**FINAL REPORT**

# CARIBOO REGION BADGER PROJECT: SUMMARY REPORT 2003-2005


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**Project 550-27.01**

**March 2006**

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**Reference**: 550-27.01

Mr. Roger Packham
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Dear Mr. Packham:

**Re: Cariboo Region Badger Project: Summary Report 2003-2005**
**FINAL REPORT**

Summit Environmental Consultants Ltd. (Summit) is pleased to provide the final report for the Cariboo Region Badger Project. The report summarizes data collected and activities conducted between 2003 and 2006, and includes advertising materials, photos, and maps as appendices.

In summary, a total of 680 burrow and badger sightings were collected within the Cariboo region. Remote hair collection using pinned knaplock snags proved to the most effective way to collect genetic information (hair follicles) for DNA fingerprinting. Using this method, 37 badgers (21 males, 14 females, 2 undetermined) were identified at a total of 207 burrows during the study. Four of five known badger mortalities were a result of vehicle collisions. Also, badgers in the region are using large home ranges as found in other studies in the province.

We trust that this provides you with the information you require. Please do not hesitate to call if you have any further comments or questions.

Yours truly,

**Summit Environmental Consultants Ltd.**

Corinna Hoodicoff, M.Sc., R.P.Bio.
Biologist

## EXECUTIVE SUMMARY

The Cariboo Region Badger Project was initiated to provide ecological information on badgers occurring at the northern periphery of their range to support recovery goals for the species. Another main objective was to develop an effective method to remotely inventory badgers using hair collection for DNA fingerprinting that could be implemented across the province. To meet these objectives, we collected burrow locations and observations of animals reported by the pubic, established Wildlife Habitat Areas (WHAs) around burrow concentrations and key habitats, and collected hair (snagged and shed) for DNA fingerprinting. Using this information, we were able to identify individual badgers, estimate their home range areas and movements for a better understanding of badger ecology in the region.

Since 2003, we have recorded a total of 680 burrow and badger sightings in five ecosections of the province. Twelve WHAs have been proposed for a total area of 797 ha, and best management practices have been developed to improve or maintain habitat conditions. Using DNA fingerprinting from hair we collected, we were able to identify 37 badgers (21 males, 14 females, 2 undetermined) at a total of 207 burrows. Five of these badgers were killed: one accidental trapping, three highway mortalities, and one suspected road mortality. In 2005, at least one family group of 5 badgers was documented with some certainty. We were able to calculate home range areas (100% minimum convex polygon) for 17 badgers with ≥3 locations. The largest home range calculated was 1280 $km^2$ occupied by male badger M008 ($n$=10) and the next largest was 190 $km^2$ occupied by male badger M005 ($n$=10). We found that badgers are using large home ranges as in other regions of the province, and that while badgers (and their burrows) are more abundant in grassland areas, they use openings in agricultural fields and openings in forests such as dry knolls.

Remote hair collection proved to be an effective way to collect genetic information (hair follicles) for DNA fingerprinting. The viability of our samples, that is the percentage of identifications made, improved dramatically in the third year of collection. This likely was due to the style of hair snag used (pinned knaplock) that was effective at pulling sufficient

hair from the badger, and by avoiding any exposure of the hair samples to moisture (i.e. inclement weather). While snagged hair provided more viable samples, shed hair were an efficient source of genetic material for DNA fingerprinting, and can be collected without a formal methodology. The current five-locus marker system used to identify individuals was sufficient considering the relatively low numbers surveyed. However, as more individuals are identified in future inventory programs, additional markers should be developed.

**Photo: Philippe Verkerk**

## ACKNOWLEDGEMENTS

The Cariboo Region Badger Project was initiated and coordinated by Roger Packham, Ministry of Environment, 100 Mile House, British Columbia. The project was funded by the Habitat Conservation Trust Fund (HCTF), Habitat Stewardship Program (HSP), and the BC Conservation Corps (BCCC), as well as the Ministry of Environment (MoE) and BC Ministry of Forests and Range (MoFR). Field work was conducted by Roger Packham, Corinna Hoodicoff, Gerry Dileva, and Philippe Verkerk. Bill Chapman (MoFR) provided advice and conducted assessments of soils used by badgers. Activities accomplished by Canoe Creek Indian Band (CCIB) were coordinated by Scott Cousins, Natural Resource Coordinator through funding provided by CCIB and the Interdepartmental Recovery Fund. The CCIB Species at Risk Inventory Team included Mildred Kalelest, Melvin Louis, Fred Louis, Kevin Harry and Allison Harry. Thanks are extended to the public for reporting badger sightings and to private landowners for maintaining badger habitat.

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# 1.0 INTRODUCTION

## 1.1 PROJECT BACKGROUND

Badgers are grassland carnivores that live in burrows and specialize in hunting fossorial prey (Rahme, et al. 1996). Their main prey species are ground squirrels, pocket gophers, and marmots that are often viewed as pests on agricultural land. Badger burrows also play a key role in providing shelter for other grassland-dwelling species, such as the burrowing owl (*Athene cunicularia*) and the gopher snake (*Pituophis catenifer*), which are considered rare in the province (Green and Anthony 1989). Due to their key ecological roles in grasslands, badgers may be considered a sentinel species.

The *jeffersonii* subspecies of North American badger (*Taxidea taxus*) is considered endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, Newhouse and Kinley 1999). Recent estimates suggest that there are less than 300 badgers remaining in British Columbia. Factors that contribute to the decline of badger populations include highway mortality, trapping and persecution, loss of prey species, and habitat loss and degradation (*jeffersonii* Badger Recovery Team 2005). Habitat in the province that is suitable for badgers mainly occurs in dry valley bottoms that experience high rates of urban development and highway construction, and agricultural activities are widespread since grasslands are some of the most productive areas in the province. Fire suppression also has lead to forest in-growth and resulted in degraded habitat conditions (Gayton 2001). The *jeffersonii* Badger Recovery Team has drafted a Recovery Strategy (2005) aimed at improving and restoring badger habitat, and increasing badger populations throughout their historic range.

The Cariboo represents the northern extent of *jeffersonii* badgers in North America. Although badger ecology has been studied in the East Kootenay and Thompson regions where animals were intensely monitored using radio-telemetry (Newhouse and Kinley 2001; Weir et al. 2003), the species is poorly understood in the region. Until recently, badgers were thought to be at low densities in the Cariboo region because it is the periphery of their range (Figure 1.1). Surveys in 2003, however, indicated that there were more badgers in the

Cariboo region than originally believed. This observation helped to initiate the Cariboo Region Badger Project.

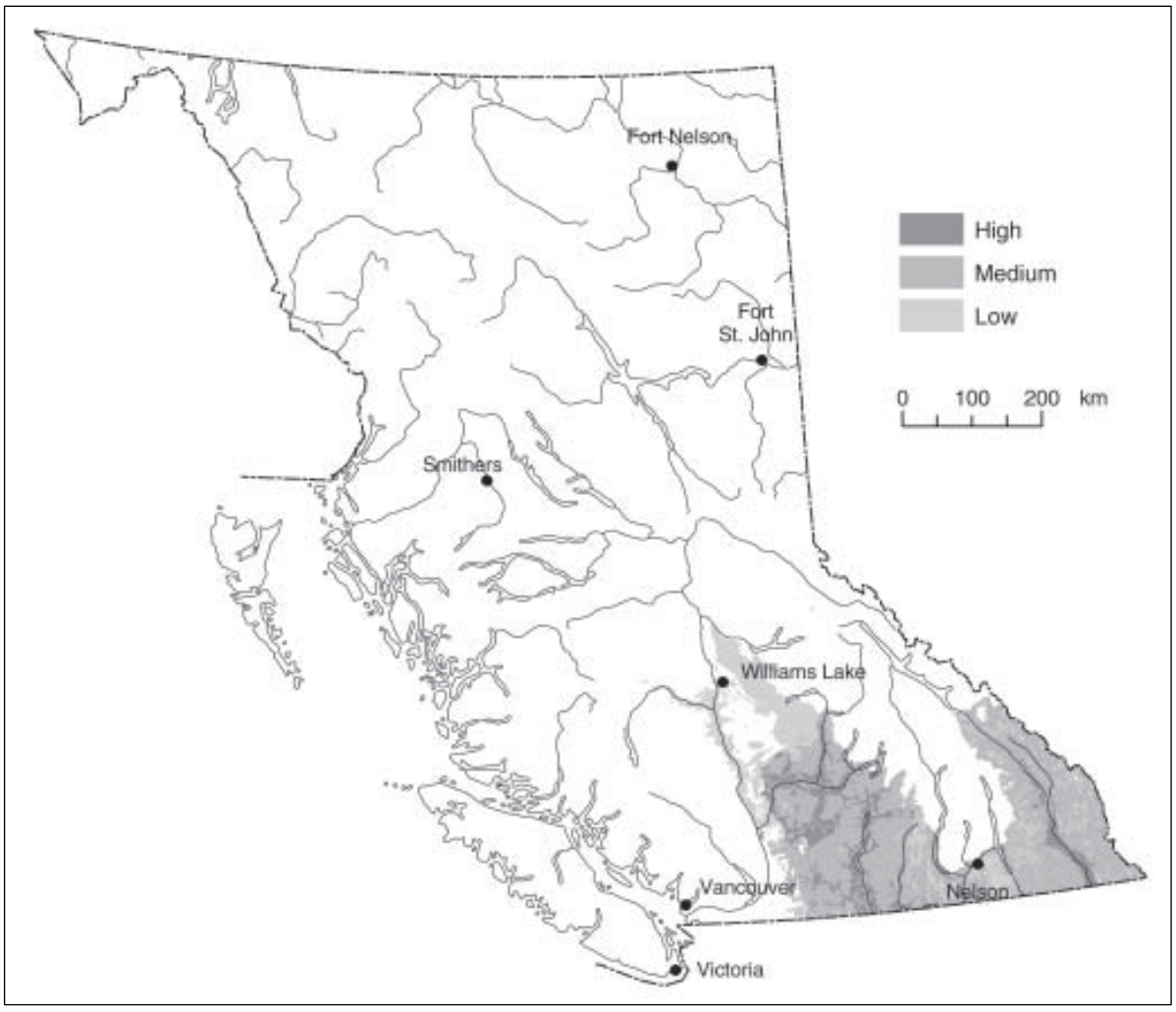


Figure 1.1. Potential distribution of *jeffersonii* badgers in British Columbia (Source: Adams and Kinley 2004).

## 1.2 PROJECT OBJECTIVES

Our general objective for the Cariboo Region Badger Project is to determine the extent of badger activity and to collect ecological information of the animals living at the periphery of their range to support future recovery activities in the region. Our specific objectives for the project are to:

1. Raise local awareness of badgers and their habitats in the Cariboo region;
2. Locate burrows and describe badger habitat in the Cariboo region to establish Wildlife Habitat Areas (WHAs) on Crown land;
3. Develop a viable method to remotely monitor badger population using genetic fingerprinting; and,
4. Estimate home ranges and movements of badgers across the Cariboo region.

### 1.2.1 Local Awareness of Badgers

Increasing the appreciation of badgers and understanding of badger ecology among landowners is a key component of the recovery plan for the species (*jeffersonii* Recovery Team 2005). This includes raising awareness of the benefits of badgers as a natural control of agricultural pests such as ground squirrels and marmots and discouraging the persecution of badgers on deeded properties. Also, the majority of badger habitat in British Columbia occurs on private land, so awareness of habitat management and stewardship initiatives is a key component of a successful recovery program. The Cariboo Region Badger Project used a community awareness campaign to improve awareness of badgers and their habitat in the Cariboo region, and to solicit sightings of badgers and their burrows from the public.

### 1.2.2 Burrow Locations and Wildlife Habitat Areas

The main recovery objectives for badgers include to protect, maintain and improve badger habitat and to ensure prey availability (*jeffersonii* Badger Recovery Team 2005). Our objective was to determine the distribution and location of burrows in the Cariboo region, and to use this information to propose WHAs to maintain badger habitat and their prey. The Identified Wildlife Management Strategy for badgers stipulates that WHAs are to be

established in areas identified as key badger habitat that may include concentrations of burrows, abundant prey resources and diggable soils suitable for burrowing (Adams and Kinley 2004).

### 1.2.3 Hair Collection and DNA Fingerprinting

Another objective of the project was to remotely inventory badgers in the Cariboo region, and to develop a standard method that could be implemented across the province. Badgers are secretive and nocturnal making it difficult to estimate resident population sizes accurately. A formal method to remotely inventory badgers would help to provide more accurate regional population estimates, and will help to identify priority areas for recovery activities in the province.

### 1.2.4 Home Ranges and Movements

Badgers in British Columbia are known to have large home ranges (Newhouse and Kinley 2001; Weir et al. 2003). This may be a result of low prey availability (prey searching) or low population density (mate searching), and may have an impact on survival and reproductive success of individuals (*jeffersonii* Recovery Team 2005). Also, the orientation of an individual's home range may increase the potential for direct mortality (e.g., proximity to highways). Because badger ecology is poorly understood in the Cariboo region, our objective was to estimate badger home ranges and their movements to gain a better understanding of these potential impacts on the local population.

## 2.0 METHODS

### 2.1 LOCAL AWARENESS OF BADGERS

We informed the public of our research by hanging posters throughout the study area to solicit sightings via a 'badger reporting line.' Information pamphlets also were delivered during landowner visits and newspaper articles were published in local papers (Appendix A). Follow-up site visits were conducted where badger sightings were reported or where researchers suspected badger habitat or activity. Presentations on badger ecology were made

to local schools and clubs, field tours were given to local government personnel and presentations were given at provincial workshops.

## 2.2 BURROW LOCATIONS AND WILDLIFE HABITAT AREAS

To determine the extent of badger distribution, we surveyed grassland habitats within the study area for badger burrows from the air and ground. An initial helicopter flight was conducted in January 2003, followed by two flights in March, 2004. Helicopter surveys included the area from Clinton to the west side of Fraser River as far north as Beaumont Creek, and along the Chilcotin River. Funding for these flights was provided by the BC Ministry of Water, Land and Air Protection (MWLAP, now Ministry of Environment) and Ministry of Forests (MoF, now Ministry of Forests and Range). From the ground, we drove paved highway and gravel roads from Loon Lake in the south to Williams Lake in the north, and from Bonaparte River in the east to the Gang Ranch and Fraser River in the west. 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. All reports were followed by a ground reconnaissance.

We proposed WHAs on Crown land in areas we identified as critical badger habitat. These included areas with concentrations of badger burrows, abundant prey resources and soils suitable for burrowing. We also proposed WHAs at maternal burrows and sites that had evidence of historic use, particularly those in unique areas such as an isolated deposit of lacustrine soil. Maternal burrows were identified where there were observations of family groups (>1 badger) or obvious juveniles. Characteristics or evidence of a maternal den included larger than average burrows with large soil berms and signs of repeated use (e.g., tracks, fresh digging). We identified sites that were used historically as those with multiple old, collapsed burrows and with berms in front of entrances that were grown over with grass sod. Burrows in isolated habitat, e.g., burrows within a grassland pocket surrounded by timber, were also incorporated into a WHA. These areas were delineated on maps following ecosystem types or existing infrastructures (e.g., roads, streams, cutblock boundaries), and were submitted for approval by the regional Wildlife Biologist (Julie Steciw, MoE).

## 2.3 HAIR COLLECTION AND DNA FINGERPRINTING

### 2.3.1 Hair Collection

We collected hair from badgers to genetically identify individuals using DNA fingerprinting (Taberlet and Luikart 1999). This method has been used to inventory bears (Woods et al. 1999; Mowat and Strobeck 2000; Poole et al. 2001), and has been successful with other species, such as American marten, Iberian lynx and wolves (Mowat and Paetkau 2002; Palomares, et al. 2002; Creel, et al. 2003). Badgers are a likely candidate for this method because hair can be collected at burrows that are repeatedly used by individuals, and monitored across the landscape. Also, once appropriate measures are in place, genetic material can provide information on the relatedness of individuals, and the genetic structure of a population (Piggott and Taylor 2003).

We opportunistically collected hair shed at burrows and systematically snagged hair using four different snag sets:

1) Barbed Wire Snag: In 2003, barbed wire was looped into a semi-circle and the ends secured inside of the burrow entrance (Appendix B, Photo 1). The ends of the barbs were clipped to avoid harming any animals;

2) Velcro Snag: In 2004, Velcro was used to snag hair to eliminate the possibility of badger injury from barbed wire. Velcro snags were made from 30 cm of 2 cm wide metal strapping, the type used to wrap lumber, formed into a 'D' (Appendix B, Photo 2). Two 3 inch nails were inserted through holes drilled at the base of the 'D' and were used to secure the snag inside the burrow. Three rivets were placed at each edge and middle to secure the strapping in its shape. The 'hook' side of adhesive Velcro (2 cm wide) was placed along the arc to capture hair; and,

3) Pinned Knaplock Snag: In 2005, the Velcro snags were remodeled to improve their ability to snag hair from badgers, particularly later in the summer after their winter

coats were shed. Two squares (approximately 2 cm by 2 cm) of pinned knaplock were riveted to the same metal strapping as the Velcro snags (Appendix B, Photo 3). We used a rubber mallet bend the teeth of the knaplock down to prevent injury to any animal.

4) Perimeter Snag: A perimeter snag was set at a burrow "complex" where a family group was observed. Lengths of 1"x2" lumber with pinned knaplock secured to the undersides were erected approximately 30 cm off of the ground surface around every burrow opening (Appendix B, Photos 4 and 5). Again, the teeth of the knaplock were bent down to prevent injury to any animal.

Badger snags were set at burrow entrances that had evidence of recent use, e.g., freshly excavated soil, tracks, or an animal observed. The snags were placed inside each burrow, along the top of the entrance, where an animal entering or exiting would brush against the snag and deposit hair. Snags were placed far enough inside of the burrow to avoid contact with precipitation, and were handled with leather gloves to minimize human scent. Set snags were checked approximately every 4 to 6 days for hair. Some sets were in remote locations and these were checked when feasible. All of the hair was collected from each snag and placed inside a paper envelope and stored at room temperature. At the end of the field season, all samples were sent to Dr. David Paetkau at Wildlife Genetics International (Nelson, BC) for DNA fingerprinting.

### 2.3.2 Laboratory Procedures

Markers (microsatellite loci) used to assign hair samples to individual badgers were selected based on results from Davis and Strobeck (1998) and Kyle et al. (2004). To test for viability of the genetic material, all of the samples were pre-screened with 2 markers (*Tt-3* and *Tt-4*) that were known to perform well in previous marker tests. The samples that did not perform well in this pre-screening were either not badger hairs or were of poor quality, and were discarded. Six of the most variable makers were used to assign hair samples to individuals (*Ma-1, Tt-1, Tt-2, Tt-3, Tt-4, Mvis072*).

Inconsistent genotyping of different samples from the same individual is expected to create pairs of geonotypes that are highly similar, and will lead to the recognition of more individuals than actually were sampled. To ensure that samples were not mistakenly assigned to individuals, the samples were also subjected to a computerized comparison of all pairs of unique genotypes, and suspiciously similar pairs of genotypes that might be indicative of genotyping errors were flagged (Paetkau, pers. comm. 2006).

Gender was determined from each sample using a nuclear DNA analysis of the SRY locus on the Y-chromosome. Mustelid-specific primers were developed from sequences deposited in Genbank and were successfully tested on fisher, marten and wolverine samples (Paetkau, pers. comm. 2006).

We used the minimum number of badgers we detected with DNA fingerprinting to approximate the density of badgers in the immediate area that was surveyed. We also used sightings of multiple badgers to estimate the minimum number of family groups in the study area.

### 2.4 HOME RANGES AND MOVEMENTS

Home ranges were calculated using locations where DNA was collected and successfully assigned to an individual badger. Home ranges were estimated as 100% minimum convex polygons (MCP; Mohr 1947) and calculated using ArcView GIS version 3.1 (ESRI 1998).

## 3.0 RESULTS

### 3.1 LOCAL AWARENESS OF BADGERS

During our field work we continued to inform the public of our research during landowner visits and hung posters throughout the study area. The public reported animal sightings to the "badger reporting line," and we recorded over 86 badger observations in the region. At least 10 landowners with suitable badger habitat and badger sign were contacted regularly.

We have partnered with the Marmot Ridge Golf Course in 100 Mile House where there was a resident badger. The badger had a number of burrows and was hunting marmots both on and near the golf fairways. The golf course has a positive reaction to the benefits of badgers and their role in rodent control. An article was published in the 100 Mile House Free Press newspaper and an information sign has been erected on the golf course (Appendix A).

A number of field trips and presentations were given to generate awareness of badgers in the Cariboo and to create partnerships between various organizations. Roger Packham delivered presentations at the Species at Risk conference in Victoria, B.C. (2004), and to members of the Habitat Conservation Trust Fund board, the Cariboo regional office of MoE, and regional managers of the Environmental Stewardship Division. Presentations were also given to the South Cariboo Trappers' Association and at the Trappers' Association Annual General Meeting, 100 Mile House Junior Secondary biology class and Horse Lake Elementary (School District No. 27), and field tours were given to provincial and regional MoE and MoFR staff and, the Lower Bridge Creek Watershed Stewardship Society.

Two slide shows were held with community members in the Canoe Creek Indian Band, and a poster was presented at the Annual General Meeting in Dog Creek. These resulted in further badger sightings and burrow locations, and a general awareness of badger habitat conservation within the community. Since 2004, the Cariboo Badger Project partnered with the Canoe Creek Indian Band (with Inter-departmental Recovery Fund) to train a crew of community members to identify badger burrows and habitat on Indian Reserve (IR) lands with the goal of writing a range management plan for the Indian Band that incorporates the requirements of badgers and their prey.

We also have been actively participating in the *jeffersonii* Badger Recovery Team meetings and activities, and our final report will be distributed to the members of the team. The jeffersonii Badger Recovery team met at the Flying U Ranch near 70 Mile House for two days (May 26-27, 2004) to discuss conservation initiatives and attended a field tour of the

study area. Our progress and final reports will be posted on the *jeffersonii* Badger Recovery Team website (www.badgers.bc.ca).

## 3.2 BURROW LOCATIONS AND WILDLIFE HABITAT AREAS

### 3.2.1 Burrow Locations and Habitat

Prior to June 2003, 16 sightings of badgers had been recorded in the region (Artemis Wildlife Consultants, Armstrong, BC). Since then, a total of 589 burrowing sites (≥ 1 burrow) and 86 sightings of animals, including five mortalities, have been documented (Table 3.1). Locations ranged from the town of Clinton in the south to north of Williams Lake, and from west of the Fraser River to the Bonaparte Plateau in the east (Appendix C). Twenty-five burrows and sightings do not have precise enough locations to be included in the summaries below.

A total of 655 burrows and badger sightings were identified in five ecosections of the province, and most locations (64.4%) were found in the Cariboo Basin (Table 3.2). Locations were identified mainly in the Interior-Douglas Fir (67%), Bunchgrass (17%) and Sub-boreal Pine Spruce (11%) biogeclimatic zones (Table 3.3).

Burrowing habitat in the Cariboo region includes glaciofluvial structures such as eskers that are subject to disturbance and excavation, for example, as a source of gravel and sand for road building and maintenance. Badgers require soils to burrow into and these are usually suitable for their fossorial prey as well (Rahme et al. 1995). Burrows that we surveyed were mainly recorded in eutric brunisols from (glacio)fluvial, or morainal parent material (Valentine and Schori 1980). Burrows were often located in Aeolian or lacustrine deposits along esker ridges or in undulating or gently sloping terrain. Soil textures at these sites were mainly coarse silts (0.02-0.05 mm), medium silts (0.006-0.02 mm) and some fine sands (0.05-0.25 mm; Bill Chapman, Research Soils Scientist, BC Ministry of Forests, pers. comm.). All have similar properties and are well drained, easily excavated, and provide stability for the burrow. Most soils dug from burrows had less than 20% coarse fragment content. On occasion, burrows were dug where two soil types met, for example, between

Aeolian silt deposited over gravel. Badgers that occur in areas with predominately morainal deposits may be limited to using disturbed soils (e.g., overburden, road fill) or small areas with glaciofluvial deposits in these areas (Adams and Kinley 2004). Some burrows in the Cariboo region show signs of historic use such as old, collapsed tunnels, or the berms in front of burrow entrances are grown over with grass sod.

Table 3.1. Burrows and badger sightings recorded during the Cariboo Region Badger Project.

| | ≤2003 | 2004 | 2005 | Total |
|---|---|---|---|---|
| Burrows | 345 | 143 | 101 | 589 |
| Sightings | 31 | 21 | 34 | 86 |
| Mortalities | 2 | 1 | 2 | 5 |
| Total | 37 | 165 | 137 | 680 |

Table 3.2. Ecosections of British Columbia where burrows and badger sightings (*n* = 655) were recorded.

| Ecosection and Biogeoclimatic Zone | Burrows | % Total |
|---|---|---|
| **Cariboo Basin** | **438** | **66.9** |
| IDF dk 3 | 418 | 95.4 |
| IDF xm | 15 | 3.4 |
| IDF xw | 5 | 1.1 |
| **Cariboo Plateau** | **83** | **12.7** |
| SBPS mk | 78 | 94.0 |
| SBS dw 1 | 4 | 4.8 |
| SBS dw 2 | 1 | 1.2 |
| **Fraser River Basin** | **125** | **19.1** |
| BG xh 3 | 38 | 30.4 |
| BG xw 2 | 77 | 61.6 |
| IDF dk 3 | 1 | 0.8 |
| IDF dk 4 | 2 | 1.6 |
| IDF xm | 7 | 5.6 |
| **Tranquille Upland** | **7** | **1.1** |
| IDF dk 3 | 6 | 85.7 |
| MS xk | 1 | 14.3 |
| **Quesnel Highlands** | **2** | **0.3** |
| IDF mw 2 | 2 | 100.0 |

### 3.2.2 Proposed Wildlife Habitat Areas

We proposed twelve Wildlife Habitat Areas (WHAs) around areas of dense badger burrows and suitable grassland habitat in the 100 Mile House Forest District (Appendix D). WHAs were bound by natural features (e.g., soil, geologic) or existing infrastructure (e.g., fencelines, roads) where possible. The total area was 797 ha, with WHAs ranging from 24.6 ha to 99.5 ha, with an average area of 66.4 ha (Table 3.4). Seventy-three burrows (12% of total identified burrows) are located within WHA boundaries.

Effort was made to incorporate unique features used by badgers, and habitat for other species where possible. WHA No. 2 incorporated a lacustrine deposit in mainly forested habitat that was isolated from other known burrows. Also, burrows and foraging sites in a gravel pit were encompassed by WHA No. 5 as it was potentially at risk from extraction and recreation.

Our intent is to work with Ministry of Transportation and Highways to develop management strategies to minimize the impact of activities on badger burrows. WHA Nos. 3, 4 and 10 were suspected maternal burrows. Also, WHA No. 3 is located at a sharp-tailed grouse lek, and two others encompassed American avocet nesting habitat. WHA No.1 incorporates a bear den, and WHA No. 12 includes wetland habitat where there was evidence of badgers foraging for muskrats. WHA Nos. 6, 7, 8, 9 and 11 were established where there is evidence of high current and historic activity by badgers.

We also developed best management practices (BMPs) for WHAs in the Cariboo region to guide managers and ensure good range and riparian habitat conditions to maximize prey numbers and diversity (Hoodicoff 2004, Hoodicoff 2005). The management recommendations made support the general wildlife measures for badgers in the IWMS (Adams and Kinley 2004), and also to address other activities that impact badger habitat not covered by the IWMS on Crown and private lands. These include: a) Range practices, b) Agricultural cultivation, c) Forest in-growth and encroachment, d) Forest harvesting, e) Urban development, f) Road construction and maintenance, and g) Golf course management. Also, because badgers use large home ranges, these areas may be used to maintain grassland habitat for other species. The BMPs we recommended also will maintain habitat suitability for sharp-tailed grouse, blue grouse and numerous species of ground nesting waterfowl that share badger habitat.

Table 3.3. Wildlife Habitat Areas (WHA) proposed for badgers in the 100 Mile House Forest District of the Cariboo region.

| No. | WHA Name | Special Features | Area (ha) |
|---|---|---|---|
| 1 | Augustine | Grass knoll in timber, bear den | 34.1 |
| 2 | Komori | Lacustrine soil deposit | 51.4 |
| 3 | 1200 Rd | Maternal burrow, sharp-tailed grouse lek site | 39.4 |
| 4 | Windmill | Maternal burrow, grass knoll in timber | 99.4 |
| 5 | Green Lk Gravel Pit | Gravel Pit | 24.6 |
| 6 | Alberta Lake West | High density badger activity, historic use | 92.7 |
| 7 | Alberta Lake East | High density badger activity, historic use | 53.9 |
| 8 | McKinley Lakes | High density badger activity, historic use | 70.3 |
| 9 | Pollard Lake | High density badger activity, historic use | 70.5 |
| 10 | China Lake | Maternal burrow, range exclosure | 87.3 |
| 11 | River Lakes | High density badger activity, historic use | 97.8 |
| 12 | Hutchison Lake | Wetland habitat | 75.4 |
| | | Total Area | 796.8 |

## 3.3 HAIR COLLECTION AND DNA FINGERPRINTING

### 3.3.1 Hair Collection Effort

Hair snagging effort and number of samples collected increased between 2003 and 2005 as awareness of additional burrows and snagging techniques improved (Table 3.5). In 2003, 54 shed hair samples and 51 snagged hair samples were collected from 65 different burrows between 16 June and 22 September. In 2004, 100 shed hair samples and 70 snagged hair samples were collected from 103 burrows between 10 May and 20 August. In 2005, 37 shed hair samples and 91 snagged hair samples were collected from 71 different burrows between 7 May and 8 September. In total, 210 snagged and 189 shed hair samples were collected from 187 burrow locations and tissues samples were recovered from five badger carcasses (Table 3.6; Appendix E).

In 2005, a total of five badgers were observed at a maternal den identified as B485 (Appendix B, Photo 6). A hair snag was set around the perimeter continuously between June 17 and August 5 (a total of 49.08 days), and an additional one to six pinned knaplock snags were set. In total, 44 hair samples were collected from the perimeter snag (25 samples) and pinned knaplock snags (19 samples) from 17 to 20 June, 2005 (49 days). Field notes suggested the site was not very active between June 20 and August 5. These samples will be treated separately in the DNA fingerprinting results that follow (Section 3.2.2).

Table 3.4. Summary of hair snagging effort between 2003 and 2005.

| YEAR | 2003 | 2004 | 2005 | 2005 at B485 |
|---|---|---|---|---|
| Method | Barbed Wire | Velcro | Pinned Knaplock | Pinned Knaplock / Perimeter |
| Snags Set | 104 | 264 | 303 | 6 / 1 |
| Trapping Session (days) | 98 | 102 | 124 | 49 |
| Snag Effort (trap·days)* | 1,551 | 1,860 | 8,327 | 59 |
| Locations Snagged | 68 | 109 | 102 | 1 |

* Snag effort is measured in trap·days (1 trap set for 24 hours)

Table 3.5. Samples collected between 2003 and 2005 from shed and snagged hair and from badger tissue (mortalities) for DNA fingerprinting.

| Sample Type | 2003 | 2004 | 2005 | 2005 at B485 | Total |
|---|---|---|---|---|---|
| Shed | 54 | 98 | 37 | 0 | 189 |
| Snagged | 50 | 69 | 91 | 44 | 254 |
| Tissue | 2 | 1 | 2 | 0 | 5 |
| Total Samples | 106 | 168 | 130 | 44 | 448 |
| Locations Sampled | 66 | 103 | 71 | 1 | 188 |

### 3.3.2 Hair Sample Viability and Error Checking

In 2003, five of 106 (5%) hair samples were of poor quality and eliminated during pre-screening. Sixty-two (58%) samples were of marginal quality (tested ≤ 3 markers) and were excluded from further analysis. In the end, 39 samples (37%) yielded viable data and were

successfully assigned to 14 individual badgers using five markers (4 badger, 1 marten) of the 12 markers initially tested (Table 3.7).

In 2004, ten samples (6%) lacked suitable material for extraction and were eliminated during pre-screening, and additional 122 samples (73%) were also eliminated due to insufficient data to establish individual identity. Thirty-six (22%) samples produced sufficient multilocus data and were successfully assigned to 18 badgers (Table 3.7).

In 2005, no samples were eliminated during pre-screening, and 33 of 130 (2%) samples produced insufficient data to establish individual identity. Ninety-four (54%) samples were successfully assigned to 18 badgers (Table 3.7). In addition, of the 44 samples collected at B485, three samples (8%) were eliminated during pre-screening and three samples lacked sufficient data to assign an individual identity. Thirty-eight samples (86%) collected at B485 were assigned to five individuals.

Inconsistent genotyping of different samples from the same individual is expected to create pairs of genotypes that are highly similar and may indicate the recognition of more individuals than were actually sampled (Paetkau, pers. comm. 2006). The 207 samples from all 3 projects were error-checked using a computerized comparison of all pairs of unique genotypes to detect those that were highly similar and may have been indicative of genotyping error. Four pairs of genotypes that matched at 4 of 5 markers were identified and re-analyzed. The re-analysis demonstrated that 3 pairs had been caused by failure to amplify 1 of 2 alleles in a heterozygous genotype during the first pass ('allelic dropout'), and 1 pair was caused by a scoring error. The conclusion was made that it was very unlikely that the number of individuals identified had been overestimated through inconsistent genotyping of different samples from the same individual.

The probability that the true number of individuals in the collection was underestimated may be determined by assessing marker power (Paetkau, pers. comm. 2006). Previous research has shown that if one or more pairs of individuals sampled had identical multilocus

genotypes (0MM-pair), such errors are expected to be outnumbered 10 to 1 by 1MM-pair and 100 to 1 by 2MM-pairs (Paetkau 2003). In total, there were 1MM-pair and 10 2MM-pairs, in accordance with the expected ratio. Based on this, there is about a 10% chance of having underestimated the true number of individuals by one.

Table 3.6. Number of hair and tissue samples assigned to individual badgers and viability (% of total collected).

| Sample Type | 2003 | 2004 | 2005 | 2005 at B485 | Total |
|---|---|---|---|---|---|
| Shed | 11 (20%) | 19 (19%) | 25 (68%) | – | 55 (29%) |
| Snagged | 26 (52%) | 16 (23%) | 67 (74%) | 38 (86%) | 147 (58%) |
| Tissue | 2 (100%) | 1 (100%) | 2 (100%) | – | 5 (100%) |
| Total | 39 (37%) | 36 (21%) | 94 (72%) | 38 (86%) | 207 (46%) |

### 3.3.3 Badgers Identified using DNA Fingerprinting

In total, 37 individual badgers were identified in the Cariboo region a total of 207 times using DNA fingerprinting (Table 3.8; Appendix E). Twenty-one badgers are males (57%), 14 are females (38%), and two (5%) are of undetermined sex. Fourteen badgers (10 males, 4 females) were identified in the first year of data collection. In 2004, 18 badgers were identified and eight of these (1 male, 6 females, 1 undetermined) were previously undetected in the region. In 2005, 18 badgers were identified, and 15 (10 male, 4 females, 1 undetermined) of these were previously undetected in the region. Five individuals were identified at B485: one female (F179) was previously detected in 2004 and the others (2 males, 2 females) are suspected to be her kits and were not detected at any other location.

At least two badgers (M004, M009) crossed Highway 97 during 2003. Multiple badgers were detected at four burrows ranging from 2 to 26 days apart. In one case, at least three badgers (M008, M031, M036) used the same burrow. A male (M097) and a female (F104) were also detected at two burrows less than 50 m apart but it is uncertain if both were in the area at the same time.

There were at least 14 reports of multiple badgers observed since 1996 and at two of these occurred in 2004. Since badgers are solitary, observations of multiple badgers likely are family groups. In the spring of 2004, two badgers were observed in a yard off of Meadow Lake Road. In July, we also observed two badgers at a burrow near McKinley Lakes (WHA No. 8). DNA fingerprinting identified the male badger M008 at that location later in July.

Table 3.7. Summary of badgers identified in the Cariboo region between 2003 and 2005.

| | | # Times Detected with DNA fingerprinting | | | |
|---|---|---|---|---|---|
| Sex | Individual | ≤2003 | 2004 | 2005 | Total |
| M | 002 | 1 (*mortality*) | | | 1 |
| M | 004 | 2 | 3 | 3 | 8 |
| M | 005 | 2 | 1 | 9 | 12 |
| M | 008 | 7 | 3 | – | 10 |
| M | 009 | 2 | 1 | 8 | 11 |
| M | 031 | 2 | 8 | 12 | 22 |
| M | 035 | 2 | – | 2 | 4 |
| M | 036 | 6 | 2 | – | 8 |
| F | 042 | 1 | – | 1 | 2 |
| M | 049 | 3 | 5 | 11 | 19 |
| F | 065 | 3 | 1 (*mortality*) | | 4 |
| M | 097 | 6 | – | 2 | 8 |
| F | 104 | 1 | 1 | – | 2 |
| F | 259 | 1 (*mortality*) | | | 1 |
| F | 126 | | 4 | 1 | 5 |
| F | 127 | | 1 | – | 1 |
| F | 135 | | 1 | – | 1 |
| F | 161 | | 1 | 1 | 2 |
| M | 164 | | 1 | – | 1 |
| F | 179 (*B485*) | | 2 | 13 | 15 |
| F | 249 | | 1 | – | 1 |
| U | 271 | | 1 | – | 1 |
| M | 278 | | | 5 | 5 |
| M | 279 | | | 8 | 8 |
| F | 280 | | | 7 (*mortality*) | 7 |
| M | 286 | | | 7 (*mortality*) | 7 |
| U | 312 | | | 2 | 2 |
| F | 316 (*B485*) | | | 10 | 10 |
| M | 326 (*B485*) | | | 8 | 8 |
| F | 328 (*B485*) | | | 9 | 9 |
| M | 355 (*B485*) | | | 1 | 1 |
| F | 366 | | | 2 | 2 |
| M | 367 | | | 1 | 1 |
| M | 383 | | | 1 | 1 |
| M | 394 | | | 1 | 1 |
| M | 409 | | | 5 | 5 |
| M | 442 | | | 1 | 1 |
| | Total | 39 | 37 | 131 | 207 |

### 3.3.4 Badger Mortalities

Five of the badgers identified are known to have died before or during the project (Table 3.8). A female badger (F259) was recovered in the winter of 2001 that was reportedly killed on Meadow Lake Road approximately 5 km from Highway 97. Badger M002 was mistakenly caught in a coyote trap by a registered trapper near Green Lake (MU3:30) in December, 2002. He weighed 8 kg (17.5 lbs). A female (F065) was killed on Highway 24 near Fawn Lake in a collision with a vehicle in November, 2004. She also weighed 8 kg. These three badgers underwent necropsy by a Dr. Helen Schwantje, a veterinarian with MoE, and tissues have been collected and archived at MoE in Victoria for future reference. All three were considered to be in excellent condition with substantial body fat. Finally, two badgers were killed on Highway 97 in 2005 that have not yet been submitted for necropsy. Male badger M286 was hit by a vehicle near 144 Mile on June 14, 2005, and female badger F280 was hit at 101 Mile on the hill adjacent to Marmot Ridge Golf Course on December 13, 2005. Locations of mortalities are illustrated in Appendix C.

## 3.4 HOME RANGES AND MOVEMENTS

Home range areas (100% MCP) were estimated for sixteen badgers with at least three locations identified with DNA fingerprinting from 2003 and 2005. These areas are described in Table 3.9 and illustrated in Appendix F. Home range areas varied from 0.9 to 1280 $km^2$. The smallest home ranges (M097, F126, F179) were calculated from few locations that formed a very narrow triangle. Longest distances calculated between two points were for M008 who used two burrows 64.6 km apart, and M031 who used two burrows 61.5 km apart. The longest distance between two burrows used by a female was 37.8 km by F065.

The highest density of badgers consistently occurred in the Alberta and River Lakes area, with at least 14 badgers detected in 11 ha (1.3 badgers per ha). Six WHAs (Nos. 4, 6, 7, 8, 9, and 11) are proposed in this area. A male badger (M049) was identified using a burrow in WHA No. 3 at a sharp-tailed grouse lek site in July, 2004. Both M049 and a female badger (F127) were detected at a suspected maternal burrow in WHA No. 10 in May, 2004 and July, 2003 respectively.

Table 3.8. Summary of cumulative home range areas (100% MCP) and longest distances between DNA sampling locations collected between 2003 and 2005.

| Sex | Individual | # Locations | 100% MCP ($km^2$) | Longest Distance (km) |
|---|---|---|---|---|
| M | 004 | 6 | 80.4 | 24.0 |
| M | 005 | 10 | 190.0 | 45.4 |
| M | 008 | 10 | 1280.0 | 64.6 |
| M | 009 | 8 | 69.3 | 22.6 |
| M | 031 | 14 | 53 | 61.5 |
| M | 035 | 4 | 20.3 | 15.7 |
| M | 036 | 7 | 20.6 | 9.3 |
| M | 049 | 12 | 141.5 | 31.0 |
| F | 065 | 4 | 98.6 | 37.8 |
| M | 097 | 3 | 1.7 | 30.0 |
| F | 104 | 2 | – | 21.0 |
| F | 126 | 3 | 2.2 | 13.6 |
| F | 161 | 2 | – | 3.3 |
| F | 179 | 4 | 0.9 | 18.7 |
| M | 278 | 2 | – | 0.1 |
| M | 279 | 5 | 146.7 | 35.6 |
| F | 280 | 6 | 37.4 | 20.4 |
| M | 286 | 4 | 27.2 | 43.1 |
| F | 366 | 2 | – | 0.9 |
| M | 409 | 4 | 17.1 | 8.0 |
| Average (SD) | | 5.6 (3.5) | 136.7 (310.3) | 25.3 (18.5) |

# 4.0 DISCUSSION

## 4.1 LOCAL AWARENESS OF BADGERS

The public reporting of badger sightings has greatly increased our knowledge of badger distribution in the Cariboo region by leading us to "new" areas where badgers were previously undetected. Also, the general appreciation for the ecological role of badgers is improving. Examples of this can be seen at the Marmot Ridge Golf Course where badgers are used to keep the local marmot population under control to minimize their damage to the golf greens. The family group in 2005 occupied burrows in a hay field on private property where the haying activities were altered to accommodate the badgers. Finally, the Canoe

Creek Indian Band has incorporated badger habitat into grassland management strategies that they will be implementing through their range and forest programs.

### 4.2 BURROWS AND HABITAT IN THE CARIBOO REGION

Low level aerial surveys to locate badger burrows proved to be a viable option to determine badger distribution in the Cariboo. We identified 30 burrowing sites during these flights, and we concluded that there are very few badgers currently west of the Fraser River. We identified badger activity as far north as Soda Creek. One, possibly two, burrowing locations were found as far west as Bald Mountain but these were not recently occupied. Numerous badger burrows were located in the Gang Ranch area; however, it is possible that these burrows are from badgers that reside mostly in the Alkali Lake area but cross the Fraser River occasionally to forage.

### 4.3 WILDLIFE HABITAT AREAS

WHAs in the Cariboo region should be established around maternal and natal burrows, sites of historic badger activity, and other burrows that may be adversely affected by forest or range practices. WHAs also should encompass aeolian or lacustrine soil deposits and protect the structure of the soil and existing burrow. Other limiting habitat features, such as concentrations of prey activity or open habitat within a forested matrix, should also be considered for protection within a WHA. According to the Identified Wildlife Management Strategy, management recommendations within WHAs should include controlling forest encroachment and in-growth, managing livestock and minimizing disturbance to badgers especially during the breeding season (Adams and Kinley 2004).

### 4.4 EFFICACY OF HAIR COLLECTION TECHNIQUES

Results from our study suggest that a systematic hair snagging regime with DNA fingerprinting was an effective way to monitor the population. Snags tended to collect multiple hairs with follicles so there was a high potential for extracting viable genetic material. We found that barbed wire snags were not as effective as other methods used to collect badger hair. On one occasion, a badger was observed sitting under a barbed wire snag for at least one hour and left no hair. Velcro snags were effective at collecting hair and

simple to install into burrows, but the viability of DNA was lowest of all methods. Pinned knaplock snags were the most effective method of consistently collecting hair with follicles, and produced the highest DNA viability.

The perimeter snag was effective at identifying multiple badgers at one location. The structure increased the potential for collecting hair. There also was some assurance that a snagged hair sample was collected from a single animal during a given time period, since this set was checked more regularly than regular hair snags.

### 4.5 DNA VIABILITY

We found that snagged hair consistently provided DNA with higher viability (i.e. greater chance of providing an identity) than shed hair. This was attributed to degradation of shed samples due to extended periods of time in the field or moist climatic conditions (David Paetkau, pers. comm. 2006). Setting snags further into the burrows, collecting samples promptly after they have been snagged from the animals and before moisture degrades the DNA would increase the quality. Frantz et al. (2004) had extremely high (93%) viability from the hair samples they snagged from European badgers (*Meles meles*). They suggested extracting DNA from samples immediately after collection using a 5% Chelex-100 protocol that can be used in the field, and this may increase the proportion of viable hair samples.

Viability of hair collected with Velcro snags was the lowest of all snagging methods. The lack of viable DNA and low success rate of assignment was likely not due to lack of genetic material, since an average of four hair roots were used when the lab is generally successful with three hair roots (D. Paetkau, pers. comm. 2005). It was probably the quality rather than quantity of samples that contributed to the high percentage of hair samples that did not provide genetic information. We believe these snags collected hair already shed but that was still attached to the badger; therefore, hair follicles may have been exposed to weather or other factors that would have reduced the quality of DNA. We collected more samples in the early spring when badgers are losing their thick winter coats; this was particularly true for 2004.