

February 2010

## MONITORING GRASSLAND BIRD NEST COVER USING DIGITAL PHOTOGRAPHY AT TWO LOCATIONS IN THE CARIBOO GRASSLANDS OF BRITISH COLUMBIA

Report prepared by Cindy Haddow and Becky Bings

February 17, 2010

Project partners: Environment Canada, Simon Fraser University,  
The Ministry of Environment, The Ministry of Forest and Range (FREP),  
The Grassland Conservation Council of British Columbia (GCC),  
The Natural Sciences and Engineering Research Council of Canada (NSERC),  
The Habitat Conservation Trust Foundation (HCTF), Simon Fraser University (SFU),  
Thompsons Rivers University (TRU), The OK Ranch



*Columbian Sharp-tailed Grouse nest: Photo by B. Bings*





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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 author offers the following recommendations to those who develop and implement forest and range management policy, plans, and practices.

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## 1.0 INTRODUCTION

The amount of cover, height, density, and spatial arrangement of forbs, grasses, and shrub species are important habitat attributes that help grassland-nesting birds avoid predation on the land and from the air, and thereby improve nesting success. Grazing on British Columbia's grasslands affects cover quality and availability for ground-nesting birds. Threshold levels of cover for grassland-nesting birds are not well defined in literature and are lacking for species found in provincial grassland areas. Data presented in this report are part of a larger, long-term study of the visual screening cover of grasslands in British Columbia available for both small mammals and grassland-nesting birds in grazed and ungrazed ecosystems. Bird species included in the evaluation are species relying on grassland structure for nesting cover: the blue-listed Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*), and the yellow-listed Western Meadowlark (*Sturnella neglecta*), Savannah Sparrow (*Passerculus sandwichensis*) and Vesper Sparrow (*Pooecetes gramineus*). Although the nests of the Vesper Sparrow found within the project study sites had high cover levels, the literature indicates that this species nests in various habitat types and available cover (Dechant et al. 2003), whereas the Savannah Sparrow prefers habitat with greater cover (Swanson 2003).

Grassland-nesting birds in North America have shown steeper and more widespread declines than other bird groups over the last 40 years, with up to 60% of grassland-breeding species showing declining population trends (North American Bird Conservation Initiative, U.S. Committee 2009). On the prairies, 40 years of breeding bird survey data indicate a decline in populations for 80% of the species normally associated with grasslands.<sup>1</sup> The conversion of natural grasslands to grain and farmland, as well as urban development and climate change, may be the leading causes of this decline. British Columbia experiences some of the same pressures, especially the conversion of natural grasslands to other uses. In addition, grasslands may be altered by forest encroachment as a result of fire suppression, and by livestock grazing. Less than 1% of the province is represented by remaining intact grassland ecosystems.<sup>2</sup> Significant areas of grassland have been lost to forest encroachment. In the Cariboo, for

example, a 37% reduction in grassland area at Becher's Prairie, west of Williams Lake, occurred between 1962 and 1993/95 based on aerial photo comparisons (Ross 1997).

Ranching and grazing of livestock may help preserve grasslands from other forms of development; however, grazing by livestock can also affect grassland-nesting bird habitat unless this habitat is managed to maintain cover for species that depend on grassland. Livestock may affect nesting bird habitat by altering the vegetation composition and structure, trampling, compacting the soil, and reducing available litter. A study in Montana examined the effects of grazing on abundance, nest site availability, nest success, and mortality factors of ground-nesting birds and found that nest density declined when grazing reduced suitable available cover (Fondell and Ball 2004).

In this study, grassland cover was measured along transects using cover boards with cut-outs of grassland-nesting birds of different sizes. To evaluate preferred nesting cover, cover measurements collected along transects were compared to cover measured at adjacent nest sites for the same bird species. Cover was measured using digital photography (Carlyle et al., 2010). Refer to Section 3.0 ("Methodology"), for a more detailed description of the methods used in this study. Distances of Sharp-tailed Grouse nest sites from the closest lek<sup>3</sup> were also determined for the Junction Sheep Range Provincial Park study site.

## 2.0 STUDY SITES

The data presented in this report were collected at two study sites in the Cariboo in 2007 and 2008 (Figure 1): the OK Ranch near Clinton, B.C. (Figure 2), and the Junction Sheep Range Provincial Park near the junction of the Fraser and the Chilcotin rivers (Figure 3). Four cover transects were established at the OK Ranch and three within the Junction Sheep Range Provincial Park.

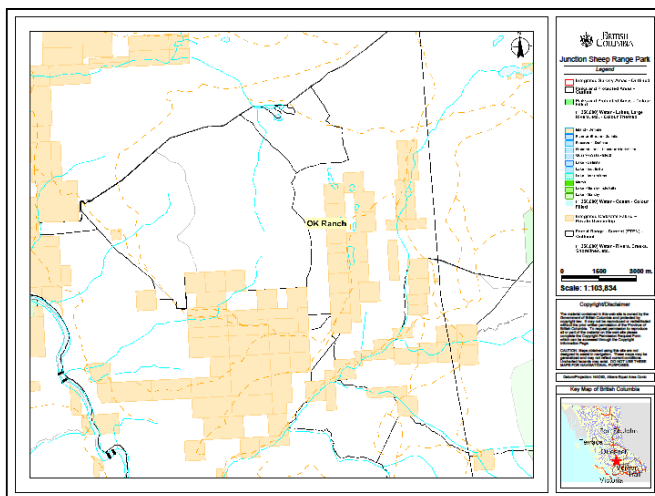
1 Information broadcast by Trevor Herriot in "Pastures Unsung," an episode presented on the CBC Radio program, *Ideas*. See: <http://www.cbc.ca/ideas/features/pastures-unsung/>

2 See the Grasslands Conservation Council of British Columbia website at: <http://www.bcgrasslands.org/distribution.htm>

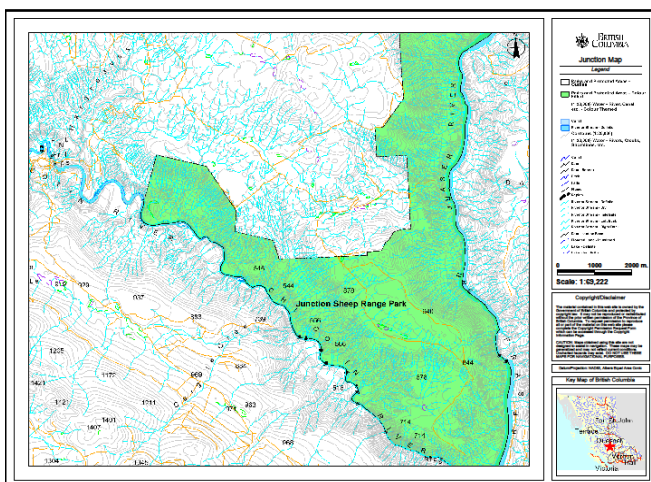
3 Lek: an assembly area where Sharp-tailed Grouse carry on display and courtship behaviour.



**Figure 1. Study sites in the Cariboo region of British Columbia.**



**Figure 2. OK Ranch study site.**



**Figure 3. Junction Sheep Range Provincial Park study site.**

### 3.0 METHODOLOGY

In April and May of 2007 and 2008, nest sites were observed and the locations recorded by Simon Fraser University (SFU) students working for Environment Canada as part of their study of the presence, abundance, and nesting success of grassland-nesting birds associated with different grassland types and different grazing intensities (Harrison et al., in press). These nest site locations provided the basis for Ministry of Environment staff to analyze the visual screening cover found at nest sites using cover boards and digital photography, and to compare this data to the average cover of the site using transects, cover boards, and digital photography.

Ministry of Environment staff returned to the nest sites in late June and early July of 2008 after the young birds had fledged. At this time, nest sites and transects were evaluated for visual screening cover provided by the vegetation surrounding the nest site. Cover boards were placed at the centre of each nest. A digital camera was placed on a tripod to take photos of the nest cover from a distance of 4 m away and at a height of 1 m. This position was chosen as it repeats the same method used to measure height and cover with a Robel pole (Robel et al., 1970). The cover boards were made of plastic with a life-sized replica of each of the bird species included in the evaluation. Fourteen nests were measured at the study sites, eight at the OK Ranch (three Columbian Sharp-tailed Grouse, three Western Meadowlark, two Vesper Sparrow) and six at the Junction Sheep Range Provincial Park (four Columbian Sharp-tailed Grouse, one Western Meadowlark, one Vesper Sparrow). No Savannah Sparrow nests were located.

Transects were located in typical vegetation near nest sites and the nest sites were often incorporated into transects. Each transect consisted of 25 plots at 2-m intervals along a 50-m transect. (Some transects have fewer than 25 plots because of digital photo memory card errors.) At each plot centre, cover boards with the bird replicas were placed and digital photos taken. Data was collected at seven transects for this study, four at the OK Ranch site and three within the Junction Sheep Range Provincial Park.

The use of life-sized replicas in this project rather than a Robel pole or a large rectangular cover board was intended to build relationships between available cover and cover required by bird species depending on the size of the bird. A sparrow would require less cover than a grouse to avoid visible detection by a predator. The replicas were spray-painted a bright orange so that the visible portions of the



bird were easily identified later in photos using an image manipulation program (GNU Image Manipulation Program [GIMP]) that is able to measure the pixels of specified colours. As most birds also use camouflage and behaviour to avoid detection by predators, it is expected that the cover results reported here may overestimate actual cover requirements for individual bird species.

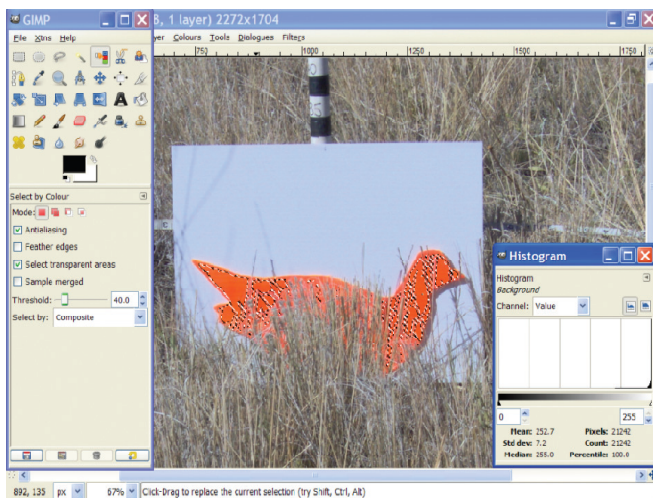


Figure 4. Analysis of cover using GIMP image manipulation program.

The maximum number of available pixels was determined by photographing the cover boards at the same distance with no vegetation; the pixels for each individual photo were standardized using this value. The resulting value was the percentage of the replica bird visible through the grassland vegetation. One hundred minus this value gave the percentage of cover. Transect and nest cover data are presented in Appendix 1. Using JMP statistical software, graphs were created showing the distribution of cover of all the plots along each transect sampled. The cover at each nest site was compared to the average cover available along the corresponding transect. The nest cover was plotted on the corresponding distribution graph providing a visual reference of the similarity in cover.

## 4.0 DATA SUMMARY AND ASSESSMENTS

### 4.1 OK Ranch Study Site

The OK Ranch is a large ranch in the vicinity of Big Bar Lake, near Clinton, B.C The study sites chosen within the OK Ranch lands are within both grazed and ungrazed pastures. Four transects and associated nest sites were chosen: (1) Racetrack, (2) Racetrack Control, (3) Poison Lake Dry Farm, and (4) Big Bar South. See Appendix 1 for transect and nest cover data.

### 4.1.1 Racetrack Pasture

The Racetrack transect, within the Racetrack pasture of the OK Ranch (Figure 5), was set up adjacent to two Western Meadowlark nests. Vegetation at the Racetrack transect was a mix of *Achnatherum richardsonii* (spreading needlegrass), *Poa pratensis* (Kentucky bluegrass), *Juncus balticus* (Baltic rush), with some clumps of *Hesperostipa curtipseta* (short-awned porcupinegrass). The Racetrack pasture was grazed and litter cover was 100%, with no bare ground showing. Along the transect, no large clumps of grass were evident except at the meadowlark nest sites.



Figure 5. Racetrack Pasture transect.

Figure 6 shows the distribution of cover of the 22 plots along the Racetrack Pasture transect. The maximum cover along the transect, measured using the meadowlark cover board, was 71%, with the average at 47%.

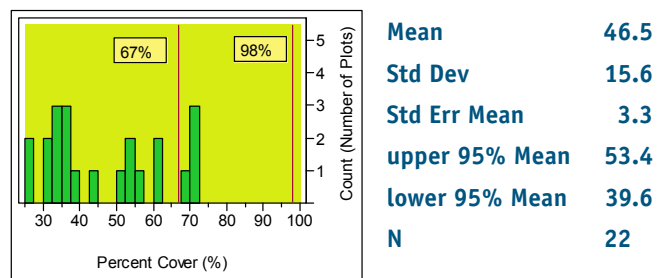


Figure 6. Distribution of Western Meadowlark cover along the Racetrack Pasture transect and percent cover of two Western Meadowlark nests: meadowlark nest cover = 98% and 67% (n = 2).

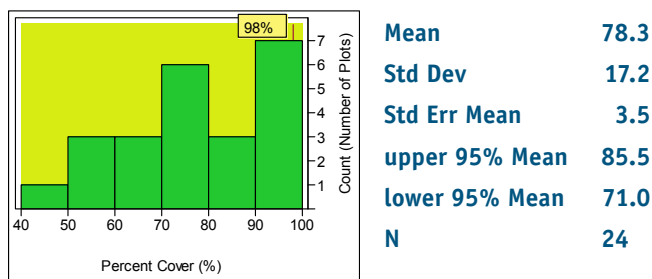
Two Western Meadowlark nests were found at the Racetrack Pasture in 2008. One nest had 98% cover, whereas the other nest had 67% cover. The mean cover along the

transect was 47% (measured using the meadowlark cover boards for comparison). Both nests had greater cover than the upper confidence interval for the transect (i.e., 53%). The meadowlarks at this site selected grassland-nesting habitat with more cover than was generally available across the site.

### 4.1.2 Racetrack Control Pasture

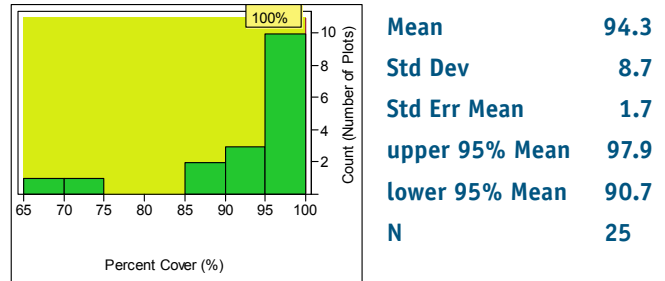
Vegetation at the Racetrack Control transect included *Poa pratensis* (Kentucky bluegrass), *Pseudoroegneria spicata* (bluebunch wheatgrass), *Balsamorhiza sagittata* (arrowleaf balsamroot), *Achillea millefolium* (yarrow), *Koeleria macrantha* (junegrass), *Achnatherum occidentale* (stiff needlegrass), *Astragalus miser* (timber milk-vetch), *Tragopogon dubius* (yellow salsify), and *Hedysarum boreale* (northern hedysarum). This pasture was chosen to represent an ungrazed area at the OK Ranch study site because little to no grazing had occurred here for a period of years. The absence of grazing on this pasture provided for taller vegetation and greater cover opportunities for nesting birds than that found in the grazed pastures. The vegetation within this pasture was not representative of the potential natural community vegetation despite the years of rest from grazing.

Figure 7 shows the distribution of grouse cover of the 24 plots along the control transect (measured using the grouse cover boards). The three Columbian Sharp-tailed Grouse nests found on the Racetrack Control Pasture had cover of 94%, 100%, and 100%. The mean cover for the three nests was 98%. All three grouse nests had greater cover than the upper confidence interval for the transect (i.e., 85%). The Columbian Sharp-tailed Grouse at this site selected nest sites with greater cover than was generally available across the pasture.



**Figure 7. Distribution of Columbian Sharp-tailed Grouse cover along the Racetrack Control Pasture transect and average cover of three Columbian Sharp-tailed Grouse nests: mean nest cover = 98% (n = 3).**

Two Vesper Sparrow nests were found in the vicinity of the Racetrack Control Pasture transect (25 plots). Both of the nest sites had 100% cover (measured using the Vesper Sparrow cover board). The mean cover for the transect was 94% and the upper confidence interval was 98%. Even though the cover was dense on this site, both Vesper Sparrow pairs chose nest sites that provided 100% cover (Figure 8).



**Figure 8. Distribution of Vesper Sparrow cover along the Racetrack Control transect and average cover of two Vesper Sparrow nests: mean nest cover for sparrow nests = 100% (n = 2).**

### 4.1.3 Poison Lake Dry Farm Pasture

Vegetation at the Poison Lake Dry Farm Pasture included *Poa pratensis* (Kentucky bluegrass), *Hesperostipa curtiseta* (short-awned porcupinegrass), *Festuca saximontana* (Rocky Mountain fescue), *Koeleria macrantha* (junegrass), *Acnatherum richardsonii* (spreading needlegrass), and *Pseudoroegneria spicata* (bluebunch wheatgrass). (Figures 9 and 10).

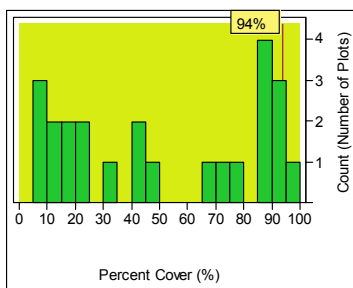


**Figure 9. The Poison Lake Dry Farm Pasture transect.**



**Figure 10. Measuring cover with the Western Meadowlark cover board along the Poison Lake Dry Farm Pasture transect.**

One Western Meadowlark nest was found at the Poison Lake Dry Farm Pasture transect (24 plots), and its cover was 94%. The mean cover of the transect was 51% with an upper confidence interval of 65% (Figure 11). The cover of the nest site chosen was greater than the average cover of the transect.



<b>Mean</b>	<b>50.8</b>
<b>Std Dev</b>	<b>34.2</b>
<b>Std Err Mean</b>	<b>7.0</b>
<b>upper 95% Mean</b>	<b>65.2</b>
<b>lower 95% Mean</b>	<b>36.3</b>
<b>N</b>	<b>24</b>

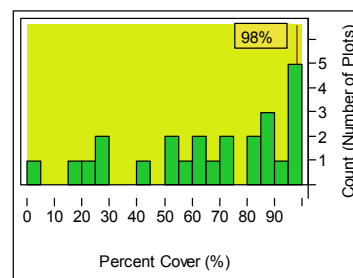
**Figure 11. Distribution of Western Meadowlark cover along the Poison Lake Dry Farm Pasture transect and cover at the Western Meadowlark nest: meadowlark nest cover = 94% (n = 1).**

#### 4.1.4 Big Bar South Pasture

Vegetation at the Big Bar South pasture was a mix of *Achnatherum richardsonii* (spreading needlegrass), *Pseudoroegneria spicata* (bluebunch wheatgrass), *Koeleria macrantha* (junegrass), and *Poa pratensis* (Kentucky bluegrass). The mean cover for the Big Bar South transect was 66% (25 plots). The upper confidence interval was 77% (measured using the grouse cover boards; see Figure 12). Although the SFU team provided the position for one grouse nest, the MOE team was unable to

locate this particular nest. Grouse activity was evident (droppings and old nest sites) and suitable habitat was also present on portions of the pasture.

As the SFU team had identified a grouse nest for the pasture and the vegetation for this pasture resembled the vegetation at the nearby Racetrack Control pasture where grouse nests were located, we chose to make a comparison of the transect cover here to the cover at the Racetrack Control grouse nest sites. For this comparison, the cover values of three grouse nests found at the Racetrack Control pasture were combined, giving a mean cover value of 98%. This mean cover value selected for nesting by Columbian Sharp-tailed Grouse was higher than the upper confidence interval (77%) of the transect mean at Big Bar South.



<b>Mean</b>	<b>65.7</b>
<b>Std Dev</b>	<b>29.1</b>
<b>Std Err Mean</b>	<b>5.8</b>
<b>upper 95% Mean</b>	<b>77.7</b>
<b>lower 95% Mean</b>	<b>53.7</b>
<b>N</b>	<b>25</b>

**Figure 12. Distribution of Columbian Sharp-tailed Grouse cover along the Big Bar South transect and average cover of three Columbian Sharp-tailed Grouse nests: average nest cover of three nests = 98% (n = 3).**

## 4.2 Junction Sheep Range Provincial Park Study Site

This study site is on the grassland plateau above the Fraser and Chilcotin rivers within the Junction Sheep Range Provincial Park. Livestock grazed this area before 1987, when it became a Wildlife Management Area, and in 1995 it was designated a provincial park. It is home to a provincially important herd of California bighorn sheep. In some parts of the study site, sheep graze the grasslands more heavily than in others, resulting in different seral stages. The authors visited the Junction in the summer of 2007 and 2008 to collect cover and nest site data. Three transects were chosen to represent the vegetation and seral stages of the Junction Sheep Range Study site: (1) Junction Cabin, (2) Junction Middle, and (3) Junction Cairn. Four Columbian Sharp-tailed Grouse nests were located within the study site (Figures 13 and 14)—three nest sites in 2007 and one in 2008. The cover at the Sharp-tailed Grouse nests was dominated by

*Pseudoroegneria spicata* (bluebunch wheatgrass), which provided the greatest level of cover, with other species such as *Koeleria macrantha* (junegrass), *Achnatherum richardsonii* (spreading needlegrass), *Hesperostipa curteseta* (short-awned porcupinegrass), *Symphoricarpos sp.* (snowberry), and *Artemisia frigida* (pasture sage), present. One Western Meadowlark nest and one Vesper Sparrow nest were also found within the Junction study site. See Appendix 1 for transect and nest cover data.



Figure 13. Columbian Sharp-tailed Grouse egg shell remnants.



Figure 14. Columbian Sharp-tailed Grouse nest.

### 4.2.1 Junction Cabin Transect

The vegetation at the Junction Cabin transect was dominated by *Pseudoroegneria spicata* (bluebunch wheatgrass) and *Koeleria macrantha* (junegrass). Four Columbia Sharp-tailed Grouse nest cover values were compared to the cover of the Junction Cabin transect as

this transect was the most similar in vegetation to the nest site vegetation. Cover was measured at the four individual Sharp-tailed Grouse nest sites from both sides of the nest (Figure 15). The transect data was collected in 2006 and nest site cover data was collected in 2007 and 2008. Although no differences in treatments were observed between years, a climatic variation could have resulted in different vegetation growth. Additional data collection is necessary to test whether these findings are consistent from year to year.



Figure 15. Measuring cover of a Columbian Sharp-tailed Grouse nest.

Figure 16 shows the distribution of grouse cover at the Junction Cabin transect and the average cover at the four Columbian Sharp-tailed Grouse nests (24 plots). Cover for the four individual nests was 96%, 94%, 94%, and 99%, respectively. The cover at the four grouse nests was greater than the upper mean value for the transect, which was 83%. In each case, the Columbian Sharp-tailed Grouse identified chose nest sites with greater cover than the average cover available across the transect.

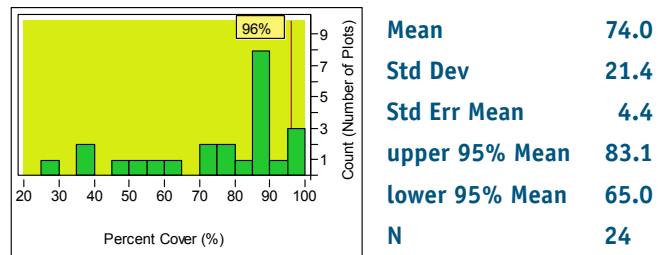


Figure 16. Distribution of Columbian Sharp-tailed Grouse cover along the Junction Cabin transect and average cover of four Columbian Sharp-tailed Grouse nests: mean nest cover = 96% (n = 4).

### 4.2.2 Junction Middle Transect

The dominant vegetation at the Junction Middle transect was a mix of *Pseudoroegneria spicata* (bluebunch wheatgrass), *Koeleria macrantha* (junegrass), *Achnatherum richardsonii* (spreading needlegrass), and *Hesperostipa curtisetata* (short-awned porcupinegrass). Figures 17, 18, and 19 show the distribution of cover along the Junction Middle transect.

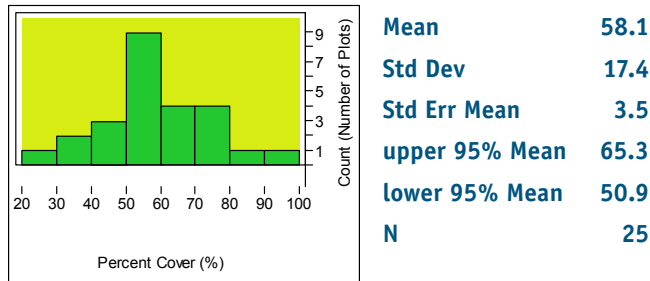


Figure 17. Distribution of cover along the Junction Middle transect (25 plots; measured using the Columbian Sharp-tailed Grouse cover boards).

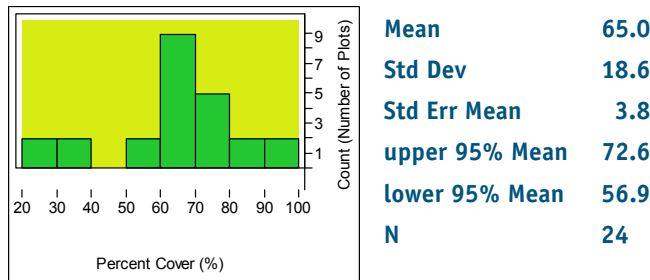


Figure 18. Distribution of cover along the Junction Middle transect (24 plots; measured using the Western Meadowlark cover boards).

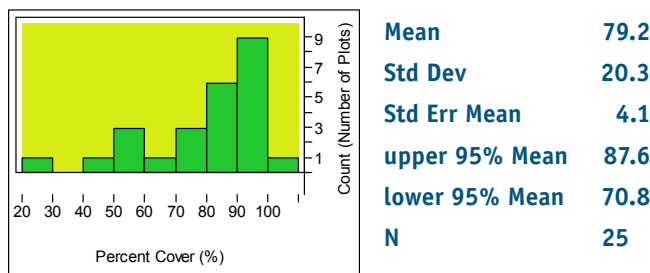


Figure 19. Distribution of cover along the Junction Middle transect (25 plots; measured using the Vesper Sparrow cover boards).

The mean cover of the Junction Middle transect was 58% with an upper confidence interval of 65% (measured using the grouse cover boards), 65% with an upper confidence interval of 73% (measured using the meadowlark cover

boards), and 79% with an upper confidence interval of 88% (measured using the sparrow cover boards). The vegetation of the Junction Middle transect was sparser than at the Junction Cabin and the Junction Cairn transects.

The mean nest cover measured at four Columbian Sharp-tailed Grouse nests was 96%; at one Western Meadowlark nest (measured from both sides of the nest) was 96%; and at one Vesper Sparrow nest (measured from both sides of the nest) was 99%. All of the bird nests of the three species found at the Junction study site had higher levels of cover than the cover available at the Junction Middle transect.

### 4.2.3 Junction Cairn Transect

The dominant vegetation at the Junction Cairn transect was a mix of *Pseudoroegneria spicata* (bluebunch wheatgrass), *Koeleria macrantha* (junegrass), and *Hesperostipa curtisetata* (short-awned porcupinegrass). Figures 20, 21, and 22 show the distribution of cover along the Junction Cairn transect.

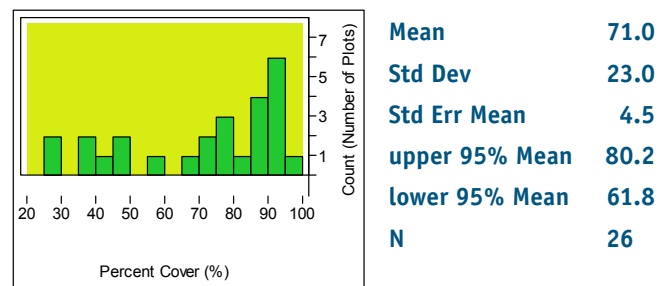


Figure 20. Distribution of cover along the Junction Cairn transect (26 plots; measured using the Sharp-tailed Grouse cover boards).

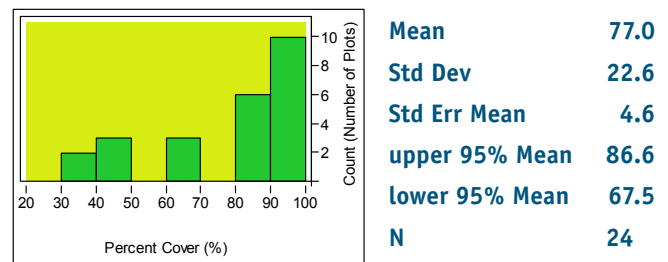
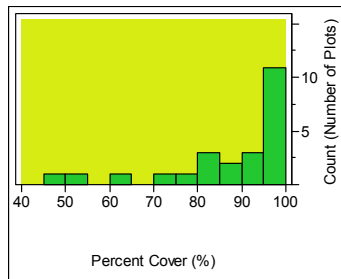


Figure 21. Distribution of cover along the Junction Cairn transect (24 plots; measured using the Western Meadowlark cover boards).



<b>Mean</b>	<b>87.1</b>
<b>Std Dev</b>	<b>15.1</b>
<b>Std Err Mean</b>	<b>3.07</b>
<b>upper 95% Mean</b>	<b>93.4</b>
<b>lower 95% Mean</b>	<b>80.7</b>
<b>N</b>	<b>24</b>

**Figure 22. Distribution of cover along the Junction Cairn transect (24 plots; measured using the Vesper sparrow cover boards).**

The mean cover for the Junction Cairn transect measured 71% using the grouse cover boards, 77% using the meadowlark cover boards, and 87% using the sparrow cover boards (Figures 20, 21, and 22). This is as expected since smaller bird species such as the Vesper Sparrow and Savannah Sparrow require less structural vegetation to remain hidden as compared to larger bird species such as

Western Meadowlark and Columbian Sharp-tailed Grouse. Similar to the Junction Middle transect, all of the grouse, meadowlark, and sparrow nests found at the Junction study site had higher levels of cover than the average cover available at the Junction Cairn transect.

### 4.3 Comparison of Mean Percent Cover Obtained Using Bird Cover Boards at Each Transect and Nest Site

Table 1 summarizes the cover at each transect and the nest sites for all three bird species, and also describes grazing activity. The transect within the ungrazed Racetrack Control Pasture had greater cover—78%, 85%, and 94% measured using the grouse, meadowlark, and sparrow cover boards, respectively—than any of the grazed pastures at the OK Ranch. The cover at the nest sites (measured using the cover board represented by the nesting bird) was greater than the mean cover of each transect.

**Table 1. Summary of percent cover at transects and nest sites**

Transect	Cattle grazing	Mean cover using grouse cover boards (%) <sup>a</sup>	Mean cover using meadowlark cover boards (%) <sup>a</sup>	Mean cover using vesper sparrow cover boards (%) <sup>a</sup>	Nest cover (%)
Racetrack	Yes	35 (2)	47 (3)	82 (2)	98, 67 (2 meadowlark)
Racetrack Control	No	78 (4)	85 (3)	94 (2)	100, 100, 94 (3 grouse) 100, 100 (2 sparrow)
Poison Lake Dry Farm	Yes	46 (6)	51 (7)	70 (6)	94 (1 meadowlark)
Big Bar South	Yes	66 (6)	73 (6)	83 (5)	No nests found
Junction Cabin	No, bighorn sheep grazing—yes	74 (4)	91 (2)	98 (1)	98, 94, 92, 96, 92, 96, 98, and 100 (4 grouse) <sup>b</sup> 98, 100 (1 sparrow) <sup>b</sup> 94, 98 (1 meadowlark) <sup>b</sup>
Junction Middle	No, bighorn sheep grazing—yes	58 (3)	65 (4)	79 (4)	
Junction Cairn	No, bighorn sheep grazing—yes	71 (4)	77 (5)	87 (3)	

<sup>a</sup> Standard error appears in parentheses.

<sup>b</sup> Note: Two cover measurements were taken at each nest found in Junction study site.

## 4.4 Distance of Sharp-tailed Grouse Nests from the Lek

The distances from each grouse nest found at the Junction study site to the nearest known lek were compared using UTM locations (Table 2).

**Table 2. Distance of Sharp-tailed Grouse nests from lek at the Junction study site**

Nest	Distance from the lek (m)
1	910
2	1080
3	531
4	381
5 (nest found in 2009) <sup>a</sup>	660

a Nest cover data for this nest is not included in this study. The average nest distance of the four grouse nests in this study from the lek was 726 m (712 m including the additional nest found in 2009).

## 5.0 DISCUSSION AND MANAGEMENT IMPLICATIONS

### 5.1 Nest Cover Selection

Average cover for the ungrazed Racetrack Control transect was 78%, greater than the average cover for the other three grazed transects at the OK Ranch study site (35%, 46%, and 66%, respectively; measured using the grouse cover boards). Even though cover appeared abundant along the Racetrack Control transect, the three Sharp-tailed Grouse nest locations had even greater cover measurements of 94%, 100%, and 100%. This strongly suggests that not only is ungrazed cover important for Columbian Sharp-tailed Grouse, but the amount, type, and arrangement of cover is also important.

Although the Junction Sheep Range Provincial Park is protected from domestic livestock grazing, California bighorn sheep do graze the grassland areas, with some areas grazed more heavily than others. The cover at the Junction Sheep Range Provincial Park was variable with the Junction Cabin transect having 74% cover, the Junction Middle transect 58% cover, and the Junction Cairn transect 71% cover (measured using grouse cover boards).

The distributions of the cover transects show that, as expected, ungrazed or lightly grazed transects have more plots with higher percent cover (with greater means and

upper confidence intervals), whereas grazed transects such as the Racetrack and Poison Lake Dry Farm transects show a more even distribution of percent cover (with lower means and upper confidence intervals). Plant communities with vegetation dominated by bluebunch wheatgrass were preferred habitat types for grassland-nesting Columbian Sharp-tailed Grouse within both study sites. Sharp-tailed Grouse are known to select nests primarily within dense stands of bluebunch wheatgrass and rough fescue, with vegetation heights that range between 27 and 45 cm (Leupin 2003); ungrazed or lightly grazed areas provide more of this preferred nesting habitat.

Four Western Meadowlark nests were assessed for cover, three at the OK Ranch study site and one at the Junction study site. At all nests, similar to the results of the grouse cover analysis, cover was higher than the upper confidence interval of the average coverage available in the surrounding area. Cover measurements of the three Vesper Sparrow nests also showed the same results. Nest site selection in this study appears to be influenced by available cover, with preference given to the sites with the most cover.

### 5.2 Management Recommendations

All nests found and evaluated within the study sites had cover greater than the cover generally available in the area. All three bird species studied (Columbian Sharp-tailed Grouse, Western Meadowlark, and Vesper Sparrow) chose nest sites with abundant cover. The high cover values at nest sites (in most cases greater than 90%) indicate that providing adequate habitat for grassland-nesting birds in livestock-grazed ecosystems will require some grassland areas to be managed with little to no grazing. Grazing systems that leave stands of grass ungrazed or patchy are likely more favourable to grassland-nesting birds than grazing systems that leave uniform levels of use with lower stubble heights on a larger land base. In addition, grassland ecosystems that have a higher percentage of tall bunchgrass species provide more opportunities for nesting cover than ecosystems with lower-growing species.

To reverse the observed trends of declining bird populations, the implementation of practices that benefit grassland-nesting birds is recommended. Range practices that benefit grassland-nesting birds should include the management of grazing timing and intensity to avoid the nesting season and to maintain adequate cover in part of the pastures for nesting birds. Leaving some areas

ungrazed in the fall may also be beneficial to some bird species as this provides residual cover for nest building and security purposes.

The nests of Columbian Sharp-tailed Grouse have been found on average within 1200–1600 m of the lek, with nests as far away as 2600 m (Leupin 2003). At the Junction study site, the average distance of the five nests from the lek was 712 m. Managing for dense cover of bunchgrass species close to Sharp-tailed Grouse leks (within 2600 m) is recommended as this is where the majority of Sharp-tailed Grouse will nest.

### 5.3 Further Work

Further research and identification of more nest sites, especially nests of Western Meadowlark, Savannah and Vesper sparrows is necessary to determine the amount, type, and distribution of cover required to maintain or increase grassland bird breeding habitat. Research plans should include implementation and study of grazing management practices that will improve habitat for grassland-nesting birds.

The use of digital photography to measure cover was shown to be a valuable tool. Future research efforts that use and refine digital photography as a tool for monitoring cover are recommended.

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APPENDIX 1. TRANSECT AND NEST COVER DATA

Vegetation Cover Requirements Project 2008																							
Transect Location (UTM): 10 U 539858 5737005																							
Transect Name: <b>OK Ranch Racetrack</b>																							
Date: July 2, 2008																							
Recorder: Becky Bings, Cindy Haddow																							
Plots: 2m intervals along 50m transect																							
Plot	Robel Pole	Photo # Sparrow	Pixel Count1	Pixel Count 2	Pixel Count 3	Pixel Average	% Vis	% Cover	Photo # M.lark	Pixel Count 1	Pixel Count 2	Pixel Count 3	Pixel Aver	% Vis	% Cover	Photo # Grouse	Pixel Count 1	Pixel Count 2	Pixel Count 3	Pixel Av	% Vis	% Cover	Comments
1	2.5	775	8871	9189	8876	8979	40	60	776	29768	29725	29592	29695	70	100	777	92284	92185	92719	92396	85	15	photos 766-804 from
2	2.5	778	6405	6563	6257	6408	29	40	71	29768	29725	29592	29695	70	100	780	80534	77289	81322	79715	73	27	268 card, date says
3	2.5	781	1265	1462	1374	1367	6	94	782	12280	12438	13257	12658	30	70	783	80534	77289	81322	0	0	100	June 26/08 (incorrect)
4	2.5	784	3614	3765	3502	3627	16	84	785	27873	27936	28131	27980	66	34	786	81096	81253	82551	81633	75	25	identical photo numbers
5	5	787	2312	2662	2452	2475	11	89	788	26149	27168	27066	26788	63	37	789	68294	69442	68801	68846	63	37	were renumbered
6	7.5	790	744	626	672	681	3	97	791	13729	11854	12473	12685	30	70	792	57299	56559	57408	57089	52	48	(i.e. 8026, 8030, 8050)
7	2.5	793	2936	2823	2733	2831	13	87	794	27637	26957	27215	27270	64	36	795	73088	75309	73970	74122	68	32	
8	7.5	796	1729	1612	1769	1703	8	92	797	11907	12680	12232	12273	29	71	798	51202	49132	50428	50254	46	54	photos for plots 11
9	7.5	799	1176	2036	1288	1500	7	93	800	16204	15927	16518	16216	38	62	801	63155	64201	61925	63094	58	42	and 12 are stuck in
10	5	802	5858	5793	5950	5867	26	74	803	23916	23297	24110	23774	56	44	804	72799	74883	72408	73363	67	33	camera internal memory!
11	5	?	?	?	?	?	0	0	100	?	?	?	?	0	100	?	?	?	?	0	0	100	photos 8023-851 from
12	7.5	?	?	?	?	?	0	0	100	?	?	?	?	0	100	802a	75791	74510	74899	75067	69	31	1GB card date says
13	5	803a	7034	7324	7189	7182	32	68	804a	31058	31077	31131	31089	73	27	805	84985	86049	84833	85289	78	22	June 26/08 (incorrect)
14	5	806	6272	6626	6655	6518	29	71	807	29761	29939	29668	29789	70	30	808	71125	70929	72140	71398	66	34	
15	7.5	809	2857	3306	3217	3127	14	86	810	26073	26411	26365	26283	62	38	811	20842	20852	20738	20611	48	52	
16	7.5	812	2244	2447	2171	2287	10	90	813	20242	20852	20738	20611	48	52	814	69839	69142	70456	69812	64	36	
17	5	815	7346	7194	7196	7245	33	67	816	28097	28086	29273	28485	67	33	817	73624	74488	74105	74072	68	32	vegetation starts
18	7.5	818	1195	1631	1635	1487	7	93	819	18127	18407	18083	18206	43	57	820	61760	62040	62839	62213	57	43	becoming heavier to
19	7.5	821	2517	2669	2546	2577	12	88	822	19413	19674	20158	19748	46	54	823	62272	57590	62520	60794	56	44	P. pratensis
20	7.5	824	1315	1357	1341	1338	6	94	825	19559	19931	19140	19543	46	54	826	64930	65949	66267	65715	60	40	
21	7.5	827	2277	2661	2110	2349	11	89	828	17080	17005	16717	16934	40	60	829	60268	61870	61213	61117	56	44	
22	5	830	7074	7166	6820	7020	32	68	831	31555	31073	31413	31347	74	26	832	91854	92653	91309	91939	85	15	
23	5	833	4570	5294	5127	4997	22	78	834	27597	27582	27971	27717	65	35	835	80524	79058	82279	80620	74	26	
24	5	836	7933	7827	7868	7876	35	65	837	27860	28262	28201	28108	66	34	838	73234	73659	73207	73367	67	33	
25	10	839	608	760	836	735	3	97	840	13398	12851	13601	13283	31	69	841	51130	48477	53263	50957	47	53	

Western Meadowlark nest not previously identified			
UTM 10 U	pixel 1	pixel 2	pixel 3
Robel Pole	22.5		
Photo # Sparrow	843		
Pixel # Sparrow	0	0	0
Photo # Meadowlark	844		
Pixel # Meadowlark	1060	822	866
Photo # Grouse	845		
Pixel # Grouse	8556	9053	9120
	pixel av	pixel av	pixel av
	%vis	%vis	%cover

Western Meadowlark nest along transect (between plots 10 and 11)			
UTM 10 U	pixel 1	pixel 2	pixel 3
Robel Pole	12.5		
Photo # Sparrow	846		
Pixel # Sparrow	1249	1484	1312
Photo # Meadowlark	847		
Pixel # Meadowlark	14778	13841	13809
Photo # Grouse	848		
Pixel # Grouse	47545	48233	48330
	pixel av	pixel av	pixel av
	%vis	%vis	%cover







# APPENDIX 1. TRANSECT AND NEST COVER DATA

UTM	Nest 1	Nest 2	Nest 3	Nest 4	Nest 5	Nest 6	Nest 7	Nest 8
Species	Sharp-tailed Grouse	Vesper Sparrow	Vesper Sparrow	Sharp-tailed Grouse	Western Meadowlark	Sharp-tailed Grouse	Sharp-tailed Grouse	Vesper Sparrow
Cindy's ID #	STGR01-08	Vesper Sparrow	VESF08-08	STGR09-07	WEMED1-08	STGR06-07	STGR02-07	VESF10-08
Patrick's ID#	8PAR-GR-09	?	08-PAR-34	STGR09-07	08-PAR-07	STGR06-07	STGR02-07	08-CS-09
Nest Year	2008		2008	2007	2008	2007	2007	2008
Robel Reading 1	35		22.5	17.5	20	35	27.5	10
Compass bearing 1	336°		336°	336°	336°	336°	336°	336°
Robel Reading 2	35		22.5	10	20	22.5	35	
Compass bearing 2	90°		90°	90°	90°	90°	90°	
Photo # Sparrow 1	53		66	78	78	86	92	
Sparrow1 Pixel Ct 1	84		632	460	460	797	0	
Sparrow1 Pixel Ct 2	98		0	556	436	928	0	
Sparrow1 Pixel Ct 3	86		0	576	514	955	0	
Sparrow1 Pixel Average	89		0	588	470	893	0	
Sparrow1 % Visibility	1		0	3	3	5	0	
Sparrow1 % Cover	99		100	97	97	95	100	
Photo # Meadowlark 1	54		67	73	79	87	93	
Meadowlark1 Pixel Ct 1	136		1539	1112	2639	3475	724	
Meadowlark1 Pixel Ct 2	188		1464	1476	2748	3631	951	
Meadowlark1 Pixel Ct 3	158		1474	1449	2573	3820	737	
Meadowlark1 Pixel Aver.	0		1492	1346	2653	3642	804	
Meadowlark1 %Visibility	0		3	3	6	8	2	
Meadowlark1 % Cover	100		97	97	94	92	98	
Photo # Grouse 1	56		68	74	80	88	94	
Grouse1 Pixel Ct 1	1286		9957	9066	10228	9635	2014	
Grouse1 Pixel Ct 2	1982		9206	8999	10963	8450	2251	
Grouse1 Pixel Ct 3	1837		9493	9176	9499	8856	2059	
Grouse1 Pixel Average	1702		9552	9080	10230	8980	2108	
Grouse1 % Visibility	2		9	8	9	8	2	
Grouse1 % Cover	98		91	92	91	92	98	
Photo # Sparrow 2	57		69	75	81	89	96	
Sparrow2 Pixel Ct 1	0		324	1146	0	0	0	
Sparrow2 Pixel Ct 2	0		343	1564	0	0	0	
Sparrow2 Pixel Ct 3	0		392	1465	0	0	0	
Sparrow2 Pixel Average	0		353	1392	0	0	0	
Sparrow2 % Visibility	0		2	8	0	0	0	
Sparrow2 % Cover	100		98	92	100	100	100	
Photo # Meadowlark 2	58		70	76	82	90	97	
Meadowlark2 Pixel Ct 1	593		2576	2708	857	2170	0	
Meadowlark2 Pixel Ct 2	615		2358	2789	943	2337	0	
Meadowlark2 Pixel Ct 3	542		2423	2745	1022	2208	0	
Meadowlark2 Pixel Aver.	583		2452	2747	941	2238	0	
Meadowlark2 %Visibility	1		6	6	2	5	0	
Meadowlark2 % Cover	99		94	94	98	95	100	
Photo # Grouse 2	59		71	77	83	91	98	
Grouse 2 Pixel Ct 1	7001		14205	4102	11857	3461	471	
Grouse 2 Pixel Ct 2	7507		13887	4298	12095	3829	569	
Grouse 2 Pixel Ct 3	7403		13729	5533	12068	4575	533	
Grouse 2 Pixel Average	7304		13940	4644	12007	3955	524	
Grouse 2 % Visibility	6		13	4	11	4	0	
Grouse 2 % Cover	94		87	96	89	96	100	
Plant species at nest site	Pseudoegneria spicata	Achnatherum richardsonii	Achnatherum richardsonii	P. spicata	mainly P. spicata	A. richardsonii	mainly P. spicata and	P. spicata
	Snowberry	and P. spicata about equal,	and P. spicata about equal,	pasture sage	Koeleria macrantha	snowberry	snowberry	lemonweed
	Achnatherum richardsonii	Koeleria macrantha,	Koeleria macrantha,	Koeleria macrantha	pasture sage	H. curtiseta	some rose,	saskatoon,
		snowberry	snowberry				kinnikinnick	
Comments	probably the same as STGR04-07 other photos of nest, eggshells: 48,49,50,51,52,60,61,63 ref pixel counts: grouse = 109281	old vesper sparrow nest, not on record, took two photos, #64,65 meadowlark=42870						site was trampled all around nest, so no photos taken

## APPENDIX 1. TRANSECT AND NEST COVER DATA

Reference photos for Junction Cabin													
junt.cabin	2006	5clip	sparrow	im000328	photosma	17mm	18104	17909	18022	18011.67			
junt.cabin	2006	5clip	lark	im000329	photosma	17mm	45797	45445	45443	45561.67			
junt.cabin	2006	5clip	grouse	im000330	photosma	17mm	116526	116753	116858	116712.3			
Transect							pixel	ct1	2	3 mean	se	% visibility	% cover
junt.cabin	2006	unclip	grouse	im000879	photosma	17mm	6441	6086	6543	6356.667	138.4995	5.45	95
junt.cabin	2006	unclip	grouse	im000899	photosma	17mm	9004	10369	10182	9851.667	427.2573	8.44	92
junt.cabin	2006	unclip	grouse	im000918	photosma	17mm	13281	13439	13379	13366.33	46.04828	11.45	89
junt.cabin	2006	unclip	grouse	im000939	photosma	17mm	25321	26373	28418	26704	909.2163	22.88	77
junt.cabin	2006	unclip	grouse	im000957	photosma	17mm	13343	13094	14973	13803.33	589.2341	11.83	88
junt.cabin	2006	unclip	grouse	im000975	photosma	17mm	19175	20518	20051	19914.67	393.6379	17.06	83
junt.cabin	2006	unclip	grouse	im000995	photosma	17mm	76078	69836	77143	74352.33	2278.999	63.71	36
junt.cabin	2006	unclip	grouse	im000012	photosma	17mm	17114	17126	17454	17231.33	111.3872	14.76	85
junt.cabin	2006	unclip	grouse	im000030	photosma	17mm	NA	NA	NA	#DIV/0!	#DIV/0!	#DIV/0!	
junt.cabin	2006	unclip	grouse	im000046	photosma	17mm	34830	32642	35986	34486	980.5332	29.55	70
junt.cabin	2006	unclip	grouse	im000064	photosma	17mm	57043	58159	57013	57405	377.0995	49.19	51
junt.cabin	2006	unclip	grouse	im000082	photosma	17mm	5979	6339	5593	5970.333	215.3952	5.12	95
junt.cabin	2006	unclip	grouse	im000100	photosma	17mm	31070	31320	32577	31655.67	466.2854	27.12	73
junt.cabin	2006	unclip	grouse	im000121	photosma	17mm	13106	12273	13269	12882.67	308.4436	11.04	89
junt.cabin	2006	unclip	grouse	im000139	photosma	17mm	13786	12845	15316	13982.33	720.0394	11.98	88
junt.cabin	2006	unclip	grouse	im000159	photosma	17mm	51648	50642	51291	51193.67	294.4568	43.86	56
junt.cabin	2006	unclip	grouse	im000178	photosma	17mm	41978	42145	46460	43527.67	1466.959	37.29	63
junt.cabin	2006	unclip	grouse	im000197	photosma	17mm	22364	26368	24086	24272.67	1159.617	20.80	79
junt.cabin	2006	unclip	grouse	im000216	photosma	17mm	15111	15602	15664	15459	174.9181	13.25	87
junt.cabin	2006	unclip	grouse	im000238	photosma	17mm	13012	12877	15282	13723.67	780.1407	11.76	88
junt.cabin	2006	unclip	grouse	im000257	photosma	17mm	84656	86904	86025	85861.67	654.0602	73.57	26
junt.cabin	2006	unclip	grouse	im000276	photosma	17mm	65205	62865	62865	63645	780	54.53	45
junt.cabin	2006	unclip	grouse	im000296	photosma	17mm	12605	14551	13562	13572.67	561.7871	11.63	88
junt.cabin	2006	unclip	grouse	im000314	photosma	17mm	77741	76022	74896	76219.67	827.2062	65.31	35
junt.cabin	2006	unclip	grouse	im000333	photosma	17mm	813	847	767	809	23.18045	0.69	99
junt.cabin	2006	unclip	lark	im000878	photosma	17mm	1327	1411	1312	1350	30.80584	1.16	99
junt.cabin	2006	unclip	lark	im000898	photosma	17mm	2888	2992	2943	2941	30.03886	2.52	97
junt.cabin	2006	unclip	lark	im000917	photosma	17mm	4868	4897	4548	4771	111.8138	4.09	96
junt.cabin	2006	unclip	lark	im000938	photosma	17mm	4832	5474	5419	5241.667	205.4477	4.49	96
junt.cabin	2006	unclip	lark	im000956	photosma	17mm	2494	2867	2776	2712.333	112.2829	2.32	98
junt.cabin	2006	unclip	lark	im000974	photosma	17mm	6337	6367	6877	6527	175.2142	5.59	94
junt.cabin	2006	unclip	lark	im000994	photosma	17mm	30594	30741	30892	30742.33	86.02777	26.34	74
junt.cabin	2006	unclip	lark	im000011	photosma	17mm	3206	2982	2877	3021.667	97.02291	2.59	97
junt.cabin	2006	unclip	lark	im000029	photosma	17mm	15177	13507	14970	14551.33	525.5747	12.47	88
junt.cabin	2006	unclip	lark	im000045	photosma	17mm	11638	11901	11708	11749	78.64053	10.07	90
junt.cabin	2006	unclip	lark	im000063	photosma	17mm	27206	28684	27061	27650.33	518.5256	23.69	76
junt.cabin	2006	unclip	lark	im000081	photosma	17mm	1195	1087	1026	1102.667	49.41097	0.94	99
junt.cabin	2006	unclip	lark	im000099	photosma	17mm	11949	11320	11797	11688.67	189.4838	10.01	90
junt.cabin	2006	unclip	lark	im000120	photosma	17mm	1412	1311	1434	1385.667	37.86966	1.19	99
junt.cabin	2006	unclip	lark	im000138	photosma	17mm	1486	1377	1469	1444	33.85754	1.24	99
junt.cabin	2006	unclip	lark	im000158	photosma	17mm	24674	23008	22971	23551	561.6016	20.18	80
junt.cabin	2006	unclip	lark	im000177	photosma	17mm	17231	17052	17253	17178.67	63.65096	14.72	85
junt.cabin	2006	unclip	lark	im000196	photosma	17mm	4240	3844	4324	4136	148	3.54	96
junt.cabin	2006	unclip	lark	im000215	photosma	17mm	2103	2152	1937	2064	65.05639	1.77	98
junt.cabin	2006	unclip	lark	im000237	photosma	17mm	1945	2028	1995	1989.333	24.12698	1.70	98
junt.cabin	2006	unclip	lark	im000256	photosma	17mm	34282	35297	35168	34915.67	319.0143	29.92	70
junt.cabin	2006	unclip	lark	im000275	photosma	17mm	19355	18991	21478	19941.33	775.4853	17.09	83
junt.cabin	2006	unclip	lark	im000295	photosma	17mm	3308	3700	3154	3387.333	162.5314	2.90	97
junt.cabin	2006	unclip	lark	im000313	photosma	17mm	21748	23716	24987	23483.67	942.2074	20.12	80
junt.cabin	2006	unclip	lark	im000332	photosma	17mm	337	304	331	324	10.14889	0.28	100
junt.cabin	2006	unclip	sparrow	im000877	photosma	17mm	28	36	32	32	2.309401	0.03	100
junt.cabin	2006	unclip	sparrow	im000897	photosma	17mm	394	411	431	412	10.69268	0.35	100
junt.cabin	2006	unclip	sparrow	im000916	photosma	17mm	1395	1363	1619	1459	80.53157	1.25	99
junt.cabin	2006	unclip	sparrow	im000937	photosma	17mm	3575	3017	3105	3232.333	173.2064	2.77	97
junt.cabin	2006	unclip	sparrow	im000955	photosma	17mm	487	412	479	459.3333	23.77908	0.39	100
junt.cabin	2006	unclip	sparrow	im000973	photosma	17mm	2698	2479	2497	2558	70.19259	2.19	98
junt.cabin	2006	unclip	sparrow	im000993	photosma	17mm	7214	7136	6762	7037.333	139.4959	6.03	94
junt.cabin	2006	unclip	sparrow	im000010	photosma	17mm	1477	1428	1405	1436.667	21.23153	1.23	99
junt.cabin	2006	unclip	sparrow	im000028	photosma	17mm	2105	2422	2481	2336	116.749	2.00	98
junt.cabin	2006	unclip	sparrow	im000044	photosma	17mm	253	266	273	264	5.859465	0.23	100
junt.cabin	2006	unclip	sparrow	im000062	photosma	17mm	8092	8250	8053	8131.667	60.22827	6.97	93
junt.cabin	2006	unclip	sparrow	im000080	photosma	17mm	410	394	416	406.6667	6.565905	0.35	100
junt.cabin	2006	unclip	sparrow	im000098	photosma	17mm	2058	2213	2077	2116	48.80915	1.81	98
junt.cabin	2006	unclip	sparrow	im000119	photosma	17mm	299	235	295	276.3333	20.6989	0.24	100
junt.cabin	2006	unclip	sparrow	im000137	photosma	17mm	103	108	107	106	1.527525	0.09	100
junt.cabin	2006	unclip	sparrow	im000156	photosma	17mm	9032	9025	9378	9145	116.5175	7.84	92
junt.cabin	2006	unclip	sparrow	im000176	photosma	17mm	8187	8705	9106	8666	266.0081	7.43	93
junt.cabin	2006	unclip	sparrow	im000195	photosma	17mm	1003	987	809	933	62.1718	0.80	99
junt.cabin	2006	unclip	sparrow	im000214	photosma	17mm	389	319	385	364.3333	22.69606	0.31	100
junt.cabin	2006	unclip	sparrow	im000236	photosma	17mm	589	628	569	595.3333	17.32372	0.51	99
junt.cabin	2006	unclip	sparrow	im000255	photosma	17mm	9484	10196	10104	9928	223.5829	8.51	91
junt.cabin	2006	unclip	sparrow	im000274	photosma	17mm	5862	5559	5680	5700.333	88.05743	4.88	95
junt.cabin	2006	unclip	sparrow	im000293	photosma	17mm	483	459	474	472	7	0.40	100
junt.cabin	2006	unclip	sparrow	im000312	photosma	17mm	8274	8099	8610	8327.667	149.9337	7.14	93
junt.cabin	2006	unclip	sparrow	im000331	photosma	17mm	130	144	148	140.6667	5.456902	0.12	100



## APPENDIX 1. TRANSECT AND NEST COVER DATA

junction cairn % cover																			
Transect	N Year	Photos	Ob #1	#2	#3	mean	se	% Cover	% Visibility	Plant Wt (g)	UTM	Coor	Path	Date	Comments	Comments 2			
junt.cairn	2006	sparrow	584	542	498	541.3333	24.8283	97	0.03	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	NA	NA	NA	#DIV/0!	#DIV/0!		#DIV/0!	NA			C:\Docum	Aug-06	Something wrong with photo				
junt.cairn	2006	grouse	15794	14187	16440	15473.67	669.8165	85	0.15	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	9111	8197	8837	8715	270.8087	48	0.52	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	28539	27930	28253	28240.67	175.9113	30	0.70	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	78385	78486	78475	78448.67	31.99132	25	0.75	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	303	287	271	287	9.237604	98	0.02	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	2599	2525	2567	2563.667	21.42688	94	0.06	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	10963	10273	10070	10435.33	270.263	90	0.10	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	3027	2927	3291	3081.667	108.5746	81	0.19	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	6605	5639	5754	5999.333	304.6475	85	0.15	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	17269	19540	19599	18802.67	767.0225	82	0.18	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	2240	2382	2289	2303.667	41.64266	86	0.14	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	25244	23372	22747	23787.67	750.1858	41	0.59	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	61476	69548	63854	64959.33	2394.829	38	0.62	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	6697	6155	6647	6499.667	172.9367	61	0.39	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	25563	24013	25563	25046.33	516.6667	38	0.62	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	68479	67351	66971	67600.33	452.8213	36	0.64	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	3883	4482	3922	4095.667	193.4945	75	0.25	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	7880	7646	7567	7697.667	93.97577	81	0.19	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	32015	34809	30442	32422	1276.964	69	0.31	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	319	347	318	328	9.504385	98	0.02	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	654	642	687	661	13.45362	98	0.02	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	6071	5119	5268	5486	295.6456	95	0.05	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	7682	7841	7572	7698.333	78.08187	54	0.46	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	23349	24645	21515	23169.67	907.9914	43	0.57	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	77298	76464	72118	75293.33	1605.817	28	0.72	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	1123	1063	1157	1114.333	27.47929	93	0.07	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	4577	5022	5012	4870.333	146.6951	88	0.12	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	24728	21398	22808	22978	965.0389	78	0.22	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	4596	4300	4752	4549.333	132.551	73	0.27	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	21215	20396	22569	21393.33	633.5967	47	0.53	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	59983	63489	61360	61610.67	1019.826	41	0.59	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	2670	2383	2527	2526.667	82.84993	85	0.15	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	16856	15170	16561	16195.67	519.8559	60	0.40	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	53895	53205	57029	54709.67	1176.649	48	0.52	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	220	264	255	246.3333	13.42055	99	0.01	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	4831	4400	5013	4748	181.759	88	0.12	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	12024	12106	13997	12709	644.4349	88	0.12	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	3245	3100	2838	3061	119.098	82	0.18	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	14696	16500	16840	16012	665.2799	60	0.40	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	44582	48804	42411	45265.67	1876.891	57	0.43	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	246	212	214	224	11.01514	99	0.01	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	NA	NA	NA	#DIV/0!	#DIV/0!		#DIV/0!	NA			C:\Docum	Aug-06	Something wrong with photo				
junt.cairn	2006	grouse	9011	10163	10296	9823.333	407.9773	91	0.09	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	2861	3136	3263	3086.667	118.64	92	0.08	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	196	173	144	171	15.04438	99	0.01	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	684	767	623	691.3333	41.73062	98	0.02	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	10229	10312	9159	9900	371.2739	91	0.09	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	315	344	350	336.3333	10.80638	98	0.02	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	2645	3017	2686	2782.667	117.7629	93	0.07	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	24683	26087	22755	24508.33	965.8222	77	0.23	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	291	254	279	274.6667	10.89852	98	0.02	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	1547	1623	1407	1525.667	63.25961	96	0.04	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	8613	8126	7705	8148	262.3477	92	0.08	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	428	382	377	395.6667	16.23097	98	0.02	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	2517	2661	3023	2733.667	150.5206	93	0.07	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	11998	11964	11228	11730	251.1918	89	0.11	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	410	407	452	423	14.52584	97	0.03	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	3301	3142	3555	3332.667	120.2696	92	0.08	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	11821	10583	11542	11315.33	374.9197	89	0.11	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	122	141	102	121.6667	11.25956	99	0.01	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	1925	2018	1995	1979.333	27.96625	95	0.05	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	7392	7389	7782	7521	130.5029	93	0.07	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	950	1033	1050	1011	30.89229	94	0.06	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	4756	4452	4473	4560.333	98.02097	89	0.11	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	29668	32258	32099	31341.67	838.0912	70	0.30	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	2913	2733	2490	2712	122.5602	84	0.16	NA			C:\Docum	Aug-06					
junt.cairn	2006	lark	15621	15303	15889	15604.33	169.3688	61	0.39	NA			C:\Docum	Aug-06					
junt.cairn	2006	grouse	54373	53070	52409	53284	576.9665	49	0.51	NA			C:\Docum	Aug-06					
junt.cairn	2006	sparrow	NA	NA	NA	#DIV/0!	#DIV/0!		#DIV/0!	NA			C:\Docum	Aug-06	Something wrong with photo				
junt.cairn	2006	lark	669	668	657	664.6667	3.844188	98	0.02	NA			C:\Docum	Aug-06					
junt.cairn	2006																		



**APPENDIX 1. TRANSECT AND NEST COVER DATA**

Vegetation Cover Requirements Project 2006										Page1/4		
Transect Location(UTM):					Stubble Height Species 1:					<i>Pseudoroegneria spicata</i>		
Transect Name: Transect 2 Junction Cairn					Stubble Height Species 2:					<i>Koeleria macrantha</i>		
Date: Aug 17, 2006					Stubble Height Species 3:					<i>Hesperostipa curtiseta</i>		
Recorder: Becky Bings, Cindy Haddow					Stubble Height Species 4:							
Plots: 2m interval starting at 2m along 50m transect; 2 plots at each stop, to right and left of centre.												
All unclipped. Stubble Heights (SH) in cm.												
Plot Number	SH1	SH1	SH2	SH2	SH3	SH3	SH4	SH4	Robel Pole Reading	Photo Sparrow	Photo Meadowlark	Photo Grouse
1 (2m)	41	34	15	12	13	15			15	373	374	375
2 (4m)	31	43	11	16	18	19			0	376	377	378
3 (6m)	36	46	12	13	14	13			15	379	380	381
4 (8m)	32	37	14	16	18	19			5	382	383	384
5 (10m)	42	40	11	12	13	18			2.5	385	386	387
6	37	45	9	10	14	15			2.5	388	389	390
7	32	37	10	7	15	14			0	391	392	393
8	37	29	9	9	14	19			20	394	395	396
9	30	35	14	15	14	18			0	397	398	399
10 (20m)	34	34	14	7	11	16			7.5	400	401	402
11	38	41	10	10	14	15			5	403	404	405
12	31	37	9	8	24	17			10	406	408	409
13	37	38	9	11	19	16			12.5	410	411	412
14	37	35	7	8	12	12			10	413	414	415
15	35	37	8	11	8	15			15	416	419	418
16	40	39	9	8	18	21			15	420	421	422
17	42	39	10	11	21	20			20	423	424	425
18	35	39	9	10	20	14			15	426	427	428
19	39	37	10	9	26	22			12.5	429	430	431
20	35	37	14	17	29	24			7.5	432	433	434
21	50	48	16	13	34	36			12.5	435	436	437
22	41	33	16	18	40	33			7.5	438	439	440
23	48	40	13	10	20	34			5	441	442	443
24	40	40	17	6	39	32			15	444	445	446
25 (50m)	40	33	14	8	37	26			10	447	448	449

## APPENDIX 1. TRANSECT AND NEST COVER DATA

Transect N	Year	Photos Ob	#1	#2	#3	mean	se	% Cover	% Visibility	Comments	Comments 2
junt.mid	2006	grouse	60618	59222	61714	60518	721.114	42	0.58		
junt.mid	2006	grouse	47916	50015	51092	49674.33	932.5207	53	0.47		
junt.mid	2006	grouse	40114	40130	40798	40347.33	225.3807	62	0.38		
junt.mid	2006	grouse	20605	23493	20412	21503.33	996.3922	79	0.21		
junt.mid	2006	grouse	51443	50960	53548	51983.67	794.497	50	0.50		
junt.mid	2006	grouse	45957	44557	44564	45026	465.5044	57	0.43		
junt.mid	2006	grouse	24401	20732	23509	22880.67	1104.761	78	0.22		
junt.mid	2006	grouse	3459	3667	3457	3527.667	69.66906	97	0.03		
junt.mid	2006	grouse	11385	10819	10936	11046.67	172.5054	89	0.11		
junt.mid	2006	grouse	32855	30399	31742	31665.33	710.0217	70	0.30		
junt.mid	2006	grouse	54078	50181	52374	52211	1127.915	50	0.50		
junt.mid	2006	grouse	61778	58472	55421	58557	1835.6	44	0.56		
junt.mid	2006	grouse	69940	69677	73511	71042.67	1236.5	32	0.68		
junt.mid	2006	grouse	31412	36252	32012	33225.33	1523.213	68	0.32		
junt.mid	2006	grouse	47350	46393	44665	46136	785.6723	56	0.44		
junt.mid	2006	grouse	45028	44703	43698	44476.33	400.3158	58	0.42		
junt.mid	2006	grouse	63113	69404	66885	66467.33	1828.023	37	0.63		
junt.mid	2006	grouse	38287	40723	38454	39154.67	785.6472	63	0.37		
junt.mid	2006	grouse	31508	32872	32973	32451	472.4006	69	0.31		
junt.mid	2006	grouse	54058	52291	50059	52136	1157.01	50	0.50		
junt.mid	2006	grouse	56582	48637	56444	53887.67	2625.636	49	0.51		
junt.mid	2006	grouse	55121	52065	50138	52441.33	1450.723	50	0.50		
junt.mid	2006	grouse	82737	83260	82780	82925.67	167.6269	21	0.79		
junt.mid	2006	grouse	25530	29934	28806	28090	1320.769	73	0.27		
junt.mid	2006	grouse	48493	46874	44881	46749.33	1044.556	55	0.45		
junt.mid	2006	lark	17573	16627	14975	16391.67	759.1525	60	0.40		
junt.mid	2006	lark	14714	17156	15548	15806	716.6505	61	0.39		
junt.mid	2006	lark	10344	8419	8933	9232	575.4584	77	0.23		
junt.mid	2006	lark	11917	12901	10978	11932	555.1729	71	0.29		
junt.mid	2006	lark	17694	15704	16241	16546.33	594.4034	59	0.41		
junt.mid	2006	lark	9873	10348	9635	9952	209.5813	75	0.25		
junt.mid	2006	lark	7018	6551	6085	6551.333	269.334	84	0.16		
junt.mid	2006	lark	2215	2146	2343	2234.667	57.71289	94	0.06		
junt.mid	2006	lark	246	218	270	244.6667	15.0259	99	0.01		
junt.mid	2006	lark	7828	7344	6590	7254	360.2018	82	0.18		
junt.mid	2006	lark	16306	19016	18043	17788.33	792.6046	56	0.44		
junt.mid	2006	lark	25093	26260	26628	25993.67	462.6937	36	0.64		
junt.mid	2006	lark	30345	29035	28816	29398.67	477.3714	27	0.73		
junt.mid	2006	lark	8872	9246	8894	9004	121.1666	78	0.22		
junt.mid	2006	lark	14903	13969	14155	14342.33	285.4291	65	0.35		
junt.mid	2006	lark	15444	13003	14077	14174.67	706.3461	65	0.35		
junt.mid	2006	lark	28865	28556	30550	29323.67	619.6209	28	0.72		
junt.mid	2006	lark	13647	13722	11854	13074.33	610.5507	68	0.32		
junt.mid	2006	lark	13673	13031	12741	13148.33	275.3672	68	0.32		
junt.mid	2006	lark	15924	14848	15136	15302.67	321.5988	62	0.38		
junt.mid	2006	lark	15827	14804	14812	15147.67	339.6745	63	0.37		
junt.mid	2006	lark	13895	12531	12988	13138	400.8321	68	0.32		
junt.mid	2006	lark	28736	24789	26472	26665.67	1143.508	34	0.66		
junt.mid	2006	lark	10727	10194	10559	10493.33	157.328	74	0.26		
junt.mid	2006	lark	NA	NA	NA	#DIV/0!	#DIV/0!	#DIV/0!	something wrong with photo		
junt.mid	2006	sparrow	4120	4368	4574	4354	131.2453	74	0.26		
junt.mid	2006	sparrow	2679	2690	2332	2567	117.5429	85	0.15		
junt.mid	2006	sparrow	753	618	722	697.6667	40.82619	96	0.04		
junt.mid	2006	sparrow	999	1068	1022	1029.667	20.28409	94	0.06		
junt.mid	2006	sparrow	3295	3316	3195	3268.667	37.32887	80	0.20		
junt.mid	2006	sparrow	796	609	646	683.6667	57.17323	96	0.04		
junt.mid	2006	sparrow	578	538	552	556	11.71893	97	0.03		
junt.mid	2006	sparrow	268	269	233	256.6667	11.83685	98	0.02		
junt.mid	2006	sparrow	42	71	42	51.66667	9.666667	100	0.00	obscured..	
junt.mid	2006	sparrow	1920	1733	1986	1879.667	75.76792	89	0.11		
junt.mid	2006	sparrow	5513	5258	6115	5628.667	254.0645	66	0.34		
junt.mid	2006	sparrow	8008	8758	7871	8212.333	275.6848	51	0.49		
junt.mid	2006	sparrow	12732	12529	11194	12151.67	482.4059	27	0.73		
junt.mid	2006	sparrow	480	592	536	536	32.33162	97	0.03		
junt.mid	2006	sparrow	4280	3761	3704	3915	183.2403	76	0.24		
junt.mid	2006	sparrow	2486	2207	2320	2337.667	81.02332	86	0.14		
junt.mid	2006	sparrow	9945	9751	10037	9911	84.29314	40	0.60		
junt.mid	2006	sparrow	2877	3143	3163	3061	92.18098	82	0.18		
junt.mid	2006	sparrow	825	1055	905	928.3333	67.41249	94	0.06		
junt.mid	2006	sparrow	8680	7811	7956	8149	268.7793	51	0.49		
junt.mid	2006	sparrow	2490	2151	2452	2364.333	107.2292	86	0.14		
junt.mid	2006	sparrow	4299	4192	4722	4404.333	161.8089	74	0.26		
junt.mid	2006	sparrow	8663	7698	7261	7874	414.1791	53	0.47		
junt.mid	2006	sparrow	300	355	369	341.3333	21.05812	98	0.02		
junt.mid	2006	sparrow	1594	1292	1449	1445	87.20283	91	0.09		
junt.mid	2006	vole	54706	52230	51745	52894	916.9188	32	0.68		
junt.mid	2006	vole	39140	35055	39607	37934	1445.799	51	0.49		
junt.mid	2006	vole	67289	67340	66539	67056	258.9189	13	0.87		
junt.mid	2006	vole	52438	53417	49160	51672	1287.24	33	0.67		
junt.mid	2006	vole	51758	52240	50253	51417	598.4015	34	0.66		
junt.mid	2006	vole	64564	64927	64382	64624	160.194	17	0.83		
junt.mid	2006	vole	47641	46981	46791	47138	257.5742	39	0.61		
junt.mid	2006	vole	42061	43817	42158	42679	569.855	45	0.55		
junt.mid	2006	vole	74685	76003	75424	75371	381.4072	3	0.97		
junt.mid	2006	vole	67303	65309	64999	65870	721.9015	15	0.85		

## APPENDIX 1. TRANSECT AND NEST COVER DATA

Vegetation Cover Requirements Project 2006				
Transect Location(UTM):		Stubble Height Species 1:		<i>Pseudoroegneria spicata</i>
Transect Name: Transect 3 Junction Middle		Stubble Height Species 2:		<i>Koeleria macrantha</i>
Date: Aug 18, 2006		Stubble Height Species 3:		<i>Achnatherum richardsonii</i>
Recorder: Becky Bings, Cindy Haddow		Stubble Height Species 4:		<i>Hesperostipa curtiseta</i>
Plots: 2m interval starting at 2m along 50m transect; 2 plots at each stop, to right and left of centre.				All unclipped.
Plot Number	Robel Pole Reading	Photo Sparrow	Photo Meadowlark	Photo Grouse
1 (2m)	5	451	452	453
2 (4m)	5	454	455	456
3 (6m)	7.5	457	458	459
4 (8m)	10	460	461	462
5 (10m)	5	463	464	465
6	10	466	467	468
7	5	469	470	471
8	15	472	473	474
9	22.5	475	476	477
10 (20m)	15	478	479	480
11	2.5	481	482	483
12	2.5	484	485	486
13	0	487	488	489
14	17.5	490	491	492
15	0	493	494	495
16	10	497	498	499
17	0	501	502	503
18	2.5	504	505	506
19	2.5	507	508	509
20	0	510	511	512
21	15	513	514	515
22	12.5	516	517	518
23	0	519	520	521
24	12.5	522	523	524
25 (50m)	12.5	525	526	527
Stubble Heights (cm) separate transect from photos				
SH1	SH2	SH3	SH4	
33	11	22	23	
36	11	24	21	
31	8	18	26	
31	6	27	26	
38	10	31	26	
24	9	23	22	
33	8	35	35	
34	10	24	25	
33	9	26	30	
40	9	21	22	
39	9	28	46	
40	10	32	28	
40	9	26	16	
45	10	25	21	
33	11	26	22	
36	8	24	27	
42	13	22	16	
31	12	16	2	
29	7	19	18	
33	4	16	22	
38	12	16	14	
31	11	15	19	
37	8	18	16	
32	6	23	29	
29	4	26	21	
28	6	27	19	
30	12	28	20	
41	11	19	19	
38	11	16	23	
40	7	25	14	
33	9	20	15	
33	10	21	11	
34	9	22	14	
27	8	23	16	
37	11	25	23	
39	13	18	18	
28	6	16	22	
32	10	17	21	
38	10	20	17	
22	7	18	14	
39	8	17	21	
35	11	20	17	
34	7	15	10	
32	10	22	16	
34	11	13	13	
39	5	17	14	
26	9	15	30	
32	7	19	12	
29	13	20	23	
30	9	16	21	

