit transects, the data from these transects were combined for Table 8.

Table 8 shows the percentage of transect plots that provided minimum and preferred nest cover for each bird species at unclipped and clipped heights. Minimum cover is the lowest level of cover measured at a nest site. These were 85%, 67%, and 62% for Sharp-tailed Grouse, Western Meadowlark, and Vesper/Savannah sparrows, respectively. Preferred cover is the nest cover selected most often and is usually greater than 90% cover for all three bird species. The Junction Cabin transect, with approximately 25 plots per transect, is shown separately.

Table 7. *Average percent cover for the three bird silhouettes at each transect and clipped height*

		Clipped height (cm)[a]				
Bird Species	**Transect**	**5**	**10**	**15**	**20**	**25**
Sharp-tailed Grouse	Loran C	17 a	34 ab	57 ab	78 a	86 a
	Toosey	21 a	38 a	60 a	76 a	86 a
	Snake Pit	20 a	31 b	48 bc	70 a	83 a
	Junction	12 b	23 c	39 c	54 b	64 b
Western Meadowlark	Loran C	15 b	37 a	66 a	85 a	89 a
	Toosey	19 a	38 a	64 ab	79 ab	89 a
	Snake Pit	16 ab	30 a	53 bc	75 b	86 a
	Junction	13 b	29 a	47 c	59 c	70 b
Vesper & Savannah Sparrow	Loran C	33 a	64 a	90 a	95 a	96 a
	Toosey	33 a	63 a	83 a	88 a	95 a
	Snake Pit	38 a	57 a	82 a	93 a	95 a
	Junction	17 b	42 b	62 b	74 b	76 b

[a] Different letters for a given clipped height show statistically significant differences in percent cover by transect; for example, at the 5, 20, and 25 cm clipped heights, Sharp-tailed Grouse cover was similar at the Loran C, Toosey, and Snake Pit sites but was significantly lower at the Junction site.

Table 8. *Percentage of transect plots that provided minimum and preferred nest cover at various clipped heights*

		Junction Cabin transect			Toosey, Loran C, Snake Pit transects		
	Clipped height (cm)	***N***	**% of plots with minimum cover**	**% of plots with preferred cover**	***N***	**% of plots with minimum cover**	**% of plots with preferred cover**
Sharp-tailed Grouse	Unclipped	24	50	17	75	89	81
	5	24	0	0	74	0	0
	10	25	0	0	75	0	0
	15	25	0	0	76	0	0
	20	25	8	4	76	22	11
	25	24	21	8	72	58	35
Western Meadowlark	Unclipped	25	72	52	76	100	83
	5	24	0	0	74	0	0
	10	25	0	0	75	0	0
	15	25	28	4	75	35	3
	20	24	46	8	75	88	21
	25	24	63	25	74	97	53
Vesper and Savannah Sparrow	Unclipped	25	76	56	76	100	99
	5	23	0	0	74	0	0
	10	25	16	4	76	51	1
	15	25	52	20	76	100	43
	20	25	72	36	76	99	68
	25	24	75	42	75	100	85

Most (89%) of the unclipped plots at the Toosey, Loran C, and Snake Pit transects provided minimum cover for Sharp-tailed Grouse, and all of the unclipped plots provided minimum cover for Western Meadowlark and Vesper and Savannah sparrows (Table 8). More than 80% (81%, 83%, and 99% for Sharp-tailed Grouse, Western Meadowlark, and Vesper/Savannah sparrows, respectively) of unclipped plots also met the preferred level of cover for all bird species.

At the Toosey, Loran C, and Snake Pit transects, about one-half of the plots with 25 cm clipped height provided greater than or equal to the minimum cover for Sharp-tailed Grouse (85% cover), but only about one-third of the plots met the preferred level of cover (Table 8). For Western Meadowlark, the majority of plots with 25 cm stubble provided minimum cover, whereas about one-half of plots had a preferred level of cover. All plots with 20 cm stubble provided minimum cover for Vesper/Savannah sparrows and approximately two-thirds of the plots provided preferred cover.

At Junction Cabin, one-half of the unclipped plots met the minimum cover for Sharp-tailed Grouse and three-quarters of the unclipped plots met minimum cover for both Western Meadowlark and Vesper/Savannah sparrows. Only 17% of the unclipped plots met the preferred level of cover for Sharp-tailed Grouse and one-half of the unclipped plots met the preferred level of cover for Western Meadowlark and Vesper/Savannah sparrows.

5.3 *Results for Sharp-tailed Grouse*

Average silhouette cover at the 25, 20, 15, 10, and 5 cm clipped grass height, plus the cover of unclipped plots, was plotted for each bird species. At the Toosey, Loran C, and Snake Pit transects, grass needed to be greater than 25 cm tall to produce average cover of at least 90%, the preferred nest cover for Sharp-tailed Grouse. At the Junction transect, the 25 cm clipped plots did not meet the preferred nest cover. Preferred nest cover (90%) at the Junction Sheep Range Provincial Park was only achieved at greater than 30 cm grass height (Figure 12).

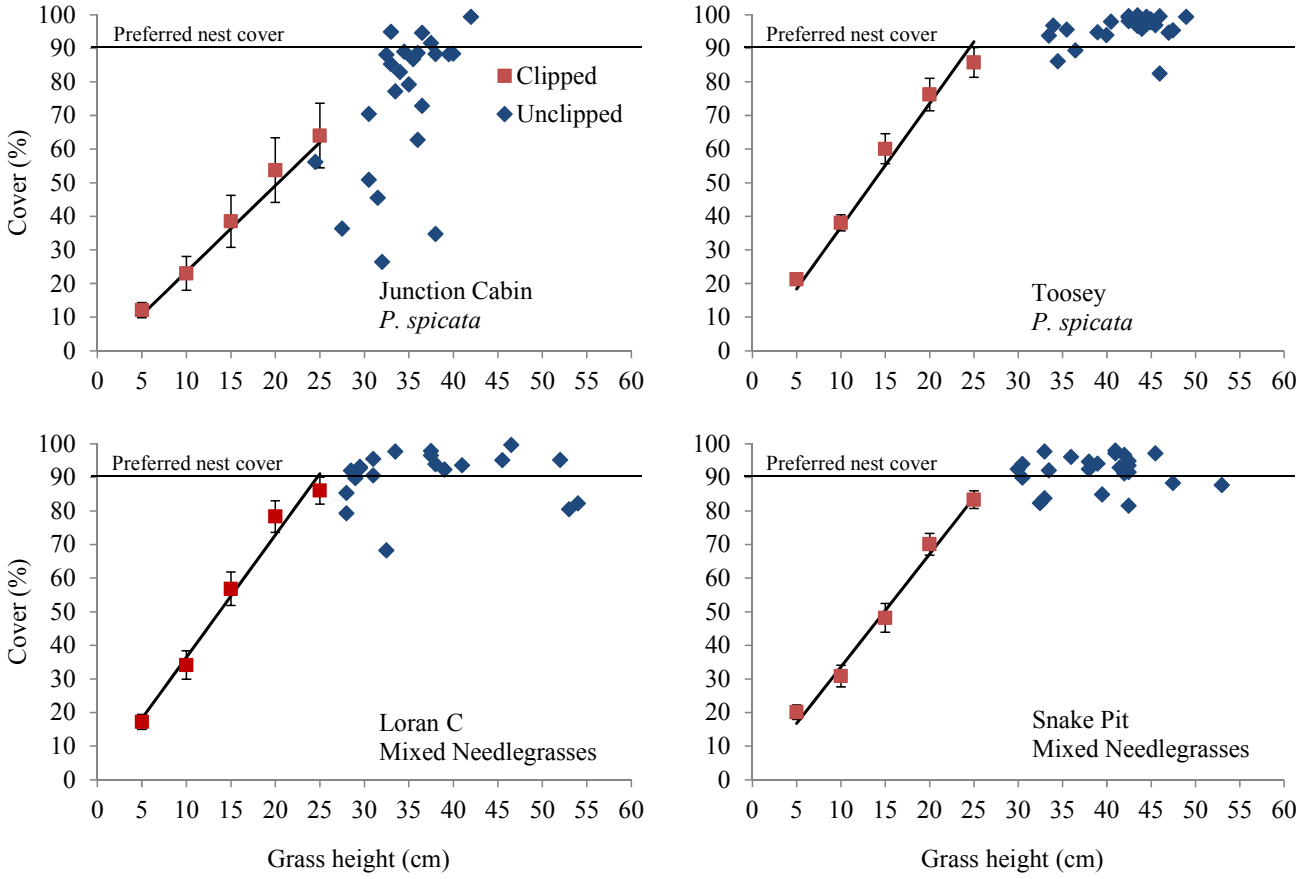

Figure 12. ***Average Sharp-tailed Grouse silhouette cover when grass is clipped versus unclipped (error bars show 95% confidence interval).***

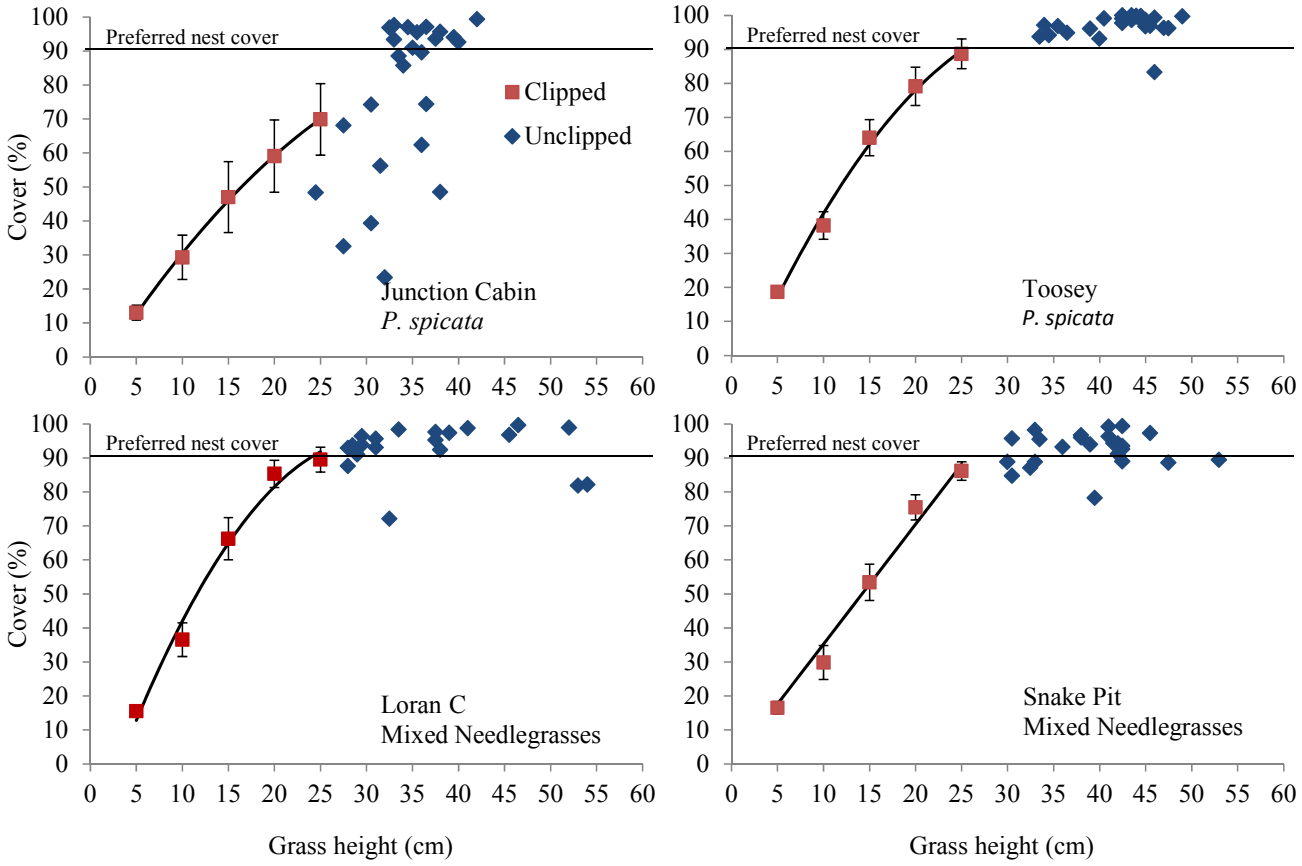

Figure 13. ***Average Western Meadowlark silhouette cover when grass is clipped versus unclipped (error bars show 95% confidence interval).***

At the Junction Cabin transect, the variability in percent cover was high for any given clipped height and the correlation between grass height and percent cover was lower at this site compared to the other sites (Table 6). At Toosey, Loran C, and Snake Pit transects, the correlation coefficients were very strong ($r > 0.90$) between clipped grass height and percent cover for the Sharp-tailed Grouse silhouette.

5.4 Results for Western Meadowlark

For the Western Meadowlark silhouettes, clipped grass height at the Junction Cabin transect showed a moderately strong ($r = 0.70$) curvilinear relationship with percent cover (Table 6). Preferred nest cover was achieved at greater than 30 cm grass height (Figure 13). At the Toosey, Loran C, and Snake Pit transects, the Western Meadowlark silhouette was, on average, 90% obscured when grasses were clipped to 25 cm. For these three transects, variation in percent cover was relatively low, and the relationship between clipped height and cover was strong ($r > 0.90$).

5.5 Results for Vesper Sparrow

For Vesper Sparrow silhouettes, the relationship between grass height and percent cover was curvilinear at the Junction Cabin transect (Figure 14). The data suggest that increasing the clipped height above 25 cm would not yield further improvements in cover; however, unclipped plots met preferred cover at greater than 30 cm. On the other three sites, average cover was approximately 90% when grasses were clipped to 20 cm.

5.6 Effect of Grazing on Nest Cover

The eleven transects used in this comparison were in two different grassland types—bluebunch wheatgrass and mixed needlegrass. Exposure to grazing intensity varied at each site and is quantified in Table 2 as "none," "light," "moderate," or "heavy." For the OK Ranch transects, domestic livestock had been excluded from the Racetrack Control pasture for approximately 15 years, except for occasional and light grazing use when the animals

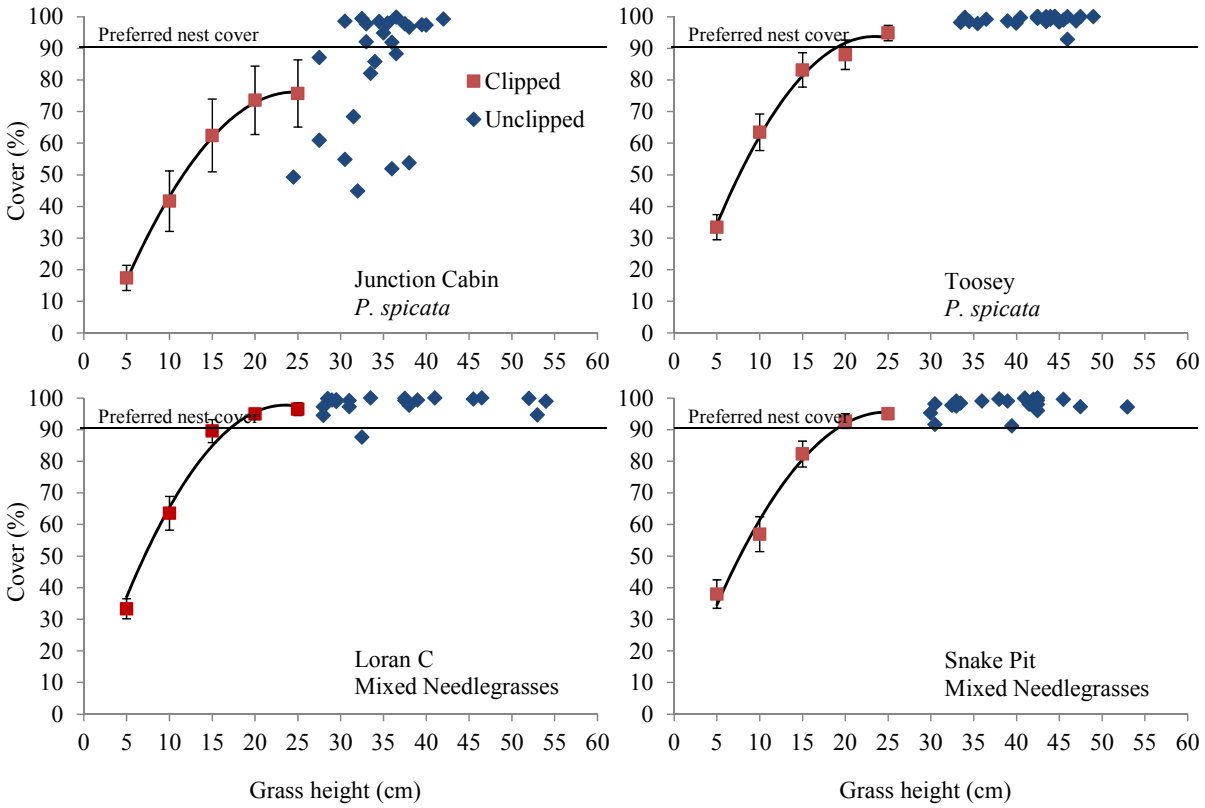

Figure 14. ***Average Vesper Sparrow silhouette cover when grass is clipped versus unclipped (error bars show 95% confidence interval).***

passed through the area to other pastures. This pasture is in mid-seral condition and shows an increase in bluebunch wheatgrass cover since livestock grazing was excluded. The Big Bar South pasture, a higher-elevation grassland opening surrounded by open forest, was exposed to light to moderate levels of grazing, with bluebunch wheatgrass and spreading needlegrass dominating the site. The Racetrack pasture was moderately to heavily grazed, which resulted in a greater abundance of spreading needlegrass, Kentucky bluegrass, and scattered bluebunch wheatgrass. Poison Lake was the most heavily grazed pasture; junegrass, Kentucky bluegrass, and needle-and-thread grass were the predominant grass species in this pasture.

At the Junction Sheep Range Provincial Park, both the Junction Cabin transect and the Junction 2009 transect were dominated by bluebunch wheatgrass. These transects were in a provincial park with no livestock grazing but with light grazing by California Bighorn Sheep.

The dominant grasses at Becher's Prairie at the Separating Lake N transect were porcupinegrass and spreading needlegrass, which are not preferred livestock forage species. Bluebunch wheatgrass was sparsely intermixed with junegrass, Kentucky bluegrass, and various forb species at the Separating Lake lek transect. Here, overwintering horses had grazed the area for several years and the condition of this pasture appears to be declining. The other Becher's Prairie transects (Toosey, Loran C, and Snake Pit) are all in exclosures and therefore ungrazed by livestock.

Grazing intensity created significant differences in bird cover between sites (Figure 15). At the Racetrack Control transect, which had little to no livestock grazing, average Sharp-tailed Grouse cover was high (78–94%), with relatively little variation within years, especially in 2011. During this latter year, the majority (84%) of plots had more than 90% cover for the larger Sharp-tailed Grouse and Western Meadowlark (Table 9). Similarly, the average cover of ungrazed exclosures was greater than 90%.

Light grazing at the Junction 2009 and Junction Cabin transects and light to moderate grazing at Separating Lakes (north of fence) produced mixed results. At the Junction 2009 transect, average cover was high for Sharp-tailed Grouse (87%), Western Meadowlark (90%), and Vesper Sparrow (96%), and a relatively high number of plots at this site (60–90%) met the preferred cover for all

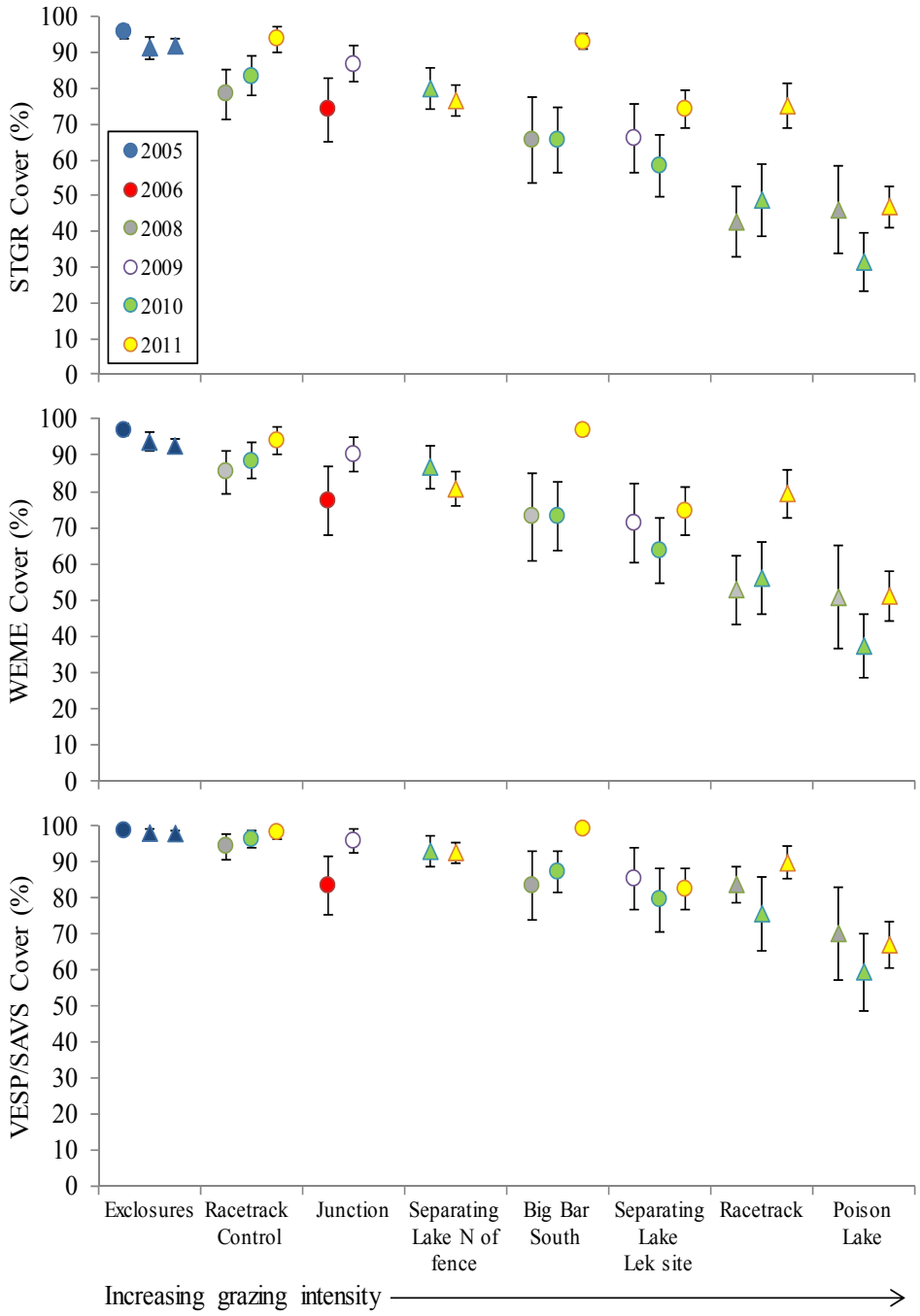

Figure 15. ***The effect of variable levels of grazing on average silhouette cover between 2005 and 2011 for Sharp-tailed Grouse (STGR; top), Western Meadowlark (WEME; centre), and Vesper/Savannah sparrows (VESP/SAVS; bottom). Circles indicate sites dominated by bluebunch wheatgrass, triangles show sites dominated by mixed needlegrass. Error bars are 95% confidence intervals.***

three bird species. The Junction Cabin site had average cover between 74% and 83%, where one-half of the plots met preferred cover for Western Meadowlark and Vesper Sparrow but only 17% of the plots met preferred cover for Sharp-tailed Grouse. The light to moderately grazed Separating Lake N transect had slightly lower average cover for all three bird species—Sharp-tailed Grouse (77–80%), Western Meadowlark (81–87%), and Vesper Sparrow (93%)—and fewer plots met the preferred level of cover (Tables 9–10).

Table 9. ***The effect of dominant grass species and variable levels of grazing on average silhouette cover between 2005 and 2011***

Dominant grass species	Transect	Grazing level	Year	Average cover (%)[a]		
				Sharp-tailed Grouse	Western Meadowlark	Vesper/ Savannah sparrows
Bluebunch wheatgrass	Toosey	Exclosure; no grazing	2005	96 (2)	97 (1)	99 (1)
	Race Track Control	No grazing	2008	78 (7)	85 (6)	94 (4)
			2010	83 (5)	89 (5)	96 (2)
			2011	94 (4)	94 (4)	98 (2)
	Junction Cabin	No livestock; wild sheep	2006	74 (9)	77 (10)	83 (8)
	Junction 2009	No livestock; wild sheep	2009	87 (5)	90 (5)	96 (3)
	Big Bar South	Moderate	2008	66 (12)	73 (12)	83 (10)
			2010	66 (9)	73 (10)	87 (6)
			2011	93 (2)	97 (1)	99 (1)
	Sep Lake Lek Site	Moderate	2009	66 (10)	71 (11)	85 (8)
			2010	58 (9)	64 (9)	80 (9)
			2011	74 (5)	75 (7)	83 (6)
Mixed needlegrass	Loran C	Exclosure; no grazing	2005	91 (3)	94 (3)	98 (1)
	Snake Pit	Exclosure; no grazing	2005	92 (2)	93 (2)	98 (1)
	Sep Lake N of fence	Light to moderate	2010	80 (6)	87 (6)	93 (4)
			2011	77 (4)	81 (5)	93 (3)
	Race Track	Moderate to heavy	2008	43 (10)	53 (9)	84 (5)
			2010	49 (10)	56 (10)	76 (10)
			2011	75 (6)	79 (7)	90 (5)
	Poison Lake	Heavy	2008	46 (12)	51 (14)	70 (13)
			2010	31 (8)	37 (9)	59 (11)
			2011	47 (6)	51 (7)	67 (7)

[a] Numbers in brackets are 95% confidence intervals.

The moderately grazed Big Bar South site had average cover for Sharp-tailed Grouse (66%), Western Meadowlark (73%), and Vesper Sparrow (83–87%), which was similar in 2008 and 2010. Average cover increased for all three bird species in 2011 (93–99%). The number of plots at Big Bar South meeting preferred cover was also fewer in 2008 and 2010 than in 2011 for all three bird species.

In 2008 and 2010, moderate to heavy grazing at the Racetrack resulted in lower average cover for Sharp-tailed Grouse (43–49%) and Western Meadowlark (53–56%) and few plots that met the preferred nest cover (8–12%). In 2011, average cover improved for Sharp-tailed Grouse (75%), Western Meadowlark (79%), and Vesper Sparrow (90%), although the number of plots that met the preferred level of cover was still low, especially for the larger birds.

Although the Sharp-tailed Grouse lek site at Separating Lakes was not grazed by livestock during the growing season, horses had overwintered in the pasture for the last few years and this may have contributed to a decline in the nesting habitat at this site. Bluebunch wheatgrass clumps were sparsely distributed in a mix of other grasses and forbs, and few plots (only 24% in 2009 and none in 2010 and 2011) had sufficient cover for Sharp-tailed Grouse, despite a nearby lek site. Only one Sharp-tailed Grouse nest was found in this area in 2011, but successful use of this nest could not be confirmed. Vesper Sparrows continued to nest in this area, although the number of plots meeting preferred cover for the smaller bird was only 36% in 2010 and 2011.

On the most heavily grazed site at Poison Lake, average cover for Sharp-tailed Grouse in 2008, 2010, and 2011 was

Table 10. ***The effect of dominant grass species and variable levels of grazing on nests and the percentage of transect plots that provided minimum cover and preferred cover***

Transect	Grazing Level	Nests	Year	Sharp-tailed Grouse		Western Meadowlark		Vesper/ Savannah sparrows	
				Min. (%)	Prefer (%)	Min. (%)	Prefer (%)	Min. (%)	Prefer (%)
Bluebunch wheatgrass dominated sites									
Toosey	Exclosure		2005	96	88	100	96	100	100
Race Track Control	No grazing	Sharp-tailed Grouse Western Meadowlark Vesper/Savannah sparrows	2008	42	33	88	48	100	84
			2010	48	48	92	52	100	88
			2011	88	84	96	84	100	96
Junction Cabin	Wild sheep		2006	50	17	72	52	76	56
Junction 2009	Wild Sheep	Sharp-tailed Grouse	2009	72	60	96	64	100	92
Big Bar South	Moderate	Sharp-tailed Grouse Western Meadowlark Vesper/Savannah sparrows	2008	36	24	67	46	80	60
			2010	28	16	60	32	96	60
			2011	92	68	100	96	100	100
Separating Lake Lek Site	Moderate	Sharp-tailed Grouse Vesper/Savannah sparrows	2009	28	24	64	32	80	60
			2010	8	0	56	4	88	36
			2011	20	0	64	16	84	36
Mixed needlegrass dominated sites									
Loran C	Exclosure		2005	84	80	100	85	100	96
Snake Pit	Exclosure		2005	88	76	100	68	100	100
Separating Lake N of fence	Light to moderate	Vesper/Savannah sparrows	2010	36	28	88	48	100	80
			2011	24	16	88	28	100	76
Race Track	Moderate to heavy	Western Meadowlark Vesper/Savannah sparrows	2008	12	12	28	12	96	40
			2010	13	8	33	8	83	46
			2011	36	16	68	36	96	56
Poison Lake	Heavy	Western Meadowlark Vesper/Savannah sparrows	2008	8	0	46	17	64	48
			2010	0	0	12	0	52	16
			2011	0	0	20	0	60	0

only 31–47%, with relatively high variability within years. Only a few plots (8%) at Poison Lake met the minimum cover requirements in 2008, while none met the preferred level of cover for Sharp-tailed Grouse, which probably accounts for the lack of Sharp-tailed Grouse nests located in the area.

Sharp-tailed Grouse nests became increasingly rare with reduced cover from more intensive grazing. Sharp-tailed Grouse nests were located only on ungrazed and lightly to moderately grazed pastures, where average cover of transects was 65–94% (Table 9). They were absent in moderately to heavily grazed areas where average cover was as low as 31–43% in some years and fewer than 12% of plots provided a minimum level of cover. On the other hand, all sites had some Western Meadowlark and Vesper Sparrow nests.

More intensive grazing also correlated with increased dominance of Kentucky bluegrass, spreading needlegrass, needle-and-thread grass, and junegrass, and reduced dominance of bluebunch wheatgrass. These grass types are shorter and less dense than bluebunch wheatgrass and porcupinegrass, and may provide less cover for grassland-nesting birds.

6.0 DISCUSSION AND MANAGEMENT IMPLICATIONS

6.1 *Cover at Nest Sites*

The grassland-nesting birds (Sharp-tailed Grouse, Western Meadowlark, and Vesper and Savannah sparrows) exhibited non-random nest site selection and chose areas where native bluebunch wheatgrass and needlegrass provided cover that usually exceeded 90% at the nest site. This measure was acknowledged as an underestimate of cover, given nests were sometimes in a depression 2.5–5 cm deep and a real bird would further avoid detection through camouflage and behaviour. A few nested in grass that provided as little as 65% cover. These results agree with those of Fondell and Ball (2004) who found high nest density where vegetation provided excellent cover for various ground-nesting grassland bird species.

Sharp-tailed Grouse, Western Meadowlark, and Vesper Sparrow showed a preference for nesting in bluebunch wheatgrass over other available grass species.

Although we collected some nest success data as part of this study, we do not present it here because the sample size was insufficient to report results; however, we observed that where nests occurred in pasture areas where the density of bluebunch wheatgrass plants was low these nests were often predated and not successful. The findings of this study indicate that grazing management practices that maintain high levels of residual cover before nesting, as well as high cover during the nesting period, would benefit grassland-nesting birds. In addition, grazing practices that result in an increase in density of bluebunch wheatgrass would also improve nesting opportunity.

6.2 *Effect of Clipped Height on Bird Cover*

Grass clipped heights between 5 and 25 cm had a pronounced effect on bird silhouette cover along transects located within exclosures where grasslands were relatively healthy. The majority of Sharp-tailed Grouse prefer nest sites with more than 90% cover; however, within the Toosey, Loran C, and Snake Pit exclosures even the tallest clipping height of 25 cm provided insufficient cover on average. On the other hand, most plots had adequate cover when unclipped grasses were at least 30 cm tall. These findings are comparable to previous recommendations, which suggested the best nesting cover for Sharp-tailed Grouse was in residual grasses with a minimum height of 25 cm (Ritcey and Jury 2004). For Western Meadowlark, more than one-half of plots within the exclosures had met the preferred nest cover when clipped heights were 25 cm, whereas for the smaller Vesper Sparrow, 90% cover could be achieved when grass height was clipped to 20 cm.

Fewer plots met the preferred level of cover at the Junction Cabin transect. The higher variability of this transect may reflect more sparsely dispersed grass clumps and (or) less biomass related to drier site conditions. Although relatively few plots at the Junction Cabin provided optimal cover for nesting Sharp-tailed Grouse, the birds continued to breed on the Junction grasslands after selecting well-concealed nesting sites in areas of higher cover. For example, Sharp-tailed Grouse nests were found in proximity to the Junction 2009 transect, which had average cover of 87% in that year.

To ensure recovery and continued root growth of grazed native bunchgrasses, Fraser (2003b) recommended removing cattle from rangeland when the average stubble heights of bluebunch wheatgrass and needlegrass are 15 and 12 cm, respectively. While following these recommendations may maintain the vitality of the grasses, clipped heights of 15 cm in this study provided only about 50% cover for Sharp-tailed Grouse, suggesting that these birds are less likely to nest in such short grass. Stubble heights of 15 cm may also be too short for Western Meadowlark, given that fewer than 35% of plots clipped to this height provided minimum cover and less than 3% of plots had preferred nest cover (> 90% cover). Nevertheless, since 100% of plots met minimum cover and 43% of plots met the preferred level of cover, a 15-cm stubble height may be adequate for the smaller nesting Vesper and Savannah sparrows.

Measures of stubble height are usually averaged across pastures where livestock have typically grazed plants to variable heights. A pasture meeting a stubble height requirement of 15 cm may retain patches of taller grasses, which could provide some suitable nest sites for the smaller Vesper Sparrow; however, 15 cm is not sufficient to provide adequate nest cover for the larger Western Meadowlark and Sharp-tailed Grouse. As the average stubble height of grazed grasslands approaches the preferred height of vegetation at the nest (generally 20 cm for Vesper Sparrow and greater than 25–30 cm for Sharp-tailed Grouse and Western Meadowlark), the density of potential suitable nest sites should increase.

6.3 *Effect of Grazing on Nesting Cover*

Variation in cover (i.e., when multiple years of data were available for the same pasture) could have resulted from changes in grazing patterns as well as annual variation in weather affecting plant growth and yield. The lack of livestock grazing at the Toosey, Loran C, and Snake Pit exclosures and along the Racetrack Control and the Junction 2009 transects resulted in grasslands that provided relatively high levels of vegetative cover, with a greater number of plots meeting the preferred nesting cover for all bird species compared to transects in grazed pastures. Moreover, although the data was circumstantial, relatively wet growing seasons further increased average cover and decreased variability in cover within an area.

Average vegetation cover decreased and variability increased when pastures were lightly to moderately grazed, such as Big Bar South and Separating Lakes (north of fence). Even though lightly and moderately grazed pastures may have had average cover that fell short of the preferred nest cover levels some years, these pastures retained a significant number of plots that continued to meet the preferred nest cover level. Light to moderate grazing is often prescribed by range practitioners to maintain or improve range condition. Grazing at this level also appears less detrimental to grassland-nesting birds.

As grazing intensity increased from moderate to heavy in the Racetrack and Poison Lake pastures, vegetation cover was further reduced and increasingly variable across the sites. Few areas at these two sites provided sufficient nesting cover for the larger Sharp-tailed Grouse and their nests were not evident. A similar situation is also likely to occur at the Separating Lake lek site where overwintering horses have caused degradation of the grasslands and a steady reduction in sites providing adequate nesting cover for Sharp-tailed Grouse. Only one Sharp-tailed Grouse nest was found in this area in 2011. The smaller Vesper Sparrow has continued to nest in both moderate and heavily grazed areas; however, as grazing intensity increased, the availability of preferred nest cover declined. Western Meadowlark nests were found in the Racetrack pasture and in one location in the Poison Lake pasture where nest cover was higher.

Heavy grazing affects plant communities. As grazers remove the preferred plant species and these are replaced with less preferred non-native species, available grassland-nesting cover and grassland productivity declines. Avoiding heavy use appears beneficial to livestock producers and grassland-nesting birds.

6.4 *Effect of Weather*

The 2008–2011 Williams Lake Environment Canada weather station data showed 2008 had the most consistent precipitation during the growing season, but early spring (March and April) and summer temperatures were higher in 2010 (Figure 16). Summer 2009 was warmer than the other years and rainfall was consistent, with the exception of a dry period in August. Spring 2011 temperatures were average, but temperatures remained below average throughout the summer, with higher than normal precipitation.

At the OK Ranch, percent cover for the bird species showed year-to-year variation that likely resulted from the confounding effects of grazing intensity and environmental conditions. Annual changes in grazing

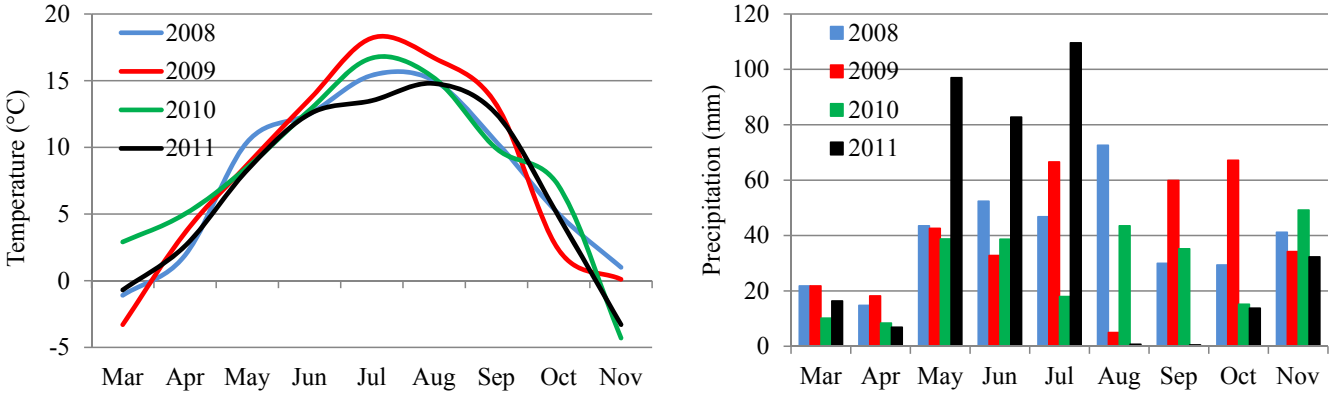

Figure 16. ***Average monthly temperature and total monthly precipitation at Williams Lake (Environment Canada website).***

practices were not recorded for this study; however, growing season temperature and precipitation appeared to have an effect on cover. For example, within a site, average cover was similar for 2008 and 2010, which may reflect the fact that one year was warmer but the other had more precipitation (Figure 16). In 2011, average cover increased and variability decreased on ungrazed (Racetrack Control) and moderately grazed (Big Bar South) sites; a change that may be related to increased summer precipitation. The apparent effect of increased precipitation on the moderate to heavily grazed site (Racetrack) resulted in higher average cover in 2011, whereas the heavily grazed site (Poison Lake) showed no increase in average cover but reduced within-year variability.

At Becher's Prairie and the Junction Sheep Range Provincial Park, year-to-year variation in cover was less apparent.

7.0 RECOMMENDATIONS TO MAINTAIN OR IMPROVE HABITAT FOR GRASSLAND-NESTING BIRDS

Improving range condition and health has benefits for grassland-nesting birds and also enhances the quality and production of native grasses, which has benefits for livestock producers. Some suggested practices and research findings that would maintain or improve grassland-nesting bird habitat are presented here for consideration.

7.1 *Restore Native Bluebunch Wheatgrass Ecosystems*

In this study, bluebunch wheatgrass was preferentially selected by grassland-nesting birds for nesting habitat. This grass type is often in poor (early seral) condition, owing to current and historic grazing practices. Livestock preferentially select this highly nutritious bunchgrass type over other grass species and therefore over time it decreases in abundance. To restore this grassland type often requires a change in grazing management. Spring grazing should occur no more than one out of three years and no more than 40% utilization should occur during rapid growth. Heavy early spring grazing is especially damaging and grazing should be delayed until at least mid-boot stage (Ogle et al. 2010). Consider implementing rotational use of pastures with periods of rest from grazing, limiting the impacts of defoliation during times when the plants are more sensitive to leaf loss through proper timing of livestock use, and reducing livestock use to match levels that pastures can support. In arid and semiarid areas, Holechek et al (1999) concluded that long-term grazing studies convincingly show that moderate (40–45%) use on most rangelands allows the palatable species to maintain themselves and that light (less than 30%) to conservative (30–35%) use is needed for improvement in rangeland vegetation.

7.2 *Maintain Adequate Stubble Height of Native Bunchgrass Species*

In early spring, when cover provided by new grass growth is limited, Sharp-tailed Grouse and other grassland-nesting birds conceal nests under dried standing bunchgrass plants and leaf litter carried over from the previous year. Inadequate height and density of this residual cover reduces the availability and quality of nesting habitat and increases susceptibility of nesting birds to predators. Managing livestock grazing to encourage and optimize residual cover of tall native bunchgrasses is fundamental to improving habitat for grassland-nesting birds.

Maintaining taller stubble heights for native bunchgrasses, such as bluebunch wheatgrass and needlegrass, will increase availability of potential nesting sites with good cover. Recommended stubble heights are ≥25–30 cm, ≥25–30 cm, and ≥15–20 cm for Sharp-tailed Grouse, Western Meadowlark, and Vesper Sparrow, respectively. In the drier Bunchgrass biogeoclimatic zone, stubble height values at the high end of these ranges and above are recommended to achieve the preferred nest cover of 90%. Achieving the taller stubble heights (≥25–30 cm) on all grassland areas, while continuing to graze livestock, may be challenging for livestock producers.

In areas of higher precipitation and in wet years, it may be possible to lightly graze native bunchgrass with livestock in late spring or early summer and still achieve the taller stubble heights by the end of the growing period once re-growth has occurred; however, in drier areas, regrowth may be restricted and other strategies may be necessary to provide some areas with residual tall bunchgrass. This may be accomplished by identifying areas where Sharp-tailed Grouse and Western Meadowlark nest and reducing livestock use in these areas. Reducing stocking rates creates variable livestock use, leaving some grass within pastures ungrazed, or lightly grazed. Maintaining light to conservative livestock utilization levels not only benefits the health of the grasslands but can provide more nesting opportunities.

7.3 Plan Timing of Livestock Use

Grazing may be deferred until late spring or early summer to avoid overlapping with the nesting period. This strategy will prevent livestock disturbing nests and allow grasses to grow tall enough to provide good cover.

Rest rotation and deferred grazing systems are beneficial to most game bird species because these systems provide pastures free from disturbance during the nesting and other critical seasons. Nevertheless, this benefit may be offset if heavy use occurs in the grazed pastures (Holechek et al. 1982). When three or more pastures are available, rotational grazing systems can provide more options and greater opportunity to rest some pastures from grazing in the spring and fall across multiple years. For example, with a four-pasture system, each pasture can be rested once every 4 years for an entire year, while the other three pastures can be grazed by livestock sequentially in the spring, summer, or fall. With this system, seasonal use of a pasture occurs only once in 4 years. As long as stocking rates in each pasture continue to be conservative, this system can be beneficial to most grassland-nesting birds.

Avoid grazing in spring and fall of the same year (Range Branch 2011) and provide adequate rest after grazing to help maintain the vigour and overall productivity of native grasses. Native bunchgrasses may require as much as 120 growing days or an entire growing season to recover from grazing (Fraser 2003a).

Use leaf stage to determine range readiness of native grasslands before turning out livestock on pastures in the spring. This can help ensure grasses have sufficient leaf area to recover from grazing, thereby minimizing the risk of over-utilization of the rangeland. On native range, Fraser (2003a) recommended using 4.0 or 4.5 leaves per tiller on over 70% of plants as an indication of range readiness.

Avoiding grazing during drought periods is particularly important for maintaining grassland health because lack of soil moisture prevents regrowth of defoliated grasses (Burkhardt and Sanders 2010).

Riparian areas can provide critical overwintering habitat for Sharp-tailed Grouse (Powell et al. 2000). To maintain riparian shrub plant communities, avoid livestock grazing in riparian areas in the fall when grass and forbs becomes less available and less palatable. Salting at least 500 m away from riparian areas is a good practice, which can help draw livestock away from these areas.

7.4 Manage Livestock Use near Sharp-tailed Grouse Lek Sites

Sharp-tailed Grouse nest within 1–2 km of lek sites; therefore, limiting livestock grazing within this area will help maintain optimal habitat attributes for nesting as well as reduce disturbance during the nesting period. In grassland areas frequented by Sharp-tailed Grouse, consider leaving some areas ungrazed. Minimize livestock grazing use near lek areas by salting or using livestock attractants in other areas to draw livestock away, riding and herding practices to move livestock away from these areas, reducing stocking and period of use to limit utilization of tall bunchgrasses, and fencing and applying rest/rotational grazing (where feasible) to encourage tall bunchgrasses and carry-over of residual grass in the fall to the spring. Although fall grazing is recommended as a strategy to improve the health of bluebunch wheatgrass ecosystems (Burkhardt and Sanders 2010), it can have a negative effect on winter carryover of residual grass cover, which is especially important for Sharp-tailed Grouse nesting habitat (Leupin 2003).

7.5 Limit Browse Use on Shrubs

Shrubs (e.g., rose, saskatoon, choke cherry, scrub birch, water birch, and willow) and important berry and bud crops for winter-feeding of Sharp-tailed Grouse may be reduced by livestock overbrowsing. It is important to monitor and limit livestock browsing of shrubs by applying livestock management practices, such as strategic placement of salt, riding, pasture rotation, and rest and removal of livestock from pastures in the fall when nutrient levels in native grasses and forbs decline. Mclean and Tisdale (1960) found the nutrient levels of native grasses in south-central British Columbia were generally adequate in the spring but inadequate in the fall for provision of maintenance levels of crude protein and phosphorus for livestock. In spring, the protein levels can be as high as 20% for bluebunch wheatgrass, decreasing to about 4% protein as the forage matures and cures (Ogle et al. 2010). In contrast, crude protein and phosphorus levels in many shrubs remain high compared to grasses and forbs in the fall and winter period, making these plants more susceptible to browsing in the fall by livestock (McLean and Tisdale 1960).

7.6 Restore Fire-maintained Grassland Ecosystems

Approximately 100 years of fire suppression has resulted in the encroachment and ingrowth of trees onto what was historically fire-maintained grassland ecosystems (Cariboo-Chilcotin Grasslands Strategy Working

Group 2007). The loss of these ecosystems further reduces available habitat for grassland-nesting birds. In recent years, the British Columbia government has been working to restore grassland areas by removal of trees through slashing and controlled burning activities. It is important that these activities continue. Where Sharp-tailed Grouse leks and nesting areas occur, burning of new areas should be delayed until adjacent burned areas have fully recovered. Sharp-tailed Grouse may have been displaced from one lek site either because of the timing of the burn or the loss of grassland structure related to the severity and frequency of burns; at another lek site, Sharp-tailed Grouse were only temporarily displaced for 1 year following a burn (authors, personal observation).

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ADDENDUM TO SECTION 4.0 METHODOLOGY

4.1 *Nest Cover*

Insert after:

Sharp-tailed Grouse, Western Meadowlark, and Vesper and Savannah sparrow nests were located in the Cariboo-Chilcotin grasslands at the Junction Sheep Range Provincial Park, Becher's Prairie, and the OK Ranch. Nests were located annually during May and June from 2007 to 2011.

Insert:

Each pasture was surveyed for breeding birds on an equal and rotational basis following RISC standard survey protocols. The following bird survey methods were used: monitoring of breeding birds present using point count surveys followed by observation of breeding birds to locate nests, absolute abundance methods such as detailed spot mapping to locate nests, encounter transects (flushing of nesting birds by traversing pastures along transects spaced 10m apart, or alternately using rope drags at 10m intervals).

Nest details were recorded on nest site description and nest status forms. Nest cover was measured at each nest.

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