Badger Recovery Science:

Best Management Practices for Prey Enhancement

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Prepared for

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BC Ministry of Water, Land and Air Protection
100 Mile House, British Columbia

To meet the funding requirements of
Habitat Stewardship Program
for Species at Risk

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EXECUTIVE SUMMARY

The *jeffersonii* subspecies of the North American badger (*Taxidea taxus*) is considered endangered by COSEWIC and is at the north-western limit of their distribution in the Cariboo region of British Columbia. Maintaining a food source for badgers is a priority in the *jeffersonii* Badger Recovery Strategy. The purpose of this project is to develop best management practices that enhance or maintain prey species in badger habitats in the Cariboo region of British Columbia. Abundant and diverse prey is found in healthy grasslands with sufficient vegetation cover typically found in well-managed grasslands. A range assessment conducted by the BC Ministry of Water, Land and Air Protection in the Cariboo Forest Region reported that the condition of grasslands is declining due to heavy to moderate grazing intensity and greatly reduced or absent litter on most sites surveyed. Other reports have shown forest encroachment onto 11% of grassland in the region. In response, we developed best management practices to improve habitat for small mammals by addressing management practices on dry range and riparian areas and to mitigating the effects of forest encroachment. These management recommendations will be implemented on twelve proposed Wildlife Habitat Areas (797 ha) established around concentrated badger burrows and incorporated onto Canoe Creek Indian Reserve Lands (5,583 ha). These recommendations also are available to provincial Range Officers managing crown range. This project will help to provide a more predictable and abundant food resource for badgers in the Cariboo region of British Columbia.

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AKNOWLEDGEMENTS

The Habitat Stewardship Program for Species at Risk is a partnership-based, conservation initiative sponsored by the Government of Canada. The program is managed cooperatively by Environment Canada, the Department of Fisheries and Oceans and Parks Canada, and administered by Environment Canada.

Roger Packham with the BC Ministry of Water, Lands and Air Protection (MWLAP), 100 Mile House District, initiated the Cariboo Badger Project in 2003 and conducts field research and administrates the project. Other portions of the Cariboo Badger Project were funded through Habitat Conservation Trust Fund. The BC Ministry of Forests, 100 Mile House District, contributed GIS mapping and printing costs in-kind. We partnered with the Canoe Creek Indian Band to inventory badgers and habitat conditions on reserve lands. We also coordinated with the Biodiversity Branch at MWLAP to initiate a province-wide study on the effects of grazing on small mammal populations and to develop appropriate management practices. Finally, this project benefited from the support and expertise of the *jeffersonii* Badger Recovery Team.

1.0 BACKGROUND

The *jeffersonii* subspecies of the North American badger (*Taxidea taxus*) occurs in the grasslands of British Columbia, west of the Rocky Mountains, throughout the Great Basin and into the south-western deserts in the United States. The subspecies is considered endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, Newhouse and Kinley 1999). It is estimated that there are less than 200 adult badgers in British Columbia (Adams et al. 2003b). Trapping and persecution, highway mortality, habitat loss and degradation, and loss of prey are all factors contributing to population declines (Newhouse and Kinley 2001; Weir et al. 2003; Adams et al. 2003b).

Large home ranges used by badgers in British Columbia suggest that food is limited. In the United States, a badger can position its home range within a large colony of ground squirrels to meet all of its resource requirements within as little as 3 km^2 (Messick and Hornocker 1981; Minta 1993). However, badgers in BC use home range areas that span more than 300 km^2 (Weir et al. 2003; Newhouse and Kinley 2004). This may be a result of limited food resources and low badger population densities. Female badgers are forced to expand their range to encompass sufficient prey resources (Minta 1993). Where prey resources and badger densities are low, male badgers need to travel farther in search of breeding females (Minta 1993). Food scarcity may be indirectly impeding reproductive capabilities of badgers.

The lack of prey is at least partially attributed to extermination and habitat loss and degradation. In British Columbia, Columbian ground squirrels (*Spermophilus columbianus*), yellow-bellied marmots (*Marmota flaviventris*), voles (*Microtus* spp. and *Clethrionomys gapperi*) and mice (*Peromyscus maniculatus*) are consistently found in diets of badgers (Rahme et al. 1995; Newhouse and Kinley 2001; Hoodicoff 2003). Most rodents are considered pests on private lands and considerable effort is put into extermination programs (Weir et al. 2004). Many rodent species in British Columbia are at the northern limit of their range, and while they may be locally common, most are

colonial and not evenly distributed in badger habitats (Adams et al. 2003b). The quality of grassland habitats where badgers procure their prey can be degraded as livestock grazing occurs across most of the province. Grasslands also are experiencing pressures from urban growth and divisions into smaller, intensely utilized acreages for cultivation or farming. Fire suppression has led to large components of grassland being converted into closed- and open-canopied forest in the region (Cariboo-Chilcotin Grasslands Strategy Working Group 2001). Depending on the ecology of the species, management techniques can encourage the colonization of prey to ensure a sustainable prey base for badgers in the province (Hoodicoff 2004).

Maintaining a food source for badgers is a priority in the *jeffersonii* Badger Recovery Strategy (Adams et al. 2003b) and is the main objective of this project. We developed management recommendations to mitigate the decline of prey for badgers based on the condition of grassland in the Cariboo region. The practices in this document are intended to improve habitat suitability and support ecologically responsible grassland management. Our goal is to incorporate management practices on Wildlife Habitat Areas established for badgers, and into range use plans implemented by BC Ministry of Forest (MOF) range officers, landowners, and resource planners on aboriginal lands. A secondary objective is to increase public awareness and appreciation of badgers and their natural role of badgers in rodent control, and to encourage conservation rather than extermination. This project will help to provide a more reliable and abundant food resource for badgers in the Cariboo region of British Columbia.

2.0 ACTIVITIES AND RESULTS

We identified sites with concentrated burrows or foraging activity in the Cariboo forest region to distinguish areas badgers use to procure prey. Some of these areas were included in a range audit conducted by BC Ministry of Water, Lands and Air Protection (MWLAP) and compared to livestock exclosures to assess range condition and habitat suitability for wildlife (Packham and Dunsworth 2005). We used the results of this audit, and other recent reports, to assess the condition of grassland habitat for small mammals.

We developed management recommendation to improve habitat conditions. These management recommendations will be proposed for implementation on Wildlife Habitat Areas established around concentrated badger burrows.

2.1 Study Area

Our activities were focused on badger habitat, mainly grasslands and open forests, within the Cariboo Forest Region (Figure 1). Grasslands in the Cariboo are divided into three general ecological classes: lower, middle and upper grasslands (Steen and Coupé 1997). The lower grasslands occur from the lowest elevations of the Fraser River valley (<650 m elevation) on lower- and mid-valley slopes. Bluebunch wheatgrass (*Pseudoroegneria spicata*) and sagebrush (*Artemesia tridentata*) are common in these grasslands but trees are restricted to moist pockets. In the middle grasslands (650m to 900 m elevation), sagebrush is uncommon and bluebunch wheatgrass and needle-and-thread grass (*Hesperostipa comata*) are the most common species. Forests are mainly composed of Interior Douglas-fir (*Pseudotsuga menziesii*), and are generally restricted to north-facing slopes and moist ravines. Most of the study area occurs in the upper grasslands. These account for nearly 35% of the grassland in the region, and generally occur in a transition zone between a predominantly grassland landscape at lower elevations and a forested landscape at higher elevations (>900 m elevation). Upper grasslands are dominated by porcupine grass (*Hesperostipa curtiseta*), bluebunch wheatgrass, spreading needlegrass (*Achnatherum richardsonii*) and Rocky Mountain fescue (*Festuca saximontana*). Within forests, small 'pocket' grasslands are common on dry, south-facing slopes. Grassland habitat in the region is more uniform and not confined to valley bottoms as in other parts of the province, and is under less pressure from human activities.

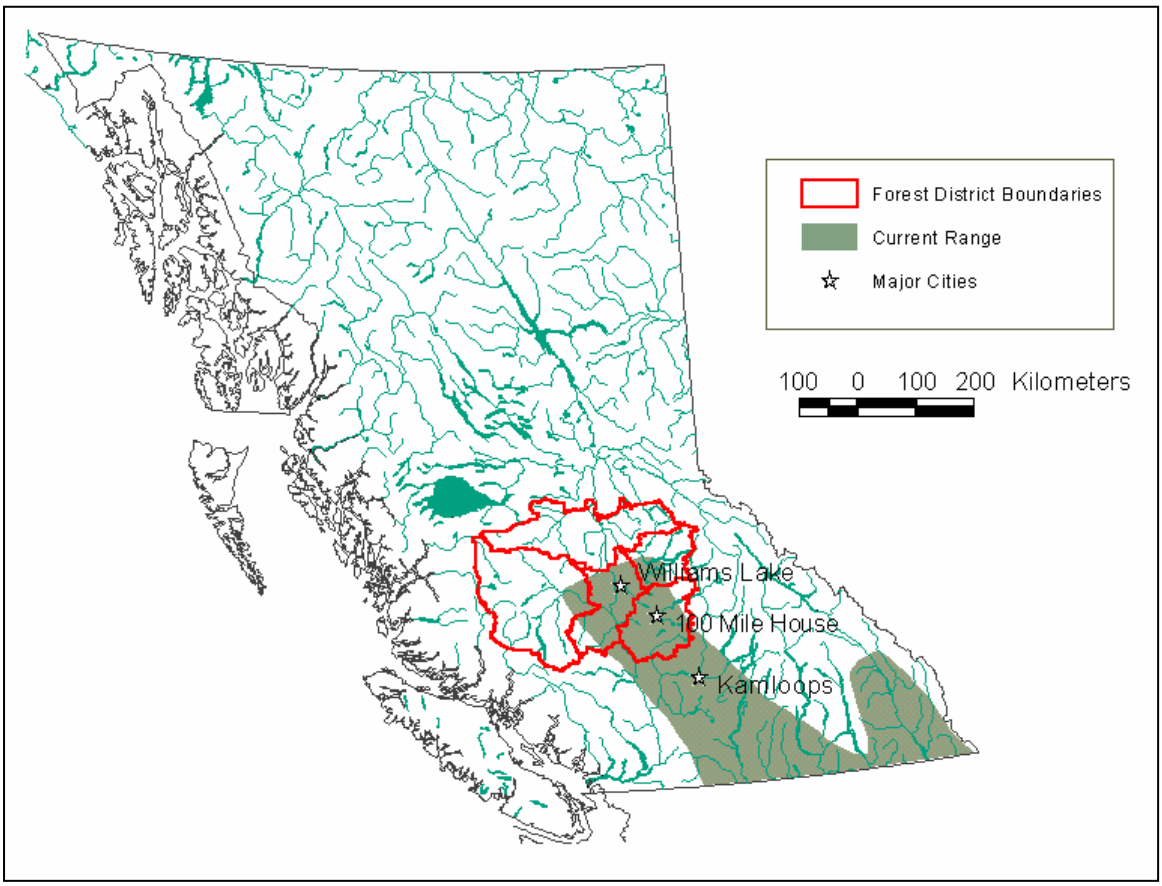

Figure 1. The range of badgers in British Columbia (Rahme et al. 1995) in relation to the Forest Districts in the Cariboo Forest Region.

2.2 Badger Burrowing Sites

The North American badger is a carnivore specialized to dig burrows and hunt fossorial prey (Todd 1980; Clark et al. 1982; Minta 1993;Weir et al. 2003). Friable soils and available prey are key habitats that badgers select for (Rahme et al. 1995; Apps et al. 2002). Weir et al. (2003) detected considerable patch-scale selection for sites with abundant prey. In Wyoming, badgers were associated with deep, silty soils in areas with abundant prey (Minta 1993). In Idaho, badger burrows were correlated with holes made by prey (Todd 1980). In another study, badger activity was positively correlated with the size and number of burrow openings in prairie dog (*Cynomys* spp.) colonies (Clark et al. 1982).

We surveyed the study area for sites with concentrated badger burrows or foraging activity from gravel and paved roads, and during 2 helicopter flights (March 18, 23, 2004) from Clinton to the west side of Fraser River as far north as Beaumont Creek along the Chilcotin River. Funding for these flights was provided by MOF and MWLAP. We also solicited sightings of badgers from the public by advertising a 'badger reporting line' for the public to phone (Appendix I). We recorded the universal transverse mercator (UTM) coordinates of all burrows and badger sightings that were reported and created a database for the Cariboo region.

In 2004/05, we documented 144 new burrow locations and 23 badger sightings for a total of 537 occurrences in the region (Figure 2). Forty badger burrows (7%) were located in riparian areas within 5 m of a wetland or lake, and most of these were associated with foraging for muskrats. It does not appear that badgers were selecting disproportionately for habitat type (within biogeoclimatic zones) at the landscape scale in the forest districts (Goodness of Fit, G=0.68, P=0.999).

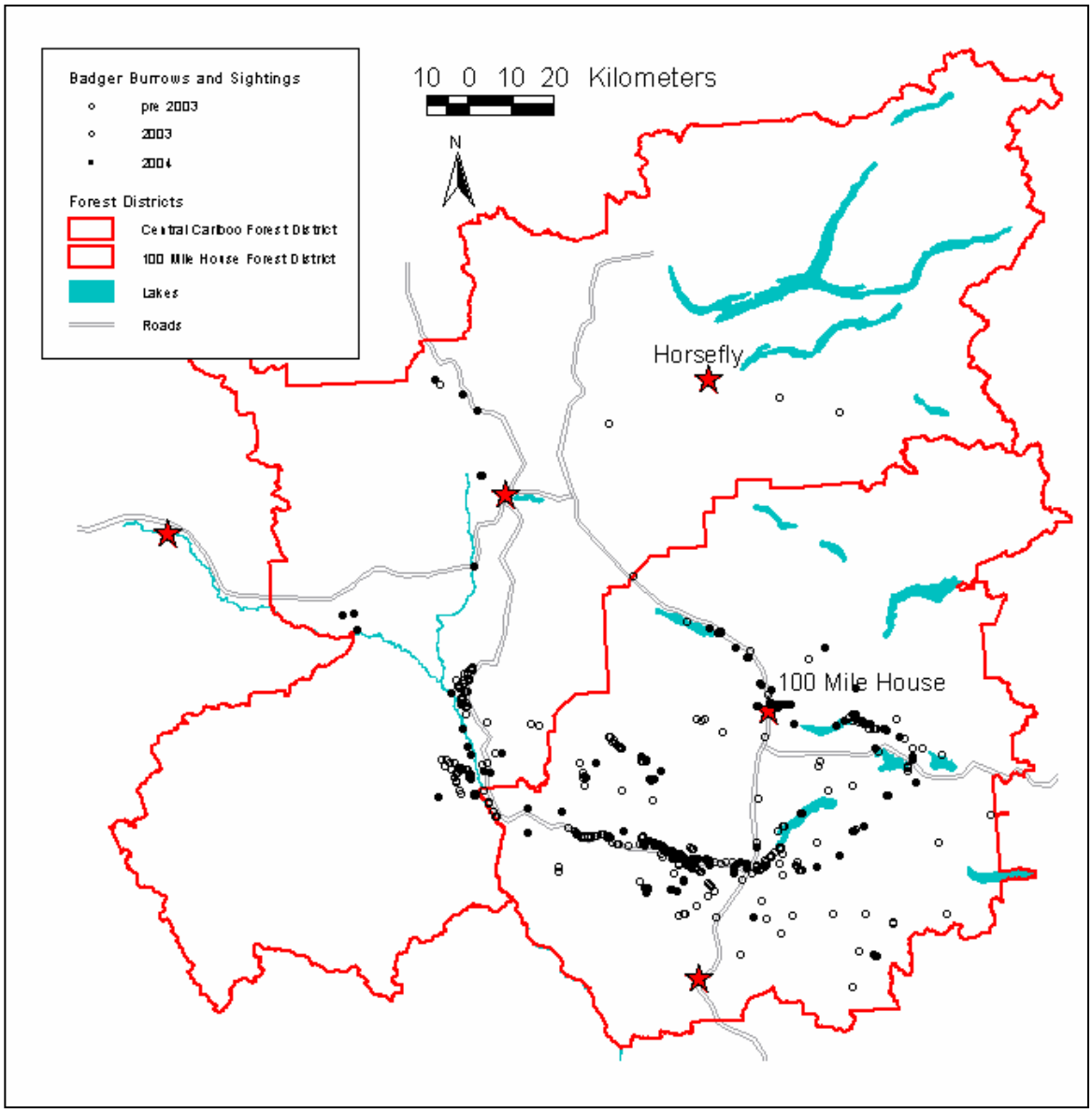

Figure 2. Badger burrows and sightings documented during the Cariboo Badger Project.

Twelve Wildlife Habitat Areas (WHA) are proposed around densities of badger burrows and suitable grassland habitat in the 100 Mile House Forest District (Figure 3). The average size of a WHA was 66.4 ha (range 24.6-99.5 ha) and the total area was 797 ha (Table 1). In British Columbia, species at risk that are listed by the Committee on the Status of Endangered Wildlife in Canada and provincially listed species may be considered 'Identified Wildlife.' The Identified Wildlife Management Strategy (IWMS) is a provision of the provincial *Forest and Range Practices Act* to minimize the effects of forest and range practices on Identified Wildlife situated on Crown land and to maintain

their limiting habitats throughout their current and historic ranges. Identified Wildlife are managed through the establishment of WHAs and implementation of General Wildlife Measures, or through other management practices specified in strategic or landscape level plans. The management recommendations in this report are meant to compliment the IWMS for badgers (Adams and Kinley 2002) to improve habitat conditions in the Cariboo.

Table 1. Number and name of Wildlife Habitat Areas established for badgers in the 100 Mile House Forest District of the Cariboo region.

WHA No.	WHA Name	Area (ha)
1	Augustine	34.1
2	Komori	51.4
3	1200 Rd	39.4
4	Windmill	99.5
5	Green Lake Gravel Pit	24.6
6	Alberta Lake West	92.7
7	Alberta Lake East	53.9
8	McKinley Lakes	70.3
9	Pollard Lake	70.5
10	China Lake	87.3
11	River Lakes	97.8
12	Hutchison Lake	75.4
	Total Area	**796.9**

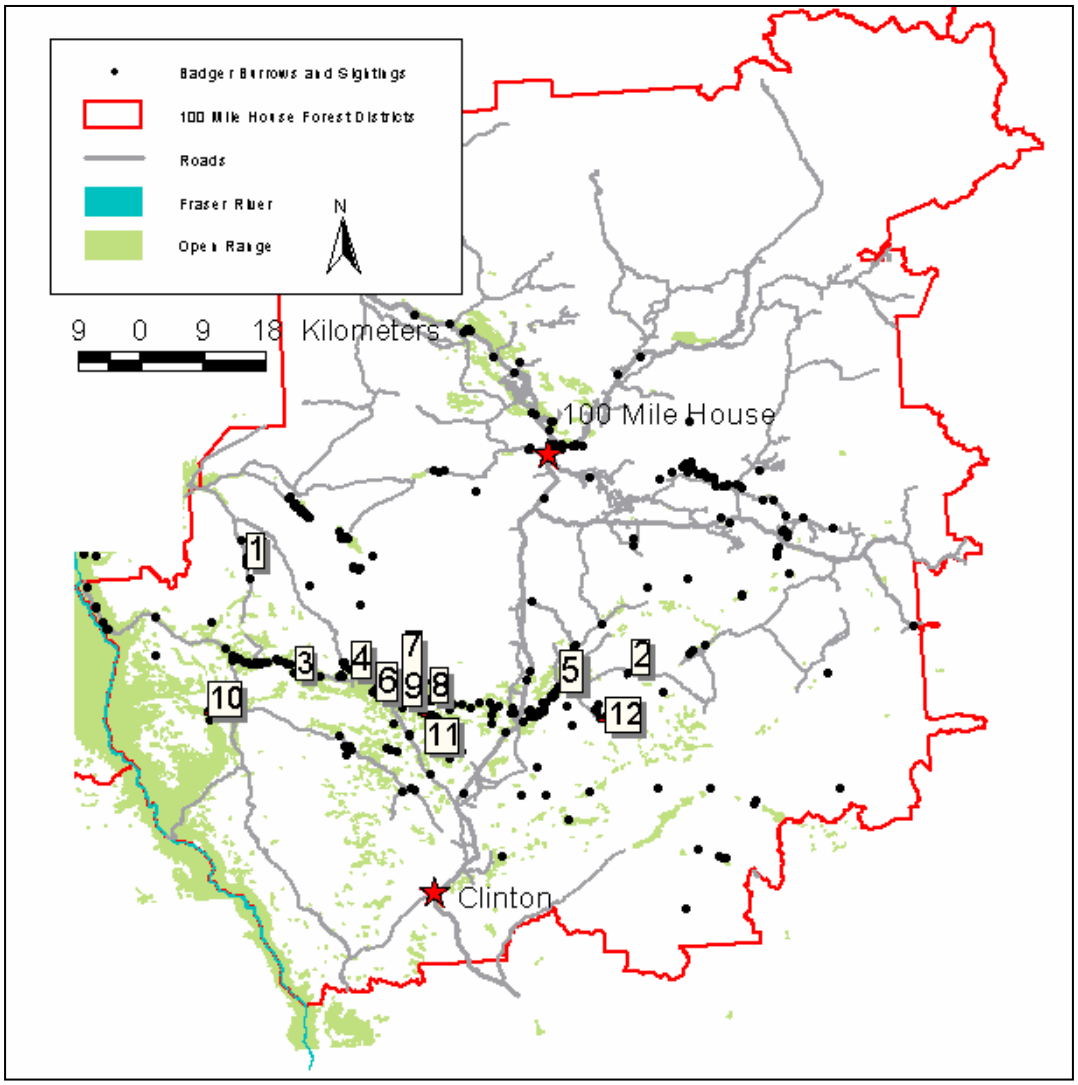

Figure 3. Location of twelve Wildlife Habitat Areas proposed for badgers in the 100 Mile House Forest District of the Cariboo region.

2.3 Grassland Habitat Condition

In a range assessment conducted by MWLAP, grassland condition was assessed in areas providing habitat for badgers (and other red- and blue-listed species) and compared to livestock exclosures (Packham and Dunsworth 2005). The methodology used for this range assessment was adapted from the "*Range Health Assessment for Grassland, Forest and Tame Pasture*" field workbook developed in Alberta (http://www3.gov.ab.ca/srd/land/m_rm_health.html; Adams et al. 2003a). Key ecological functions and conditions were used to assess range health, including: plant species

composition and community structure, plant litter retention, grazing intensity, and range trend in relation to the previous years' observations of residual vegetation. The health categories were: 1) Healthy: a health score of 75 % or greater, where all key functions of rangeland health are being performed, 2) Healthy with Problems: a health score of 50 to 74% where most but not all key functions of healthy range are being performed and, 3) Unhealthy: A health score of less than 50% where a few functions of healthy range are being performed. Robel pole measurements also were taken to measure visual obstruction, which is the height and vertical density of standing vegetation (Robel et al. 1969).

Health assessments were conducted on 16 selected grassland areas on five range tenures, and eight livestock exclosures between October 6 and October 15, 2004 (Figure 4). None of the 16 assessments resulted in a 'healthy' designation, six (38%) of the assessments were categorized as 'healthy with problems' (four of which were at the lower end of this category) and the remaining 10 (62%) assessments were categorized as 'unhealthy.' None of the key ecological functions assessed were adequate to maintain health of grasslands. Range trend for 13 of the 16 sites was assessed as downward and historical information was lacking for three of the sites. None of the 16 sites examined were assessed to be representative of the climax community for the site. Grazing intensity was rated moderate to heavy ($n=9$), or heavy ($n=7$) across the area surveyed. Litter on four sites was greatly reduced or absent, on nine sites liter was slightly to moderately reduced, and only two sites contained the expected amount of litter. The average visual obstruction value in the exclosures was 6.4 cm (4.5–9.5 cm) and the average VO in the grazed areas was 1.2 cm (0–6.5 cm).

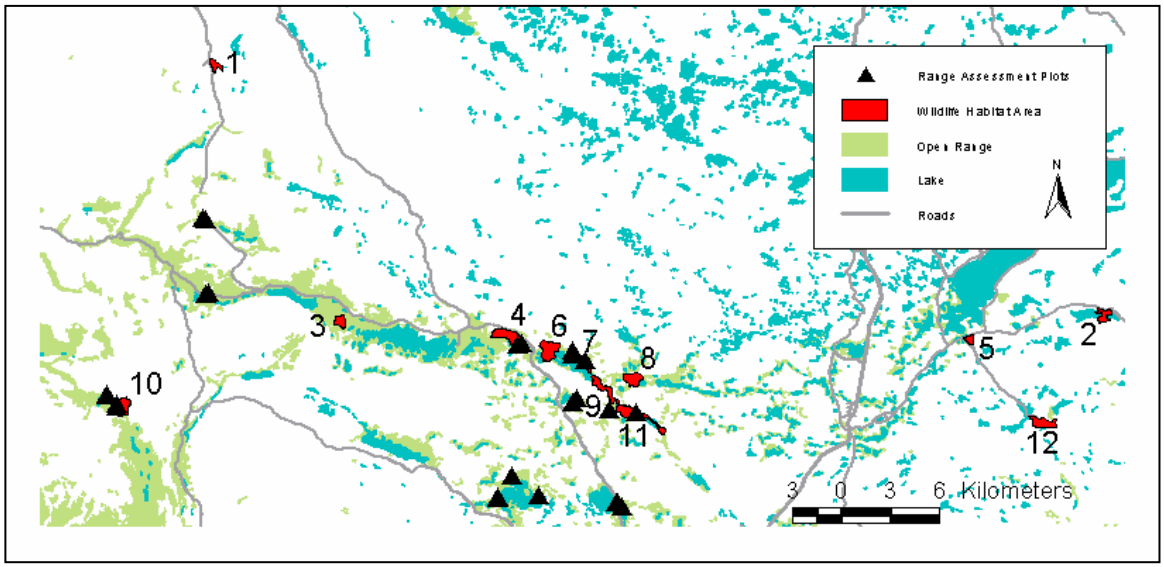

Figure 4. Location of range assessment plots in respects to twelve Wildlife Habitat Areas in the 100 Mile House Forest District of the Cariboo region.

2.4 Communications and Outreach

We worked to change perception of badgers and their prey as pest species and promoted the role of badgers as effective rodent predators on the landscape. We met with the two Range Officers at the BC Ministry of Forests to discuss the habitat requirements of small mammals on rangeland in the Cariboo region. We also contacted at least 12 landowners, most on an on-going basis, about the status of badgers and the occurrence small mammals on private and crown range. At least one was actively controlling rodents on his property and he was receptive to making changes to the way and timing of his actions to minimize the impact on badgers. We also are working with Marmot Ridge Golf Course to maintain prey (marmots) and to minimize the impacts of a badger occurring on their property. We will be installing a sign that promotes tolerance of badger and marmot burrows on golf greens (Appendix II).

A partnership with the Canoe Creek Indian Band was established (with the Interdepartmental Recovery Fund). A team of four people from the Canoe Creek Indian Band was trained to inventory species at risk on Indian Band lands. Badgers were a focal species for the year. The team recorded burrow locations, habitat, and helped to generate habitat management guidelines on Indian Reserve lands (total 5,583 ha). A community

document was created to guide the chief and council, resource managers, and Band members on badger conservation and habitat management. Best management practices for small mammals will be incorporated into the document and will be consistent with the objectives of this project.

Very positive benefits have come from this partnership, including local community awareness and support for badger conservation and habitat management. Three meetings were held with the Canoe Creek Wildlife Planning Committee to discuss badger inventory and habitat management on Indian Reserve lands. A slide show on badger conservation was presented to 15 Canoe Creek community members at the Dog Creek Indian Reserve. A poster that raised awareness of badgers and their habitat requirements was presented at the Canoe Creek Indian Band annual general meeting.

Finally, we met with provincial Ministry of Water, Land and Air Protection, Ministry of Forests, and other *jeffersonii* Recovery Team members to discuss our findings and the need for a future study on the habitat requirements and cover threshold values for small mammals in the province.

3.0 CONDITION OF GRASSLAND HABITAT

Results of the audit indicated that grassland health in the 100 Mile House Forest District of the Cariboo region was declining and that livestock are having a significant impact on the grassland habitats evaluated. The results of this range audit were similar to the findings of a range effectiveness evaluation conducted by BC Ministry of Forests in the 100 Mile House Forest District in 2004 (D. Fraser, pers. comm.). Twenty-seven upland ranges were evaluated and several were located within the same range tenures as the MWLAP audit. Of the 27 sites, nine (33%) were non-functional, nine (33%) were highly at risk, five (19%) were moderately at risk, one (4%) was slightly at risk, and only three (11%) were in properly functioning condition. Fraser also noted poor standing residual cover and litter, extensive soil compaction, lack of shrubs, early seral plant communities,

non-compliance with range use plans. These audits indicate a need to change range management to improve grassland condition and small mammal habitat.

Litter retention on the audited sites was poor and this will affect the suitability of habitat for small mammals. Standing vegetation and litter help to maintain soil moisture, improve water infiltration, protects against soil erosion, and cools the soil surface (Adams et al. 2003a). Small mammals use cover for food, nesting, and as refuges from predators (Birney et al. 1976). Vole populations, in particular, respond negatively to practices that reduce vegetative cover and forage, such as grazing (Birney et al. 1976; Jones 1990). Cover may be even more critical to maintaining population densities of some small mammals than food availability (Lin and Batzli 2001).

The composition of small mammal communities on grasslands is determined, in part, by the structural attributes of the habitat. Rosenstock (1996) found greater species richness and abundance on sites with taller and greater cover of grasses and more surface litter. Grant et al. (1982) reported that in tallgrass habitats, reduction in cover resulted in decrease in total small mammal biomass, increase in species diversity, and shift away from litter-dwelling species with relatively high reproductive rates (e.g. microtines) to surface-dwelling species with relatively low reproductive rates (e.g. sciurids and heteromyids). In montane grasslands, reduction in cover resulted in a decrease in both small mammal biomass and species diversity, but there was a shift to species with higher reproductive rates (e.g. cricetines). Schulz and Leininger (1991) also reported a shift in community composition between grazed and ungrazed sites, despite even species richness values in the two treatments.

As litter retention declines, we would expect to see a shift from cover-dependent species to favor species that prefer early succession habitat. Livestock can alter the community structure of small mammals because grazing prevents growth of perennial grasses and promotes early succession vegetation with higher nutritive quality that some prey favour (Bucyanayandi and Bergeron 1990). Ground squirrels, in particular, respond positively to minor habitat disturbance that increase herbaceous food resources (Elliott and Flinders

1991). On deferred grazing pastures in Alberta, biomass of Richardson's ground squirrels (*S. richardsonii*) was estimated at over 73 times the biomass of mice and voles (Skinner et al. 1996). Moderate grazing also may provide more food resources for marmots; however, heavy grazing (>40% of the standing crop) may reduce food supply for marmots when they are accumulating fat before hibernation (Frase and Hoffmann 1980).

Visual obstruction values are related to litter accumulation, and were relatively low in the audit. Swift foxes (*Vulpes velox*) in southwestern South Dakota foraged where on sites where VO = 11.9 cm (± 0.7) in relatively dense vegetation compared to random sites (Ursek et al. 2003). Similar to badgers, the main prey species of swift foxes were voles (*Microtus* spp.) and northern pocket gophers (*Thomomys* spp.) in dense vegetation, and cottontail rabbits (*Sylvilagus* spp.), pocket mice (*Perognathus* spp.) and thirteen-lined ground squirrels (*S. tridecemlineatus*) found in less dense vegetation. On grazed sites in the 100 Mile House Forest District, maximum VO measurements were nearly 5.5 cm less, and 10.5 cm less on average, compared to sites where foxes foraged in South Dakota. Maximum VO measurements taken from ungrazed sites during the audit in the Cariboo were closer to the value Ursek et al. (2003) reported at 9.5 cm.

Livestock changed the vegetative composition of the audited sites as none were deemed to reflect the presumed climax community. Plant species composition is a key indicator of the ecological status of grasslands (O'Brien et al. 2003). Healthy native grasslands normally have a diversity of plant species that vary in size, height and rooting depth. Heavy grazing pressure can cause a shift to less productive forage species and may result in the invasion of non-native plants that lack drought tolerance and have little value for wildlife habitat cover (Packham and Dunsworth 2005). Grazing also favours annual grasses and herbs rather than the perennial species, such as bluebunch wheatgrass (Gayton 2003). Rosenstock (1996) found more perennial grass and litter cover and taller plants on ungrazed sites. Greater cover of annual forbs was recorded on the adjacent grazed areas. Grazing has been linked to structural loss in shrub-dominated sites and in-growth of open forests (Fleischner 1994).

One factor that the audit did not document was the effect of forest in-growth and forest encroachment on the grasslands. Forest encroachment is the advancement of trees and other forest vegetation onto previously open grasslands, and forest in-growth is the filling-in of open forests by tree regeneration. Both are widespread and prevalent throughout the Cariboo region. The Cariboo-Chilcotin Grasslands Strategy Working Group (2001) estimated that 11% (21,474 ha) of the estimated total grassland area in the region has been encroached by forest in the last 35 years. Factors contributing to forest encroachment and in-growth were attributed to the reduction in the frequency of fires in grasslands and adjacent forests that killed young Douglas-fir trees before they developed a thick basal bark.

Conservative grazing regimes should be adopted to ensure a healthy grassland habitat that supports small mammals. Badgers in the Cariboo rely on a diversity of prey such as ground squirrels, marmots, voles, and muskrats, and will switch prey as one species becomes less available (Messick and Hornocker 1981). Conditions that benefit ground squirrels do not always allow sufficient vegetative coverage for other species, especially voles. Therefore, if areas were managed for a diversity of species in a range of successional stages, then badgers would be able to access alternate food sources.

4.0 MANAGEMENT RECOMMENDATIONS

Management recommendations made here are intended to improve habitat suitability for small mammals by addressing specific habitat issues found in the audit. Methods to minimize the effects of grazing livestock on dry range and in riparian zones, and measures to mitigate forest canopy dominating grasslands are summarized in Table 3. Finally, targets for prey densities and establishing evaluation techniques are discussed.

4.1 Managing Livestock Grazing

Objective: *Increase habitat cover for small mammals while maintaining vegetation in a variety of successional stages.*

The ecological costs of livestock grazing include loss of biodiversity, decline of population densities, and disruption of ecosystem functions such as nutrient cycling and succession (Fleischner 1994). Livestock grazing and trampling can change the composition of vegetation communities (Reynolds and Trost 1980). This, in turn, affects the composition of communities and the abundance of small mammal. Rosenstock (1996) reported higher small mammal species richness and abundance on ungrazed grassland at the macrohabitat scale (≥ 100 ha) than grazed sites. Bock et al. (1984) found that there was a lower abundance of small mammals on a grazed area than on an adjacent site left ungrazed for nearly 15 years.

Small mammals, particularly voles, require sufficient cover for shelter and to hide from predators. Conley et al. (1976) reported that meadow voles (*Microtus pennsylvanicus*) require 20-41 cm of vegetative cover and litter. Birney et al. (1976) clipped and raked all standing vegetation and litter from an area, and found that meadow voles require a threshold cover of 400-600 g/m^2 of dried vegetation. They noted that threshold levels may need to be higher on sites that are drier or have larger populations of voles or predators. Ground squirrels and marmots have much less rigid habitat requirements with respects to cover (Banfield 1974). Both species benefit from moderate grazing, although removing greater than 40% of cover may hinder the ability of marmots to accumulate sufficient fat stores before they enter torpor in mid-August (Frase and Hoffmann 1980).

Important factors to consider in livestock management to maintain cover include the timing of grazing, intensity of grazing, and the time interval before re-grazing. In British Columbia, these factors are incorporated into Range Use Plans that are required for crown land under the *Range Act*. The BC Ministry of Forests has published useful guidebooks to manage livestock effectively, and we have referred to a number of them in the following recommendations (http://www.for.gov.bc.ca/hfd/pubs/Bro.htm).

The time of year when livestock may be set out to graze is referred to as 'range readiness.' Fraser (2003b) cites the Society for Range Management definition of range readiness as "a defined stage of plant growth at which grazing may begin under a specific management plan without permanent damage to vegetation or soils." Adequate volume and quality of forage must be available to graze on a site, but also the soil must be dry enough to prevent soil compaction and to secure plants to prevent uprooting during grazing. The guidebook suggests a reliable method to assess range readiness by using leaf development in grasses (Fraser 2003b). Leaf development is correlated with growing degree days and varies for each grass species. On native range, generally 4.0 to 4.5 leaves per tiller is the criterion and this should be averaged on approximately 50 plants across the pasture.

Ensuring range is ready for grazing in the spring will maintain healthy plant structure and sufficient cover for small mammals, and will minimize soil disturbance and damage to burrows from livestock trampling. Deferred grazing systems, where livestock are intentionally kept off of a site until the active growing season for most grass species is over, provides an opportunity for plant species to gain and maintain vigor, store carbohydrates, and set seed. Certain grasses are more sensitive to early grazing, especially those with growing points higher from the ground. For example, spring grazing on bunchgrass range has a greater negative effect than grazing in the summer or fall (Gayton 2003). It is important to identify the species most susceptible to grazing to be used to determine range readiness in an area.

Stubble height, the height of herbaceous plants remaining after grazing or harvesting, can be used to evaluate the intensity of grazing on rangeland. Fraser (2003a) reported that cattle graze most efficiently when plants are 15 cm high. Short and widely spaced plants make cattle take more bites, travel farther and graze longer to meet nutritional requirements. Grass plants will stop root growth if more than half the leaf area is grazed leading to reduced vigor and drought resistance (Fraser 2003a). Willms et al. (2002) also found that the removal of grassland litter on experimental sites reduced total grass production in the next growing season by 25%. By maintaining a minimum of 15 cm

stubble height, cattle foraging effort would be maximized while providing sufficient cover for most small mammals.

Maintaining standing vegetation and litter for cover can be accomplished by enforcing grazing limits on livestock. Stubble heights are met by managing the density of livestock to meet animal unit month (AUM) targets set out in Range Use Plans. An AUM is the quantity of forage consumed by a 450 kg animal in 30 days and is a measure of forage consumption by herbivores (Fraser 2004). Leaving a previously overgrazed area to rest for a period of time may allow plants to recover; however, often the recovery period is more than 120 growing days for many native grass species (Fraser 2003b). In particularly heavily grazed pastures, 25-30 years of rest may be needed before communities of small mammals recover (Rosenstock 1996). Excluding livestock for this duration of time may not be operationally feasible in many cases.

The most effective method for managing healthy range and suitable habitat is preventing overgrazing. This can be accomplished by limiting grazing intensity or duration to allow grass to recover, and following Range Use Plans in place. The purpose of Range Use Plans is to prevent ecological damage while optimizing grazing potential. During the range effectiveness audit conducted by Ministry of Forests, many Range Use Plans were not being followed (D. Fraser, pers. comm.). Packham and Dunford (2005) suggest increasing the monitoring and compliance to ensure Range Use Plans are being followed, but this also should accompany educational contributions such as the BC Ministry of Forests guidebooks.

4.2 Managing Livestock in the Riparian Zone

Objective: *Decrease trampling and over utilization of riparian vegetation by livestock to maintain habitat cover and soil integrity.*

Riparian habitats are a special consideration for livestock management as generally they are the most productive habitats for both plants and wildlife (Fleischner 1994). When riparian habitats are negatively affected, wildlife productivity in adjacent habitat is also

depressed (Carothers 1977). Riparian areas are a source of water, food and cover for many species. Muskrats are specially adapted to use riparian habitats as they swim, nest on the water, and eat mainly emergent aquatic vegetation (Willner et al. 1980). Meadow vole densities may be highest (up to 371 per ha) in marsh habitats (Banfield 1974). In Idaho, red-backed vole densities also were highest in ungrazed riparian areas (Eder and Pattie 2001). Other species also rely on riparian habitats. In Oregon grazing in riparian areas correlated with the decrease in bird abundance and species richness, shrub volume and shrub heights (Taylor 1986).

The negative impacts of livestock in riparian areas include soil compaction and erosion, decreased richness of plant species, and the reduction of structural diversity and cover for prey (Kauffman and Krueger 1984). Trampling by cattle and horses can have a significant impact on the area around a watering site (Plumb et al. 1984). Cattle tend to congregate in riparian areas in search of lush forage, water and shade leading them to spend a disproportionate amount of time there (Fleischner 1994). Attraction to riparian areas is exaggerated during extremely dry years as cattle herds search for green forage and water, becoming even more condensed around fewer wetlands. During the particularly dry summer of 2004 in the 100 Mile House Forest District, cattle congregated at large wetlands that still held moisture and disregarded smaller wetlands that had dried up (R. Packham, pers. comm.). The areas with green forage were heavily grazed often revealing bare ground, and saturated soils exposed by retreating water levels were trampled. Intense grazing pressure in riparian zones can reduce habitat suitability for species limited to high cover such as voles (Johnson 1982). Livestock also can damage muskrat runs with their hooves and limit aquatic forage for muskrats (Figure 5).

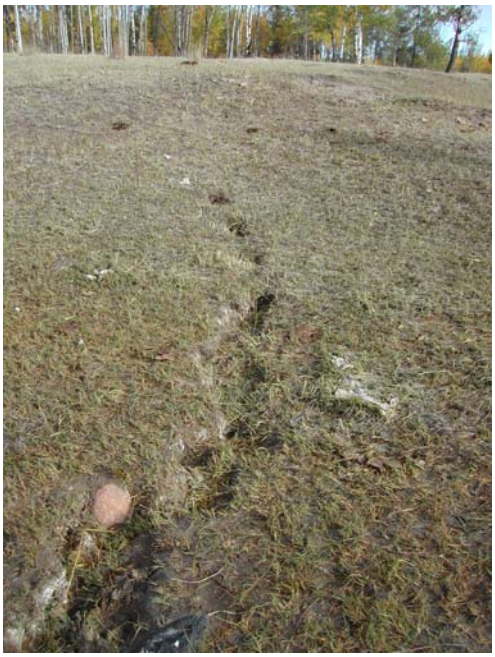

Figure 5. Example of a muskrat run damaged by cattle trampling.

BC Ministry of Forest guidebooks recommended stubble heights for riparian species at a minimum of approximately 10 cm for most grass species, but as high as 20 cm for large sedges (Fraser 2003a). Clary and Leininger (2000) also suggested maintaining at least 10 cm as a minimum stubble height in a pasture to prevent cattle from leaving dry range for riparian vegetation. Kauffman and Krueger (1984) cited various references that suggested maintaining less than 65% grazing pressure in riparian areas to prevent habitat alteration, though this is a relative target and difficult to monitor.

Grazing systems can help to minimize impacts on riparian vegetation and allow habitat to recover. Deferring grazing may be especially helpful in heavily grazed sites such as riparian zones. Skinner et al. (1996) recommended deferring grazing on sensitive sites until after mid-July to encourage small mammal colonization. Giuliano and Homyack (2004) found that small mammal communities responded quickly to grazing exclusion in riparian zones. Kauffman and Krueger (1984) reported that riparian areas recover after a rest from grazing and suggested a rest-rotation of at least 1 year in 3. Rest is probably most effective during the early growing season in spring to summer (August). Winter

grazing of riparian areas may minimize damage but this will depend on the dominant forage species.

In some cases, retaining ungrazed corridors along riparian areas may provide wildlife habitat. Chapman and Ribic (2002) found that ungrazed buffer strips along stream banks adjacent to agricultural fields contained greater species abundance and richness than adjacent grazed areas. Buffer strips were 7 to 15 m wide along each side of stream (1.3 ha on average), and had greater litter depth (avg = 56.2 cm) and Robel pole readings (avg = 57.5 cm) than adjacent grazed sites. The most abundant species found on buffer strips was the meadow vole. However, they found there was no significant difference between species richness and abundance on sites that were continually grazed and sites with rest-rotation regimes. They attributed this to the lack of temporal stability to support an extensive small mammal community.

Because livestock are naturally attracted to riparian vegetation, there are methods to increase the use of upland range. Fencing can limit livestock access to riparian zones, and allows riparian areas to be managed separately from adjacent range. Range managers can also use attractants such as mineral blocks and alternative water sources to draw livestock away from sensitive riparian areas. Increasing riders on the range to herd livestock to other upland areas is also effective but is time intensive and requires daily effort from range managers. Ecological benefits are not always accounted for when analyzing the costs of making such range improvements or time commitments. In some cases, the cash costs are compared only to benefits with respects to livestock production and available forage (e.g.,Unterschultz et al. 2004).

4.3 Managing Encroaching Forests

Objective: *Increase areas of grassland and open forest by reducing forest in-growth and encroachment.*

Loss and degradation of grassland to forest reduces the overall area of suitable habitat for badgers and their prey. This is mainly attributed to suppression of wildfires as the

Cariboo became inhabited with ranches (Cariboo-Chilcotin Grasslands Strategy Working Group 2001). While some wildlfires were ignited by lightning, most fires in the region were started by aboriginal peoples who traditionally used fire to improve hunting, enhance production of food or medicinal plants, clear campsites and reduce the threat of damaging wildfire. As forest canopy closes, bunchgrass is shaded and eventually replaced by pinegrass (*Calamagrostis rubescens*), which has different habitat values for small mammals (Gayton 2003).

The Identified Wildlife Management Strategy (IWMS) for badgers recommend managing forest cover in the vicinity of active burrows to a target of 20 stems/ha and less than 75 stems/ha (Adams and Kinley 2002). Methods to restore grassland habitat also have been outlined by the Cariboo-Chilcotin Grasslands Strategy Working Group (2001). Those recommendations include retaining isolated individual or small groups of large veteran trees as wildlife habitat. In the grassland where encroaching trees are widely spaced (>4 m), maintaining at least 50% of the widely spaced stems as wildlife habitat up to 15% canopy closure is recommended. In upper grasslands and open forests, removal of at least 95% of newly established trees is suggested. In old closed stands where new seedlings are establishing, retain at least 90% of large veteran trees (>140 yrs old), and maintain non-veteran stems >12.5 cm in diameter up to three times the density of veteran trees (stems/ha) to ensure some large wildlife trees in the future. Retention of newly established seedling (<12.5 cm diameter) up to 10 times the density of veterans, preferably in clumped distribution, will provide future canopy cover. Remove all stems with fire or manual cutting in areas of recent encroachment where stem densities are high (>20,000 stems/ha).

Prescribed burning and mechanical clearing is recommended to mitigate forest encroachment and in-growth to maintain grassland and open forest conditions suitable for badgers and their prey. Species that prefer open habitats, such as deer mice and ground squirrels, generally recolonize after fire relatively rapidly (Ream 1981). Rahme et al. (1995) suggested that prescribed burning benefited badgers by providing habitat for Columbian ground squirrels and northern pocket gophers in Douglas-fir habitat types.

Willner et al. (1980) suggested that fires may help to arrest marsh succession to maintain habitat for muskrats, as long as the fire does not damage the basal parts of perennial plants. However, Yensen et al. (1992) reported that Townsend's ground squirrel (*S. townsendii*) populations fluctuated widely on burned sites, destabilized the prey base, and potentially affected badger populations. In south-western Idaho, wildfire reduced the abundance of small mammals in the first year after burn, and badger burrow counts were lower on burned sites than on adjacent unburned sites (Groves and Steenhof 1988).

Forest harvesting opens some forested areas to grass-dominated habitat. Badgers appear to use cutblocks in the Cariboo where prey are abundant but this relationship is not well understood (Adams et al. 2003b). In ecosystems which historically experienced frequent, stand maintaining fires (Natural Disturbance Type 4; BC Ministries of Forests and Environment, Lands and Parks 1995), the IWMS for badgers suggests reducing or delaying re-stocking rates to less than <75 stems/ha to obtain an ultimate target of 20 stems/ha of mature trees (Adams and Kinley 2002). This may require reducing or delaying Free-to-Grow standards in these zones to maintain low tree densities.

Seeding newly clearcut patches with a mix of naturally occurring grass and legume species may encourage colonization of small mammals by increasing forage available (Sullivan and Sullivan 1984). Increasing vole populations may also prevent forest in-growth onto grasslands or fields. In central New York, voles substantially reduced tree and shrub colonization of old fields (Gill and Marks 1991). Non-native grass species should not be included in the seed mix in high volumes. Grazed sites dominated by non-native crested wheatgrass (*Agropyron cristatum*) were reported to support lower densities and fewer species of small mammals and other birds and reptiles than adjacent non-grazed sites (Reynolds and Trost 1980).

4.4 Setting Targets and Evaluation

Minimum required prey densities should be established for managing resources for badgers. Badgers are reported to need anywhere from a quarter of an adult rabbit to more

than two ground squirrels per day during the active season (Jense 1968; Messick and Hornocker 1981). Juvenile badgers require over 60% more calories than an adult (Jense 1968). Carbone and Gittleman (2002) used biomass of prey to predict average density of carnivore populations. For example, in two red fox (*Vulpes vulpes*) populations (average fox mass = 4.6 kg), they estimated that there would be over 32 foxes per 10,000 kg of prey biomass, or 10 to 112 foxes per 100 km^2. They also reported that 10,000 kg of prey biomass would supports approximately 90 kg of a given carnivore; or, 1,000 kg of prey would maintain a badger with an average mass of 9 kg. We extrapolated this relationship and calculated prey biomass per hectare using average masses of adult prey and average densities reported in review literature (Table 2). This estimated an area needed to provide enough prey for a 9 kg badger.

Table 2. Average prey masses and densities used to estimate the area needed to support a 9 kg adult badger with 1,000 kg of prey biomass (taken from Hoodicoff 2004).

	Avg. adult mass (kg)	**Avg. adult density** (per ha)	**Prey biomass** (kg / ha)	**Area to produce 1,000 kg prey** (ha)
Columbian ground squirrels	0.503[1]	43[2]	21.6	**46**
Yellow-bellied marmots	3.350[3]	patchy		**(298 marmots)**
Northern pocket gophers	0.122[4]	25[1]	3.1	**323**
Muskrats	1.250[1]	8[5]	10.0	**100**
Red backed voles	0.024[6]	6[1]	0.14	**7143**
Meadow voles	0.044[7]	74[1]	3.3	**345**

1 (Banfield 1974), **2** (Elliott and Flinders 1991), **3** (Frase and Hoffmann 1980), **4** (Verts and Carraway 1999), **5**(Willner et al. 1980), **6** (Merritt 1981), **7** (Reich 1981)

Relative targets of range utilization are insufficient to retain cover targets for small mammals. Traditionally, range managers tried to maintain 50% of the available forage before moving livestock (Cariboo-Chilcotin Grasslands Strategy Working Group 2001). Because targets were set at a relative percentage of available forage, changes to rangeland health could only be assessed compared to the condition in previous years. Eventually, grass production compared to utilization declined and carryover of ungrazed forage decreased despite livestock numbers remaining fairly constant. By the mid 1990s, overall range condition deteriorated in the Cariboo. In reports of cover thresholds for small mammals, some authors only reported relative values of range use or forage availability

rather than observed cover levels (e.g., Frase and Hoffmann 1980; Kauffman and Krueger 1984). Using relative guidelines to determine maximum grazing pressure will eventually lead to a decline in habitat condition

Empirical measurements, such as weight of dried vegetation per area, stubble heights, or visual obstruction, are a more consistent means to estimate cover. Stubble heights of grazed grass are relatively easy to measure and simple to communicate to range managers. Turner and Clary (2001) discuss a method to use stubble height measurements as a means to monitor pasture use. Visual obstruction (VO) is an effective way to measure cover and is more time efficient than clipping and raking vegetation and taking the dry weight (Benkobi et al. 2000). VO measurements are most accurate for grassland with greater than 30 g/m^2 dry vegetation weight (VO = 1.3 cm approximately; Benkobi et al. 2000). In British Columbia, there are no threshold values for VO measurements to ensure adequate cover for wildlife. The BC Ministry of Water, Land and Air Protection is conducting a longer-term study using the Robel pole and other methods to determine the vegetative cover requirements of selected grassland wildlife species. Until VO thresholds are verified, stubble height of residual vegetation can be used as an appropriate measure to gauge the immediate intensity of grazing by cattle.

A component of implementing new practices is evaluating the changes incurred as a result of management regimes. Initially, the community structure and densities of small mammals should be identified at a site with respects to the existing habitat conditions. Activities to achieve the minimum targets for vegetation cover or tree density are implemented. Finally, an evaluation should be conducted on how well the activities achieved the objectives and resulted in an increase in prey densities or changed the community structure of prey.

Table 3. Summary of management practices to improve habitat for small mammals on rangeland and riparian areas, and to increase the habitat for small mammals by mitigating the effects of forest encroachment.

	LIVESTOCK GRAZING	LIVESTOCK IN RIPARIAN AREAS	ENCROACHING FORESTS
Objective	*Increase habitat cover for small mammals while maintaining vegetation in a variety of successional stages.*	*Maintain habitat cover and soil integrity by decreasing trampling and over utilization of riparian vegetation by livestock.*	*Increase areas of grassland and open forest by reducing forest in-growth and encroachment.*
Minimum Targets	• Maintain minimum 15 cm stubble height • Retain ≥40% vegetation cover at mid-August	• Maintain minimum 10 cm stubble height • Retain ≥65% vegetation cover	Late seral target 20 stems/ha; ≤15% canopy • Retain ≥90% vets >140 yrs old • Maintain 50% widely spaced seedlings Mid seral target <75 stems/ha • Retain vets >140 yrs old • Retain stems ≤12.5 cm diameter up to 3x density of vets • Retain stems of ≥12.5 cm diameter up to 10x density of vets Early seral target <75 stems/ha • Remove stems where densities >20,000 stems/ha
Activities to Achieve Targets	• Follow Range Use Plans • Ensure range readiness is determined • Defer grazing on bunchgrass until late spring • Monitor AUMs on rangeland • Use rest-rotation grazing where appropriate • Exclude livestock in heavily grazed pastures where appropriate	• See *Livestock Grazing* • Manage adjacent sites to healthy levels • Use fencing to limit livestock access • Provide alternate water sources • Increase riders on range to move livestock • Locate mineral blocks away from riparian areas to attract livestock to upland range • Maintain ungrazed buffer strips 7-15 m wide (approx. 1.3 ha) • Defer grazing until Mid-July • Rest pastures at least 1 in 3 years	• Prescribe burning in early seral stands • Employ mechanical thinning in mid-late seral stands • Utilize forest harvesting where appropriate • Re-seed natural grass species in openings

5.0 CONCLUSION

Ensuring abundant prey is available to badgers in British Columbia is a main objective in the *jeffersonii* Badger Recovery Strategy (Adams et al. 2003b). Abundant and diverse small mammals are found in healthy grasslands with sufficient vegetation cover (Birney et al. 1976; Jones 1990; Lin and Batzli 2001). Cover for small mammals includes standing vegetation and litter which also are important for grassland ecosystem function (Fleischner 1994; Willms et al. 2002; Adams et al. 2003a). Structurally diverse grasslands also provide habitat for higher songbird diversity and nesting success for songbirds and waterfowl (MacKenzie 2004). Maintaining grassland integrity dominated by perennial grasses, and encouraging upward plant succession to climax grass species will provide the most diverse and consistent prey supply for badgers.

Ecological integrity on grasslands can be maintained with conscientious management practices. The condition of grasslands in the 100 Mile House Forest District is declining due to low vegetation carryover from livestock grazing. Quality habitat and livestock grazing, however, are not mutually exclusive. Grazing encourages colonization of ground squirrels and marmots that prefer early succession vegetation (Frase and Hoffmann 1980; Elliott and Flinders 1991; Skinner et al. 1996). Grassland area in the Cariboo also is lost to forest in-growth and encroachment. Mitigating the effects of crown closure will increase the area of grassland habitat in the Cariboo. Lighting low-intensity fires to burn certain areas with establishing and young trees will help to maintain bunchgrass-dominated understories. Livestock and small mammals can co-exist if threshold habitat requirements, mainly cover and vegetative structure, are upheld.

This project met our objective to develop management practices to maintain prey species in badger habitats. We were able to link Best Management Practices with existing range management plans. Range Use Plans provide a framework for implementing our recommendations thereby increasing the likelihood that they may be put into practice. In the future, the recommendations made in this report will be implemented on approximately 6,380 ha and we believe it will significantly improve habitat for prey.

We believe that management of livestock in proposed Wildlife Habitat Areas and mitigating forest encroachment onto grassland would increase prey populations and habitat suitability for badgers in the Cariboo region. Additional fencing would increase range management capability to improve range condition. This would be particularly effective at excluding the substantial feral horse population from especially sensitive sites. Mechanical removal and thinning of forest encroachment onto grasslands within Wildlife Habitat Areas and adjacent sites would help to ensure open habitat for badgers and their prey, and would benefit other grassland-dependent species. The Canoe Creek Indian Band and the BC Ministry of Forests has expressed interest in partnering with the BC Ministry of Water, Land and Air Protection to work toward these efforts.

Further research is needed to identify threshold cover requirements for small mammals in western Canada. A monitoring program should be established to document prey densities before and after ecosystem restoration activities take place. This will require establishing regional benchmarks for prey species occurrences and densities, and assessment of wildlife responses to different cover values. The BC Ministry of Water, Land and Air Protection is conducting a longer-term study to identify conditions for suitable habitat for small mammals such as litter, visual obscurity, stubble heights, vegetation species composition of 'healthy' range, and invasive species. This study also will evaluate the capability of current standards for range assessment to reflect habitat condition for small mammals.

Although it was a secondary objective in our project, we were successful at bringing awareness of badgers to people in the Cariboo region. It was our experience that most people were not aware that badgers occurred in the region, and most people were not aware that there was a conservation concern for the species. Over the last two years, we have had a working relationship with a number of landowners and have been able to suggest alternative practices to maintain prey populations in their fields. We established a firm relationship with the communities at Canoe Creek and Dog Creek. Other Indian

Bands in the area (e.g., Canim Lake, Williams Lake) also have expressed interest in partnering on future inventory and public extension activities. Marmot Ridge Golf Course has graciously accepted the burrowing activities of at least one badger and a colony of marmots and has posted a sign to feature badger activity at the course.
We have made considerable headway in bringing awareness of badgers to the Cariboo region and would like to continue these efforts. Increased signage, such as the one we installed at the Marmot Ridge Golf Course, would increase the profile of badgers in the region. We recovered one badger killed on a highway, received reports of another mortality on a well-traveled gravel road, and documented at least two badgers burrowing next to a highway during the summer months. Signage, such as those mounted in the Thompson Region, would warn motorists of badger activity and reduce the threat of road mortality.

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APPENDIX I. Poster advertising the badger study and reporting line.

HAVE YOU SEEN A BADGER?

We are trying to determine the current distribution of badgers in the Cariboo.
PLEASE CALL if you have recently seen a badger or badger burrows.

Badgers have been seen in the 100 Mile House area
including 108 Mile, Horse Lake, Bridge Lake, and Forest Grove.

BADGER REPORTING LINE

250-395-7853

Email us at **info@badgers.bc.ca**

For more information on badgers go to **www.badgers.bc.ca**

HABITAT CONSERVATION TRUST FUND

The Cariboo Badger Project is coordinated by the BC Ministry of Water, Lands and Air Protection, and is funded by the Habitat Conservation Trust Fund, and by the Habitat Stewardship Program for Species at Risk through the Canadian Wildlife Service in. The Habitat Conservation Trust Fund was created by an act of the legislature to preserve, restore and enhance key areas of habitat for fish and wildlife throughout British Columbia. Anglers, hunters, trappers and guides contribute to the projects of the Trust Fund through license surcharges.

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APPENDIX II. Sign to be installed at Marmot Ridge Golf Course promoting tolerance of badger and marmot burrows.