Assessment Method for Vegetative Cover Requirements of Wildlife Species in the Cariboo Grasslands of British Columbia

Initial Assessment of Data Quality and Needs

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1.0 INTRODUCTION

The grasslands of British Columbia provide habitat for a wide variety of wildlife species; therefore, it is important to develop useful tools for monitoring grasslands to ensure the appropriate management of habitat. This is especially true in multi-use landscapes. Vegetation structure is an important determinant to where birds and small mammals choose to reside. Livestock grazing alters the structure of grassland vegetation and thus may impact the quality and quantity of areas suitable to wildlife species. Analyzing the amount of vegetative cover available in different grassland types and with different grazing regimes is one method of assessing how grazing impacts wildlife species. To this end the British Columbia Ministry of Environment (Cindy Haddow and Becky Bings) have undertaken the development of methods to assess the vegetative cover requirements of ground nesting birds and small mammals in Cariboo region of southcentral British Columbia. The specific objectives of this project are:

1) To determine hiding and nesting cover requirements for selected ground nesting birds and small mammals in livestock grazed and ungrazed Cariboo grassland ecosystems;

2) To develop visual screening monitoring tools for application in Cariboo grassland ecosystems to help evaluate and manage the impacts of livestock grazing on wildlife habitat quality;

3) To use the information from this project to create Best Management Practices document (BMP), which will aid in meeting the Forest and Range Practices Act (FRPA) objective "To maintain or promote sustainable healthy, viable, productive and diverse wildlife populations and their associated habitat".

Photos of shapes (cut-outs) representing sharp-tailed grouse (*Tympanuchus phasianellus*), western meadowlark (*Sturnella neglecta*), vesper sparrow (*Pooecetes gramineus*), and voles (*Microtus sp.*) were taken in 2006 and 2007 (along with Robel pole readings). For bird species, this entailed taking a photo of a representative cut-out of each species at a specific distance. The vegetation between the camera and cut-out was left intact and photos were taken both inside and outside grazing exlosures. Additional photos were taken with the clipping of vegetation to 25, 20, 10, 15 and 5 cm vegetation heights above the ground. For voles (represented by doweling 10 cm long by 2.5 cm diameter) a 0.5 m^2 frame was placed on the ground, the camera was set above at a height of 1 m, and a photo was taken. Each photo was examined using freely available computer software (GNU Image Manipulation Program, GIMP 2.2.12) and the number of pixels representing the cut-out or doweling that were not obscured by vegetation were counted. The number of visible pixels was then compared to a representative photo taken of the cut-out when it was not obscured by vegetation (i.e., it was completely visible) and the difference in the number of pixels was calculated (i.e., percent visibility).

This report, and its accompanying spreadsheet, summarizes the data collected in 2006 and 2007 from grazed and ungrazed areas in different grassland locations throughout the Cariboo region of southcentral British Columbia. Our objectives are to:

- analyze all digital photos following in a consistent method;
- design a spreadsheet to contain information about each picture and site;
- provide a brief summary of the data collected;
- outline possible approaches to the analysis of this data;
- recommend future data collection efforts.

Thus, this report is intended as an interim document, to compile and summarize data collected thus far and to guide future data collection and analysis activities. It contains: (1) study sites and samples sizes; (2) photo interpretation; (3) data compilation; (4) data summary and assessments; and (4) a summary and recommendations for future work. This report is not intended as a comprehensive analysis; rather it is a brief assessment of data quality and gaps.

2.0 STUDY SITES

Photos were taken at 9 study sites throughout the Cariboo region of southcentral British Columbia (Table 1). The location of each site was recorded in a Universal Transverse Mercator (UTM) projection standardized to the 1983 North American Datum (NAD 83) for UTM Zone 10 N. These location are Loran C (0541505, 5759561), Snake Pit (0540049, 5759417), Toosey (0534708, 57755612), Junction Cabin (0538100, 5738705), Junction Cairn (0540575, 5736331), Junction Mid (0539518, 5737552), Doc Eng Glul (0545454, 5754073), Sword Creek (543748, 5761788), and OK Ranch (unavailable).

Table 1: Study sites for grassland cover assessment plots in the Cariboo region of southcentral British Columbia including grassland type, year of sampling, grazing status, the cut-out types examined, and number of photos taken

Site Name	Grassland Type[1]	Year	Grazing Status[2]	Photo Type[3]	Number of Transects/Photos
Loran C	Mixed Grass	2005	ungrazed	Both	481
	Mixed Grass		grazed	Both	20
Snake Pit	Needle Grass	2005	ungrazed	Both	470
			grazed	Both	20
Toosey	Bunch Grass	2005	ungrazed	Both	470
Junction Cabin	Bunch Grass	2006	ungrazed	Both	456
			grazed	Both	20
Junction Cairn	Mixed Grass	2006	Ungrazed	Both	87
Junction Mid	Mixed Grass	2006	Ungrazed	Both	85
Doc eng glul	Mixed Grass	2007	Grazed	Bird	92
Sword Creek	Mixed Grass	2007	Grazed	Both	98
OK Ranch	?	2006	?	Both	108
		2007	?	Bird	96

[1] Needle Grass = *Hesperostipa curtiseta*, Bunch Grass = *Pseudogregnaria spicata*, Mixed Grass= some combination of *Hesperostipa curtiseta, Poa pratensis, Acnatherum richardsonii, Acnatherum occidentale, Koeleria macrantha, Festuca saximontana, Pseudoroegnaria spicata, Poa sandbergii, Potentilla pennsylvanica, Achillea millefolium and Tragopogon sp.*

[2] Grazing status was determined by whether sample transect was located inside or outside a grazing exclosure. Ungrazed transect were inside grazing exclosure, Grazed transects were outside grazing exclosure.

[3] Photo types include: Bird = all three bird species cut-outs, Both = bird cut-outs and vole doweling

3.0 PHOTO INTERPRETATION

Photo interpretation activities were coordinated with the Ministry of Environment staff to ensure consistent and repeatable pixel counts. To ensure some measure of precision, the number of visible pixels of each cut-out on each photo was counted three times using PROGRAM GIMP v2.2.12. Each photo was cropped to the size of the cut-out and zoomed to 200%. The 'colour select' tool was used to select pixels of the cut-out not covered by vegetation. Other locations were selected until all pigments of the cut-out were selected within the cut-out. Certain 'selection thresholds' were useful for different photo qualities. For example, darker photos (i.e., taken on an overcast day) were more easily processed using a selection threshold of 15. For other photos, a threshold of 40 was initially used and the threshold was changed to 15 to select more detailed areas on subsequent selections. After all visible pixels were selected; each photo was screened to ensure that no other pixels (e.g., grass, hands tools, etc) were accidentally selected along with those of the cut-out. The mean pixel count was then calculated and recorded into a spreadsheet. A sub-sample of photos was independently assessed by Ministry of Environment staff (Cindy Haddow and Becky Bings) in order to ensure consistent and repeatable results. Photos representing a range in the amount of cover obscuring the photo were sent for outside interpretation at the Ministry of Environment during photo interpretation activities. Our pixel counts were consistent with those done by Ministry of Environment staff on the sub-sample of photos selected.

4.0 DATA COMPILATION

Photo information, pixel counts, site and vegetation information was synthesized into a single spreadsheet (Table 2). The average pixel count and standard error was calculated for each photo. Visual obscurity was expressed as a percent, by comparing the average number of pixels covering the cut-out and not obscured by vegetation to a reference photo where the entire cut-out was visible. The reference photos were chosen such that they have the same focal length, were taken with the same camera model, and following the same procedures as with the initial photos.

Table 2: Field names and descriptions of the data available (speadsheet attached to this report).

FIELD NAME	EXPLANATION
Transect Name	Name of the site
Inside/Outside Exclosures	Outside of exclosures is grazed, inside is protected from grazing
Year	Year of data collection
Plot Number	Location along transect and direction of photo
Plot Type	Height of vegetation clipping (cm)
Litter	Vole plots had litter removed, or available
Photos Object	Animal cut out in photo: Vesper sparrow, Western meadowlark, Sage grouse, or vole.
Photo Number	The title of the photo file
Camera Model	Model of camera used to take photographs
Camera Focal Length	Focal Length in mm used to take photographs
#1	First pixel count
#2	Second pixel count
#3	Third pixel count
mean	Mean pixel count
se	Standard error of pixel count
% Visibility	Percent visibility of pixel count, via comparison to a reference photo pixel count (the amount of the cut out not covered by vegetation, in proportion to the total cut-out size)
Robel Pole	Height of vegetation against Robel pole (cm)
SH1a	First stubble height of grass species 1 (cm)
SH1b	Second stubble height of grass species 1 (cm)
SH1 Median	Median stubble height of grass species 1 (cm)
SH2a	First stubble height of grass species 2 (cm)
SH2b	Second stubble height of grass species 2 (cm)
SH2 Median	Mean stubble height of grass species 2 (cm)
SH3a	First stubble height of grass species 3 (cm)
SH3b	Second stubble height of grass species 3 (cm)
SH3 Medain	Mean stubble height of grass species 3 (cm)
SH4a	First stubble height of grass species 4 (cm)
SH4b	Second stubble height of grass species 4 (cm)
SH4 Median	Median stubble height of grass species 4 (cm)
SH1 id	Scientific name of grass species 1
SH 2 id	Scientific name of grass species 2
SH 3 id	Scientific name of grass species 3
SH 4 id	Scientific name of grass species 4
Small Mammal Activity	Was there small mammal activity detected (y/n)
Litter Wt (g)	Weight of plant litter (g)
Plant Wt (g)	Weight of live plant (g)
UTM Coordinates	Universal
Path	Where the photo is located
Date	Date photo was taken
Dominant Vegetation	"Mixed", or the scientific name of the dominant plant
Comments 1	Comments about photo quality
Comments 2	Notes from data sheets

5.0 DATA SUMMARY AND ASSESSMENTS

We developed a series of interim analysis questions (i.e., empirical hypotheses) in order to assess the data that have been collect thus far. These questions are designed to provide a preliminary assessment of data quality and quantity and thus can be used to guide future data collection and analysis needs. The questions were developed in order to meet primary research questions outlined by the BC Ministry of Environment. Our interim data assessment questions are:

1) Is there a difference in visibility between study sites?
2) Is there a difference in visibility between grassland types?
3) Is there a difference between using pixel counts and the Robel pole?
4) Is there a difference in visibility between grassland types for each cut-out type?
5) Is there a difference in visibility at each clipping level between cut-out types?

Is there a difference in the visibility between study sites?

We compared all photos taken at 7 sites where the vegetation had not been clipped grouped by grazing history. If there is no difference between sites, these sites can be grouped in future analyzes; if sites are different, they should be assessed individually. We would expect to see differences in the visibility of cut-outs for each site if sites provided different amounts of cover for wildlife species. Additionally, we expect to see differences between sites with different grazing histories. Therefore, we summarized data from grazed sites (Figure 1) and ungrazed sites (Figure 2) by bird cut-out type.

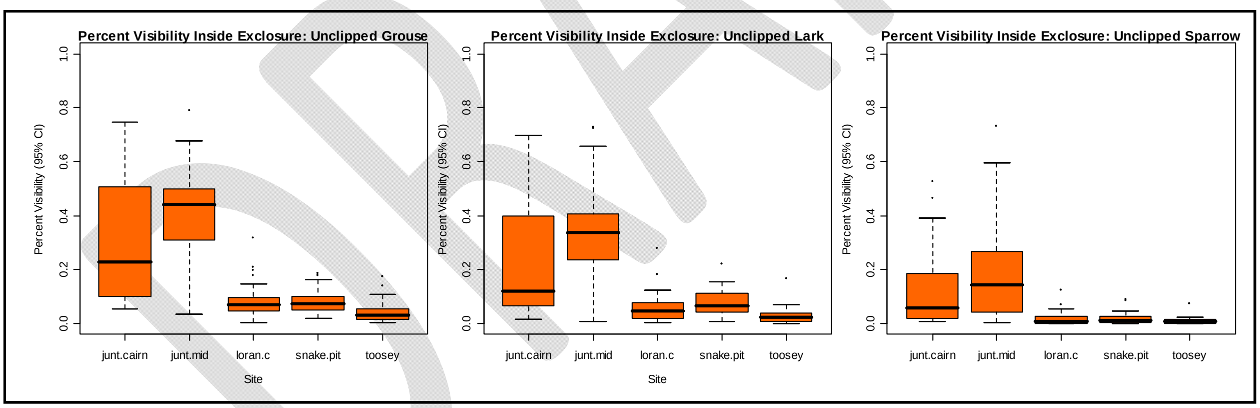

Figure 1: Percent visibility of bird cutouts by type with no clipping treatment and no grazing. Box plots provide with 95% confidence intervals (boxes) and Quartiles (lines). Sample sizes are provided in Table 1.

These data show differences between sites at both grazed and ungrazed locations. Ungrazed sites can be grouped into roughly two categories with some sites showing little variation in the amount of cover at each site and some sites have large amounts (Figure 1). Loran C, Snake Pit, and Toosey sites show little variation in the percent visibility of photos, and Junction Cairn and Junction Middle sites show larger amounts of variation. Loran C, Snake Pit, and Toosey sites appear more similar to each other than to the Junction sites. We were only able to assess two grazed sites and these appear quite different from each other (Figure 2).

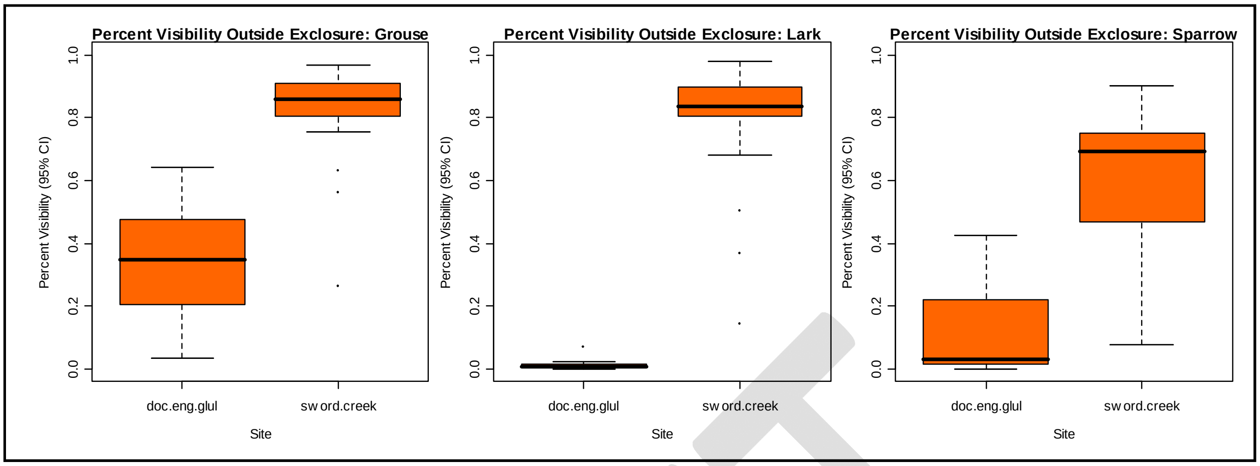

Figure 2: Percent visibility of bird cut-outs by type with no clipping treatment and with grazing. Box plots provide with 95% confidence intervals (boxes) and Quartiles (lines). Sample sizes are provided in Table 1.

Differences in the percent visibility between sites may arise from a number of factors and future data collection and analysis activities should attempt to address this. First, the growing conditions (e.g., productivity) of each site may differ from others and result in different amounts of cover for wildlife. Alternatively, differences in the species composition of the dominant vegetation may differ between sites resulting in differences in the amount of cover available for wildlife. Future data collection activities should increasing the number sites located in grazed locations since only two sites have data collected in grazed areas and because there is a large amount of variation between photos taken at grazed sites. Also, a larger number of photos taken at the Junction Middle and Junction Cairn sites may reduce the amount of variation seen in photos at these sites.

Is there a difference in visibility between grassland types?

Along with grazing, the dominant vegetation occurring at a site may influence the amount of cover available for wildlife species. For this preliminary summary, we defined grassland type by the dominant grass species that occurred at each site. If a site was dominated by more than one grass, it was classified as a mixed grassland type. This classification system has resulted in three main grassland types (Table 3).

We compared photos take in each of the grassland type for each bird species cut-out type. Similar to the site level analysis, we were interested in determining whether photos could be grouped by grassland type in future analysis, and if our delineation of grassland type was suitable. We expect to see differences between photos taken at sites with similar dominant vegetation types (i.e., grassland type). If our classification of grassland type is adequate we expect to see similar patterns to those seen in the site analysis (Figure 1 and 2), and we expect to see strong
differences between grassland types for each bird cut-out type. Therefore, we summarized data by dominant grassland type for each bird cut-out type (Figure 3).

Table 3: Grassland types as determined by dominant vegetation of each site and number of photos taken in each type.

Dominant Vegetation	**Dominant Species**	**Site Name**
Bunch Grass (p.spic)	*Pseudoregenaria spicata*	Toosey, JunctCabin
Porcupine Grass (h.curt)	*Hesperostipa curtiseta*	SnakePit
Mixed Grass (mix)	n/a	Doc, Swordcreek, JunctMid, JunctCairn, LoranC

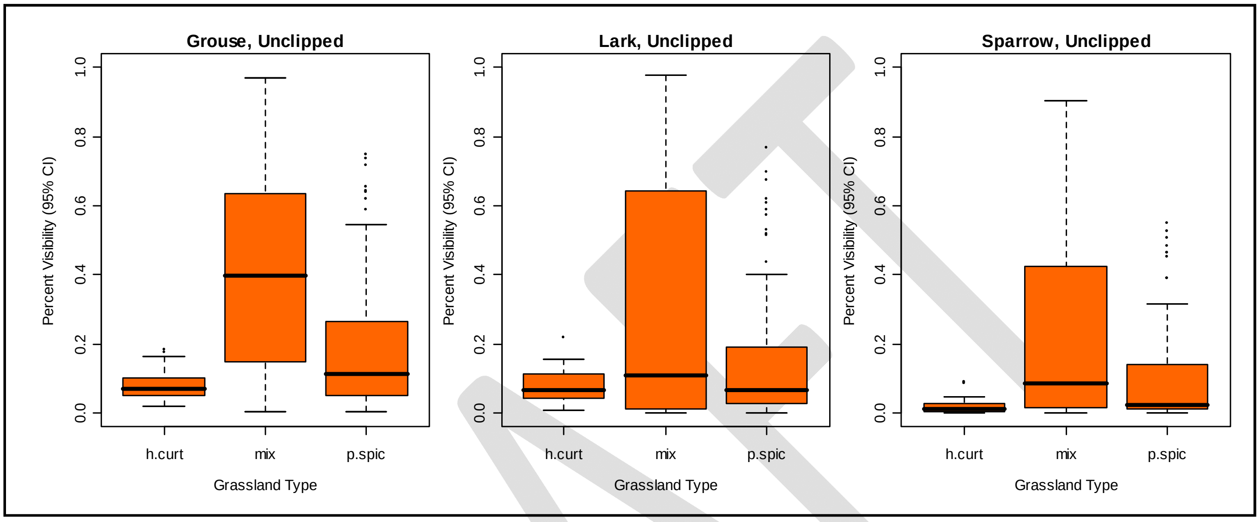

Figure 3: Percent visibility for each grassland type with 95% confidence intervals (boxes), and Quartiles (lines) for all sites inside grazing exlosures for data from unclipped plots grouped by bird cut-out type.

We observed only limited differences between photos taken in different grassland types and observed little correlation between the site location data and grassland type data. Data from all grassland types appears quite similar, although porcupine grass sites may be different from other types (Figure 3). However, the large amount of variation within grassland types somewhat obscures these relationships. There is a particularly large amount of variability in mixed grassland data. For each bird type, the trend in variation is the same; a large amount of variation is observed in mixed grasslands and very small amount of variation is seen in the western porcupine grass type. Additionally, because stronger differences were observed between study sites and because site groupings don't correlate with grassland type our classification of grassland types does not appear adequate.

Grassland cover types may be better defined by using other site level variables such as: moisture level (e.g., xeric, mesic, hydric), soil type, elevation, aspect, physical structure (e.g., vegetation height), geographic area (i.e., site), stubble height, biomass, or some combination of these descriptors. At this time we have only limited information on the conditions of each site and are not able to classify grasslands in different ways. Upon further investigation and with new site level description variables, it might be possible to simply separate the mixed grassland type by some metric to create a number of new categories. Further assessments of the differences between grassland types should include a statistical (not simply qualitative) assessment of the differences between grassland types. This analysis (an ANOVA or other similar assessment) would provide a better delineation of differences between grassland types. If the grassland types are separated appropriately, this type of test would become more powerful.

With improved information on the nature of each site it may be possible to statistically define grassland types. A principle components analysis, or other similar assessment, performed on site descriptors may be able to help guide the definition of grassland types. However, this statistical treatment, and the final definition of grassland type, must be sensitive to future management objectives. If grassland types are defined in a manner different from how livestock are distributed by range managers, this project will provide little useful information.

Is there a difference between using pixel counts and the Robel pole?

One fundamental objective of this project is to assess whether using photo interpretation of bird species cut-outs improves the amount of information over using traditional Robel pole readings. If photo interpretation and Robel pole methods provide similar assessments of the obscurity of grassland vegetation, we would expect these methods readings to be highly correlated. We would expect to see a strong relationship between the reading taken with the Robel pole and those obtained through digital photo interpretation and this relationship should be similar between all grassland types and for all cut-out types. The correlation between Robel pole and digital photo measurements should be the same across all levels of visibility and for all cut-out sizes. To qualitatively examine the relationship between Robel pole readings and measurements taken with digital photos, we examined these relationships for all grassland types and bird cut-out types (Figure 4).

We observed that the variability between Robel pole readings and digital photo measurements was relatively high and that the correlation between these readings appears to differ across the range of visibility examined. For all grassland types the relationship between the sparrow cut-out and Robel pole readings was much closer than either the grouse or lark cut-out (Figure 4). The grouse cut-out showed the largest amount of variability relative to Robel pole readings. The change in correlation between cut-out types across the range of obscurity examined (i.e., slope of the line) was different for different cut-out types and for all grassland types. This relationship seemed different for the sparrow cut-out than for the grouse or lark cut-out and for all grassland types. The grouse and lark cut-out types showed similar changes for mixed and bunchgrass types, but the change in the correlation between Robel pole and digital photo readings was different for all cut-out types in the porcupine grassland type.

We think that digital photo interpretation is an improved method of measuring grassland cover over the Robel pole. Our qualitative assessment suggests this might be the case since Robel pole readings vary widely for individual measures of percent visibility (Figure 4). However, how theses correlations may not be consistent across cut-out type or grassland type. This suggests differences between Robel pole readings and those obtained with digital photo interpretation stemming from both the size of the cut-out used and across different grassland types. As described above, a reclassification of grassland type may improve this relationship; however, differences between readings taken across a range of cover values and differences due the effect of cut-out size need further investigation.

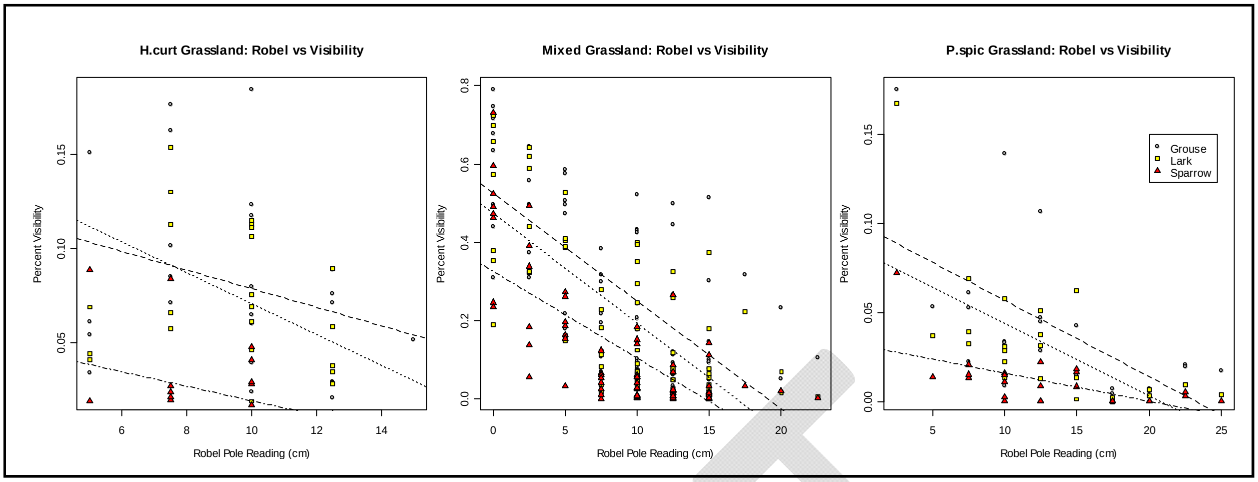

Figure 4: The percent visibility of each cut-out type for different readings of the Robel pole for ungrazed sites where no vegetation clipping occurred separated by grassland type. Sample sizes are provided in Table 3.

We suggest a more complete assessment the differences between Robel pole readings and those made with digital photos. This analysis would be substantially improved with the inclusion of new data. A further analysis should include links to obscurity at nest sites, comparisons to actual vegetation height, and an assessment of how each metric varies with different levels of visibility (clipping level or site level variables). New grassland vegetation type classifications would help future analyzes by reducing the amount of variation with each vegetation category (especially mixed grass). Additionally, assessing how the Robel pole readings correlate with stubble heights (and/or biomass) measured at each site may provide additional information.

Improvements of digital photo measurements over Robel pole readings occur because of two factors. First, digital photo measurements provide a more precise measurement how the height of vegetation changes between locations. The fine scale measurement of pixels will provide greater resolution than the categorical measures obtained with the Robel pole. Second, digital photo measurements provide some indication of horizontal vegetation cover. The growth form of bunch grass distributes cover unevenly in a horizontal direction, where other grasses (such as western porcupine grass) distribute horizontal cover more evenly. The Robel pole does not account for these differences, but digital photos may. However, how well digital photos measurements assess the distribution of cover will change with the size of the cut-out used. How the correlation between the amount of cover and size of cut-out used to measure it changes must be assessed.

Is there a difference in visibility between grassland types for each cut-out type?

This project seeks to develop an improved method of measuring vegetative cover in grassland ecosystems. Three sizes of cut-outs were used to simulate the cover afforded to three representative bird species. The size of each cut-out type may result in differences in the ability to measure the amount of cover afforded to wildlife species. For example, since obscurity is a relative measurement a large cut-out may show only small differences in the percent visibility afforded by different grassland types where a small cut-out will a large difference. Alternatively, small cut-outs may not show any difference if a grassland type completely obscures the cut-out, but large cut-outs may detect this difference. To assess the effect of cut-out type, we examined the distribution of the percent visibility for each cut-out type by grassland type (Figure 5).

The range of variability appears similar for each grassland type but the distribution of cover measurements differs between cut-out types. As expected each grassland type provides a different maximum visibility with only mixed grassland providing measurements that completely obscured the cut-out (Figure 5). The distribution of cover measurements appears different for the grouse cut-out than for the lark or sparrow cut-out. The smaller cut-outs (lark and sparrow) had a higher frequency of measurements in the high percent cover categories and the grouse cut-out provided a more even distribution of cover measurements. These differences suggest that the amount of cover provide by grasslands does change by grassland type, although cut-outs did not appear to capture the entire range in variability provided by the mixed grass type (i.e., cut-outs were too small). Additionally, because the distribution in cover measurements, take at the same site, differs between cut-out type and from the results described above (Figure 4) it appears that the assessment of cover with cut-outs may change dependent on cut-out type. Again, this relationship needs further investigation.

The effect of cut-out type may have an important influence on the assessment of vegetative cover and the relationship between cut-out type, grassland type, and clipping level should be examined further. As we have described above this analysis will be improved by a re-evaluation of grassland types and an assessment of how Robel pole reading vary with cut-out type and grassland type. Many of the investigations described above will help determine the effect of cut-out type on assessments of vegetative cover measurements and a comparison of cover measurements take at bird nesting locations and at other comparison points will help determine if the cut-out sizes and shapes are adequate to fulfill project objectives.

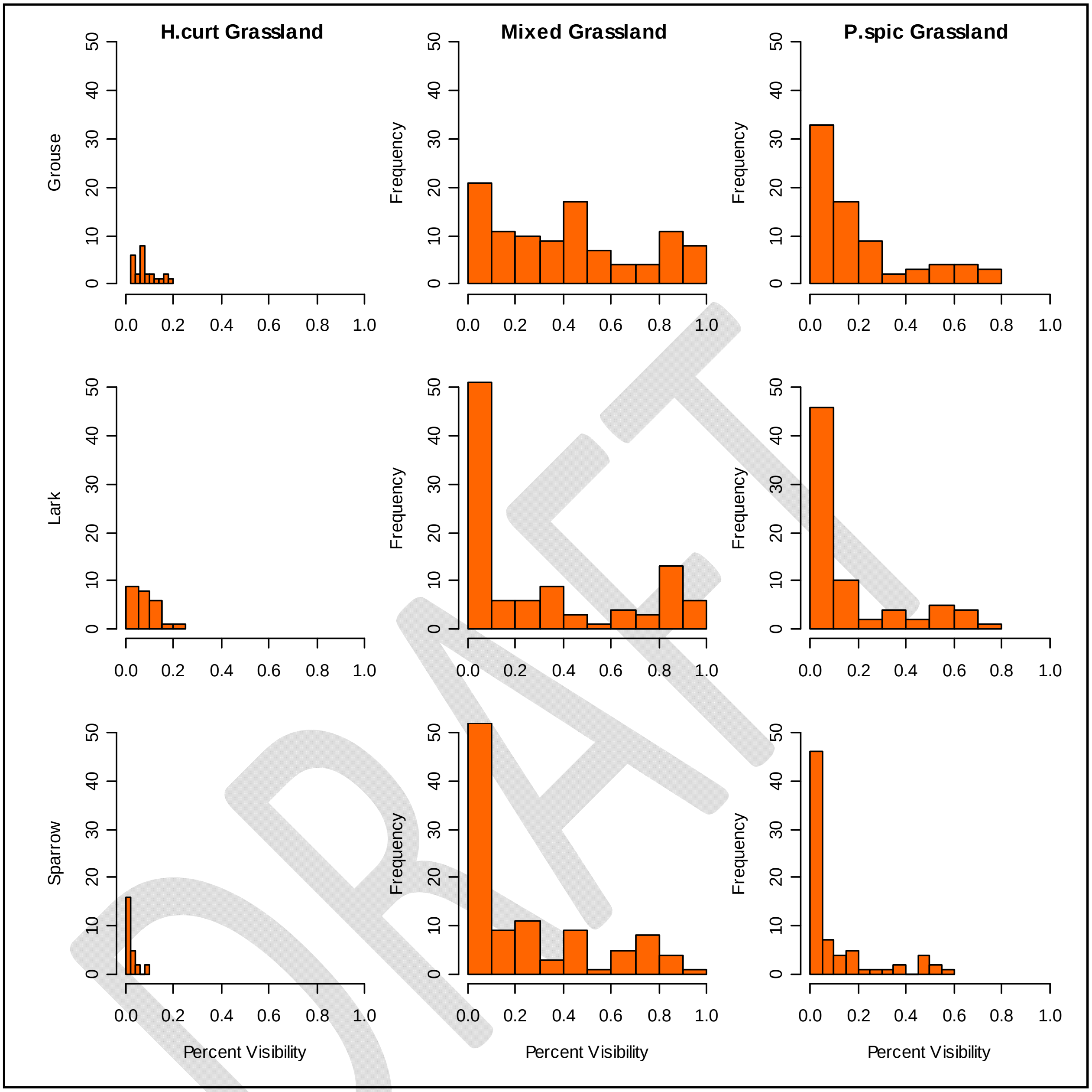

Figure 5: Histograms of the distribution of percent visibility by grassland type (*Hesperostipa curtiseta*, Mixed, or *Pseudoregenaria spicata*) and bird species of cut-out (Grouse, Lark, or Sparrow). Sample sizes are provided in Table 1.

Is there a difference in visibility at each clipping level between cut-out types?

The impact of grazing levels on grassland cover was simulated by clipping vegetation to different heights and measuring changes in the amount of cover. This will show how measurements of cover, taken with both digital photos and the Robel pole, will change across a range of grazing intensities. This information will help standardize and assess readings. When linked to grazing intensity, it will also help infer the effect of grazing on treatments. We expect to see a similar rate in the reduction of cover with each cut-out type in each grassland type. The rate in the reduction of cover may vary between grassland types, since each grassland type distributes cover in a different manner. To determine if the rate of change in visibility with clipping is different between cut-out types and between grassland types we qualitatively examined whether the slope of the line representing the change in visibility with clipping was different for each cut-out type and between grassland types (Figure 6).

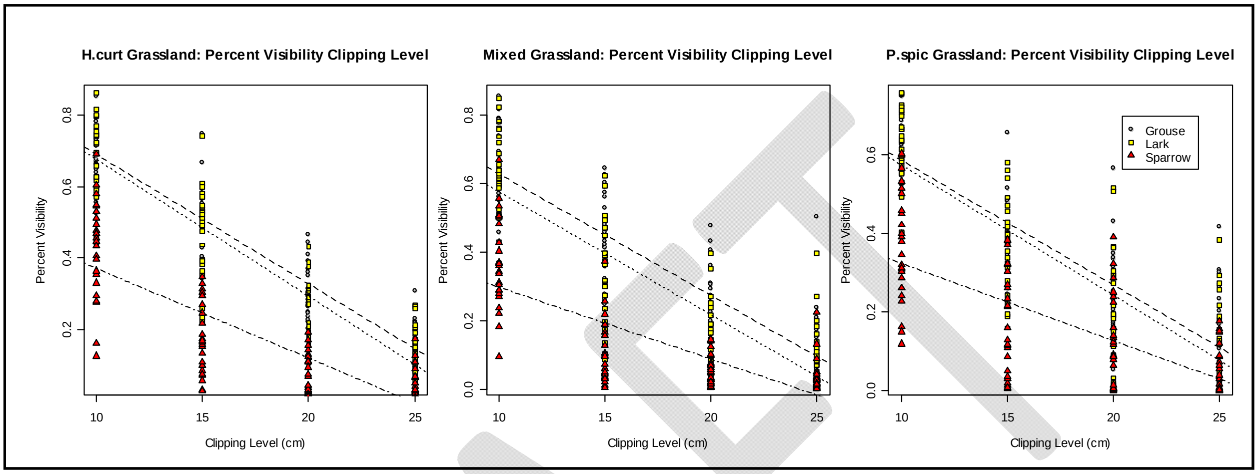

Figure 6: The percent visibility of each cut-out type for different clipping levels for each grassland type. Each line represents a different bird species cut-out type.

These data appear to show similar rates in the reduction of cover across all levels of clipping within each grassland type for grouse and lark cut-outs. Sparrow cut-outs appear to show a different rate of decline. The decline in visibility also seems to be different between grassland types with the bunchgrass type declining at very different rate than the other types. However, we did not include reference photos in our current examination. With clipping cover measurements should fall to zero when all vegetation is removed. Thus, all regressions assessing the effect of clipping should either force the intercept of these regressions through the origin, or reference photos taken at each site should be included to provide an indication of the percent visibility with a complete removal of vegetation. Again, our assessments of these data are simply qualitative. Future analyses should examine these relationships using an ANCOVA, or other similar methods, and should ensure that references photos are included in the dataset.

6.0 SUMMARY AND RECOMMENDATIONS

An essential part of any research project is the need to assess its current progress, with regard to its primary objectives, and determine if current activities are working to meet broad project objectives. This visual screening research project was undertaken by the BC Ministry of Environment to: (1) determine hiding and nesting cover requirements for selected ground nesting birds and small mammals in livestock grazed and ungrazed grasslands; (2) develop visual screening monitoring tools to help evaluate and manage the impacts of livestock grazing on wildlife habitat; and (3) aid in the development of a Best Management Practices document (BMP) to meet Forest and Range Practices Act (FRPA) objectives. The use of the Robel pole to assess vegetative cover was seen as insufficient in meeting project objectives, and the development of a new method using digital photo interpretation was undertaken. Future work should proceed to address these broad objectives and fill data and knowledge gaps identified by an examination of current interim results.

We have attempted to assess project objectives, evaluate current data quality and quantity, and provide a series of empirical and statistical hypotheses to guide future research. To this end, we propose that a number of questions to be addressed that will help meet project objectives. These are:

1) How does visibility of 3 bird species cut-outs, Robel pole readings, and small mammal doweling differ between grassland types?
2) What is the relationship between the 3 bird species cut-outs and Robel pole readings at identified nest sites and potential nest sites? What is the relationship between small mammal doweling readings and the abundance of small mammals or small mammal sign?
3) How much visibility is lost under simulated grazing treatments (i.e., clipping levels) for each of the 3 bird species cut-outs, the Robel pole, and small mammal doweling?
4) What is the impact of current grazing regimes (i.e., inside or outside exclosures) on the visibility of 3 bird species cut-outs, the Robel pole, and small mammal doweling?

To answer these questions we propose a series of actions to improve both the quality and quantity of the data set. These questions will address four major concerns. These are: linking data to measures of wildlife use; the classification of grassland types; assessing the impact of current grazing practices; and data collection and management. We hope that by addressing these concerns and answering the empirical hypotheses we have developed, this project will better able to meet its objectives.

Linking Cover to Wildlife Species

In order to effectively assess how different measures of visibility impact wildlife species measurements must be linked to some indication of species use, risk of mortality, or exposure. Measuring the risk of mortality or measuring the effect of cover on the reproduction and survival (i.e., exposure) of wildlife are dauntless tasks and are far beyond the resources available to this project. To link measures of visual obscurity to wildlife populations we suggest that visual obscurity reading be taken at sites used by animals and compared to sites where animal use has not been observed. These standard methods will then provide information on how species select areas with different amounts of cover.

The information collected with the Robel pole, bird species cut-outs, and small mammal doweling do not currently assess the selection of cover by wildlife species. These representations simply provide a more accurately measure the amount of cover that occurs at a site. Thus, some measure of wildlife use must be made in order to assess the influence of different levels of cover on wildlife. For birds, we propose the most easily measured variable are nest or lek locations of different species. Future measurements of visual obscurity should be made at as many nest or lek locations as possible in order to effectively link cover measurements to wildlife use. Quantifying the escape or foraging cover requirements for wildlife is difficult, expensive, and time consuming. Thus, we recommend that Study Objective 1 be modified to include only an assessment of nesting cover requirements.

For small mammals, we propose that either a measure of small mammal density or some index of small mammal abundance be used to link measures of litter amount (height, depth, or mass) and measurements of visual cover to wildlife species. Since small mammal abundance is expensive and time consuming to measure, we suggest that this project link some index of small mammal abundance (i.e., the presence of small mammal sign) to small mammal density estimates currently being collected by a concurrent project near Kamloops BC. The correlation curves developed from this work can then be used to link the small mammal index currently being used (presence or absence of sign) or a more comprehensive index (relative abundance of sign by species, similar to that used by the Badger Recovery Team) to actual measurements of abundance. This will allow the assessment how a small mammal abundance index relates to visual obscurity measurements over a much larger area.

- **To link visual obscurity measurements to bird species, we suggest future measurements be made at nesting and lek locations.**

- **To link visual obscurity measurements to small mammal species, we suggest that measurements be made in areas of known small mammal abundance.**

Grassland Classification

The amount of cover available to wildlife presumably differs between grasslands with different species compositions and with different levels of productivity. Our qualitative assessments of the effects of grassland type on visual obscurity highlight the need to re-classify grassland types. This could be as simple as reclassifying the mixed grass type. However, it will be difficult to define new grassland types with the data currently available. Future data collection should include the collection of information similar to that described in the British Columbia Government's, Field Manual for Describing Terrestrial Ecosystems (1998, Land Management Handbook 25) Site Description Form. Although some of the fields on this form are irrelevant, this standardized site description form fulfills both Resource Inventory Standard Committee requirements and will provide valuable data for classifying sites. Along with this site description form, information should be collected on the species composition and abundance of vegetation at a site. This information can be collected by completing the Field Manual for Describing Terrestrial Ecosystems (1998, Land Management Handbook 25) Vegetation Form although a plot size and shape for vegetation descriptions must be defined. Additionally, site and vegetation information should be collected at as many old sites as possible. These new data will provide enough information to quantitatively define grassland types. Finally, although stubble height measurements are included in the current database, and will provide surrogate measures of site productivity and growing condition, it may be possible to collect biomass information and link this to cover measurements?

- **To better define grassland types, we suggest collecting more data on site level characteristics.**

- **To better define grassland types, we suggest a quantitative assessment of differences in vegetation and site level variables between sites.**

Assessing the Impact of Current Practices

An important consideration in the development of new management practices is the assessment of how current management practices are affecting the variable of interest. For this project, measurements were made of the amount of visual cover both inside and outside of grazing exlosures. This work can effectively determine the impact of current grazing practices on the cover available to wildlife. However, only limited data exist for sites that are outside exlosures and many sites that were completed inside exlosures do not have pair plots outside of these exlosures. More equal sample sizes, including more plots located at grazed sites will help determine the current impact of grazing on vegetative cover.

Both location and year may have important effects on determining impact of grazing on vegetative cover. We would expect that the growing condition for grasses, and thus the amount of cover they provide differs because of the local growing conditions at a site and due to the yearly growing conditions (yearly levels of temperature and precipitation). Therefore, we suggest collection data both inside and outside exlosures at the same site and doing this in the same year. This information should substantially reduce the variation observed between grazed and ungrazed sites and thus increase the power of any statistical tests.

- **To better define what the current impact of grazing is on cover, we suggest that more data should be collected at grazed sites.**

- **To better define what the current impact of grazing is on cover, we suggest that paired plots (i.e., those inside and outside exlosures) be done at the same site and in the same year.**

Data Collection and Management

An essential component of any research project is the systematic collection and organization of data. In order to standardize data collection, data collection protocols should be developed. These would include standardized procedures for site descriptions, vegetation descriptions, photographic procedures, and a method to quantify of the effort required to perform Robel pole and digital photo methods. These methods should include the collection of a single reference photo at the start of each transect. This photo will allow the comparison of obscured photos to a photo taken with a similar focal length and light conditions and will allow different cameras and cut-outs to be used at each site. These procedures will not only help in standardizing data collection, but also will assist in future analysis and write up since they will provide detailed descriptions of all methods used.

The development of detailed data collection procedures will allow the creation of standardized dataforms and these dataforms can then be linked to a centralized database for data entry, storage, and archiving. A centralized database should consist of a Microsoft Access or similar database, created to allow easy and accurate entry of data, the consistent and easy updating of datatables and queries, and the easy archiving of study datasets.

- **To fill data gaps and standardize data collection, we suggest the development of detail methods for data collection, site description, and vegetation description methods.**

- **To avoid problems with local light conditions, differences in bird cut-out shapes, and differences in camera types (and focal length), we suggest that a reference photo be taken at start of each transect.**

- **To standardize and centralize data entry, queries, and archiving, we suggest the development of a Microsoft Access data base that can be located and updated from a central location.**

7.0 CONCLUSION

In summary, an excellent preliminary dataset exists and this dataset is a strong start at meeting this project's objectives. However, in order to adequately assess the impact of grazing on wildlife we require data on wildlife; in order to assess the impact of grazing on different grassland types we require more detailed site descriptions; and in order to assess the impact of current management practices on vegetative cover we require more paired plots placed inside and outside exlosures. These data also will help clarify how digital photo interpretation is an improvement over the use of the Robel pole. These new data will fill essential knowledge gaps and ensure that adequate data exists to meet all project objectives.