ECOLOGY OF GRIZZLY BEARS IN THE CHEVIOT, LUSCAR AND GREGG RIVER MINE AREAS (1999-2004)

Submitted to Elk Valley Coal Corporation, Cardinal River Operations and Foothills Model Forest Grizzly Bear Research Project

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1.0 INTRODUCTION

Elk Valley Coal Corporation, Cardinal River Operations (CRO) initiated this project as part of its commitment to address grizzly bear issues within the context of the Cheviot Mine development.

Since 1999, the Foothills Model Forest Grizzly Bear Research Project (FMFGBRP) has studied grizzly bears in a 10,000 km^2 area that includes the Cardinal River Operations and has made significant advances in improving our understanding of grizzly bear use of this landscape. This research program has also developed tools and models to assist industry sectors to make informed decisions towards grizzly bear conservation and management.

CRO requested that the FMFGBRP conduct a detailed analysis, using data from the 6 years of integrated grizzly bear research, which would summarize current knowledge and understanding of grizzly bear use of the Cheviot, Luscar and Gregg River Mines. This analysis will establish pre-development baseline grizzly bear use in the Cheviot Mine area, and provide insight into grizzly bear use in and adjacent to active/reclaimed open pit coal mines. Based on these assessments, this project will provide important grizzly bear information that can be incorporated into the planning and the operational development of the Cheviot Mine. Data from the FMFGBRP was the best available data on grizzly bears within the Mine study areas, however we emphasize that the data was not collected to address specific grizzly bear/mining responses and consequently limited our ability to conduct rigorous analysis and address some questions.

This report is presented in 3 chapters. Each chapter analyses grizzly bear and mining activity data to achieve the following 3 goals:

1. Provide a summary of current knowledge and understanding of grizzly bear use of the landscape within and around the Cheviot Mine (pre-development).
2. Provide a summary of current knowledge and understanding of grizzly bear use of the landscape within and around the Cardinal River Operations (CRO) Luscar and Gregg River Mines (during active mining and reclamation activities).
3. Design a long-term grizzly bear monitoring program for the Cheviot Mine.

We emphasize that the intent of this report is *not* to compare/contrast bear use of mines versus non-mines. It is a summary of knowledge of what bears did in the respective areas based on activities that were occurring at the time.

Section 1 and 2 of this report includes a summary of geographical ranges of radio-marked bears occurring in each area, physiological characteristics from the capture data, a summary of den site parameters and a diet analysis. Across each study area we also extracted habitat quality, probability of mortality risk and movement corridors based on pre-established, peer reviewed GIS-based models. Section 3 outlines a DNA monitoring program designed to detect bear abundance, distribution and demography coinciding with future mining sites in the Cheviot area.

1.1 Study area

The study area is located in the front ranges of the Rocky Mountains in west-central Alberta. At its broadest scale, the project area is defined within the boundaries of an identified grizzly bear population unit (BPU) (Figure 1-1). Highway 16 borders the BPU

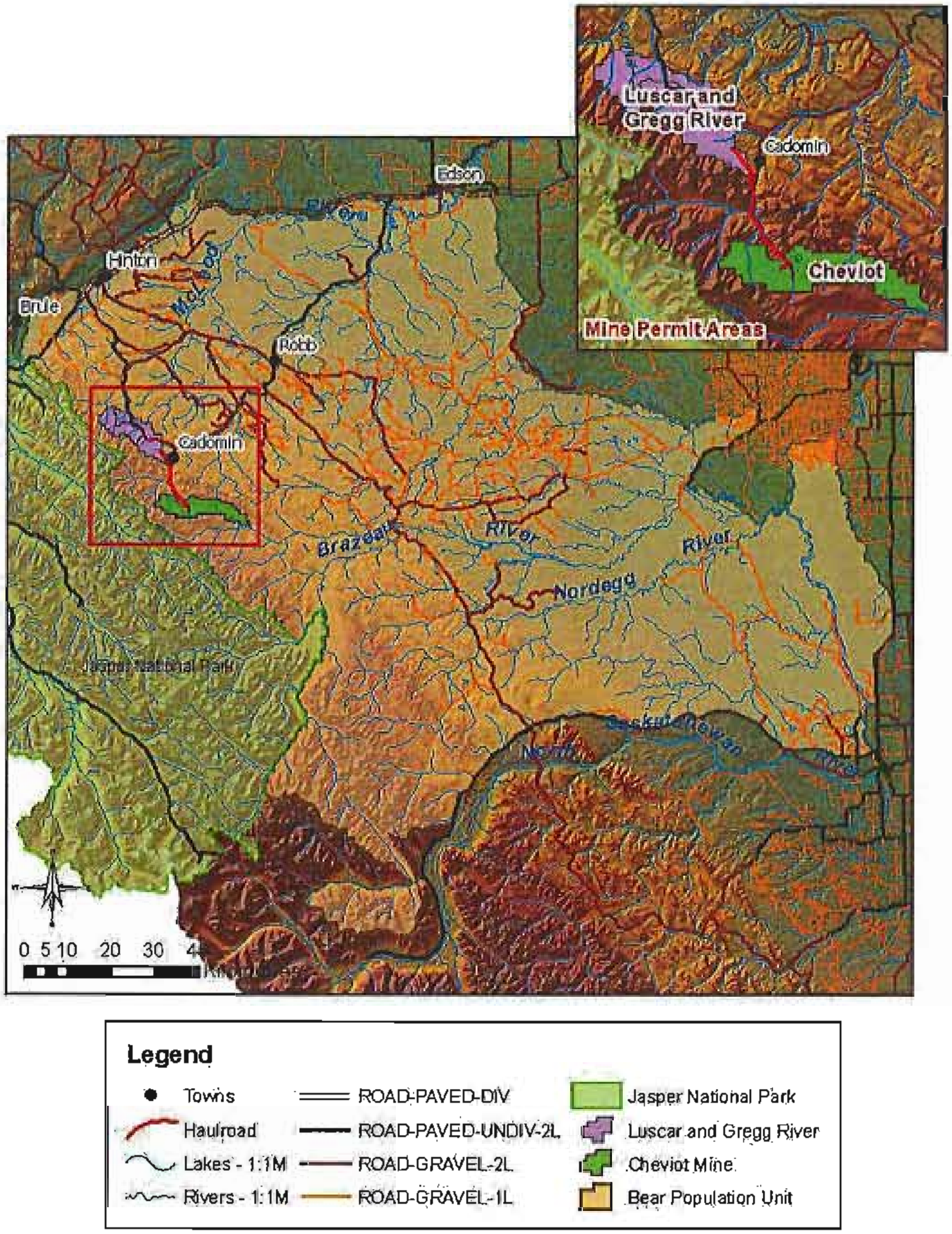


Figure 1-1. Study area boundaries including Bear Population Unit (BPU) and mine lease areas.

to the north and Highway 11 borders the south. The east slope BPU boundary is defined by the same boundary established by Alberta Environmental Protection for grizzly bear management. The western boundary of the BPU is the Jasper National Park boundary. It is an area of 16,786km^2 and the topography varies from gently rolling forested foothills in the east to mountainous areas in the west. Elevations across the BPU range between 771m and 3365m. Land cover in the mountains consists of montane, conifer, sub-alpine forests, alpine meadows and rock outcrop (Achuff 1994). In contrast, the eastern foothills contain conifer, mixed and deciduous forests, wetlands, herbaceous meadows and regenerating forests from clearcut harvesting (Achuff, 1994).

A number of resource extraction activities occur in this foothills region, including forestry, oil and gas, and open pit coal mining. Many roads and seismic lines cross this landscape creating a network of access points for human recreation. Parks and public lands with restrictive zoning also occur within the BPU, these include Whitehorse Wildland Park and Forest Land Use Zones. There is no agriculture across most of the BPU with the exception of the eastern boundary near Edson. Also, cattle grazing does not occur in the northern Foothills as it does in southern Alberta.

Within the BPU we narrowed our analysis to the landscape use of individual grizzly bears occurring within and around two smaller study areas, the Cheviot and Luscar/Gregg River Mine permit areas (Figure 1-1). All three areas are open pit metallurgical coal mines (MacCallum 2005).

The Cheviot Mine permit area is approximately 7,150 hectares (72km^2) with topographic elevations ranging from 1,640m to 2,500m. It is bounded to the north and east by Cadomin Mountain and RedCap Mountain range. To the south and west are Cheviot Mountain, Cardinal Divide, Tripoli Mountain and Prospect Creek. The Cheviot was permitted in 1997 and again in 2000, haul road construction and pit development began in 2004 (MacCallum 2005). Historically, coal mining in the Cheviot lease began in 1911. The small town (~1000 people) of Mountain Park was then established and mining activities continued until the industry and town succumbed to the coal depression following World War II and ceased all operations by 1950 (MacCallum 2005). Sub-alpine and alpine regions characterize the Cheviot mine permit area, and vegetation varies from forests of Lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea* engelmannii) and Subalpine Fir (*Abies* lasiocarpa) to mixed willow (*Salix* spp.), grasslands, alpine vegetation and rock (MacCallum 2005).

The Gregg River and Luscar mines, referred to in this report as the Gregg River/Luscar mines are located approximately 22km to the north of Cheviot and 50km south of the town of Hinton. The two lease areas are adjacent to each other and separated by the Gregg River (Figure 1-1). The Luscar lease area is 4,818 hectares and the Gregg River 3,700 hectares. Operation of the Luscar mine was initiated in 1969 and suspended in 2004 with reclamation and possibly further mining to follow. The Gregg River mine began operations in 1981 and was closed in 2000; by 2004 95% of the earthwork associated with reclamation was complete (MacCallum 2005). Both lease areas are located in the sub-alpine with elevations ranging between 1,540m and 2,080m. Undisturbed areas within the mine lease boundaries are vegetated predominantly by coniferous forests, with small amounts of coniferous and shrub riparian habitat and sub alpine grasslands (MacCallum 2005). The Cheviot and Luscar mines are owned by Elk Valley Coal Corporation and operated by Cardinal River Operations. At the time the Gregg River mine was closed and reclaimed, it was owned by Luscar Ltd.

1.2 Grizzly bear capture methods and data collection

We obtained grizzly bear location data from the Foothills Model Forest Grizzly Bear Research Program (FMFGBRP). Between 1999 and 2004 within the 10,000 km^2 FMF study area (Figure 1-2), FMF personnel captured 78 bears and radio-collared and monitored 64 individuals (Stenhouse et al. 2004). Bears were captured using aerial darting or leg hold snares during the spring capture periods (Stenhouse and Munro, 2000). GPS (global positioning system) radio collars were fitted on both male and female bears that were suitably large enough to carry the collar. Some small sub-adult bears were instead fitted with a VHF ear tag transmitter. While immobilized, bears were processed to obtain information including a premolar tooth for aging, hair and blood samples for DNA/blood chemistry analysis, weight and standard morphological measurements (Stenhouse and Munro, 2000).

The deployment of GPS radio collars allowed researchers to collect detailed movement data at maximum every 4 hours on a 24-hour basis over a 9-10 month period (Stenhouse and Munro, 2000). Some limitations to GPS collars were encountered, which affected the overall sample of grizzly bear locations. These included bears slipping collars off because of poor fit, or simply removing their collars, mechanical failure of the collar and poor quality GPS signal depending on vegetation cover and landscape topography (Stenhouse and Munro, 2000). An average of 4 locations per day were acquired from deployed GPS collars. When opportunity allowed, by re-capturing individuals and replacing their battery-expired GPS collars with new collars, multi-annual location data was collected.

Location data was stored in the GPS collar and retrieved by different methods. Researchers would either upload data every month from a helicopter circling in the vicinity of the bear or the data would be stored within the memory of the collar until the researcher recovered the collar to download the data. To facilitate collar recovery, some collars had a remote drop off system allowing the researcher to remotely trigger the collar to release from the animal, or the animal was re-captured to have the collar removed. All collars had a canvass "rot-off" to ensure the collar dropped off the animal at some point in time (Stenhouse and Munro, 2000).

2.0 GRIZZLY BEAR USE OF THE CHEVIOT MINE AREA

2.1 Geographical range and physiological characteristics of Grizzly bears

2.11 Home ranges

We identified radio-collared grizzly bears occurring annually within the Cheviot Mine lease area. For each bear we calculated annual home ranges by means of the 95% fixed kernel technique with an adhoc smoothing parameter, using the Animal Movement Extension (Hooge and Eichenlaub, 1997) for ARCVIEW GIS (ESRI Inc.). Between 1999 and 2004, 30 annual home ranges overlapped or bordered the Cheviot Mine lease area (Table 2-1). Bears from each cohort were identified, including 17 adult female, 8 adult male, 1 sub-adult female and 4 sub-adult males. These were all represented by 7 individual female bears and 8 individual male bears. Adult bears were defined as 5 years old or older while radio tracking, while sub-adult bears were defined as those being 2-4 years old.

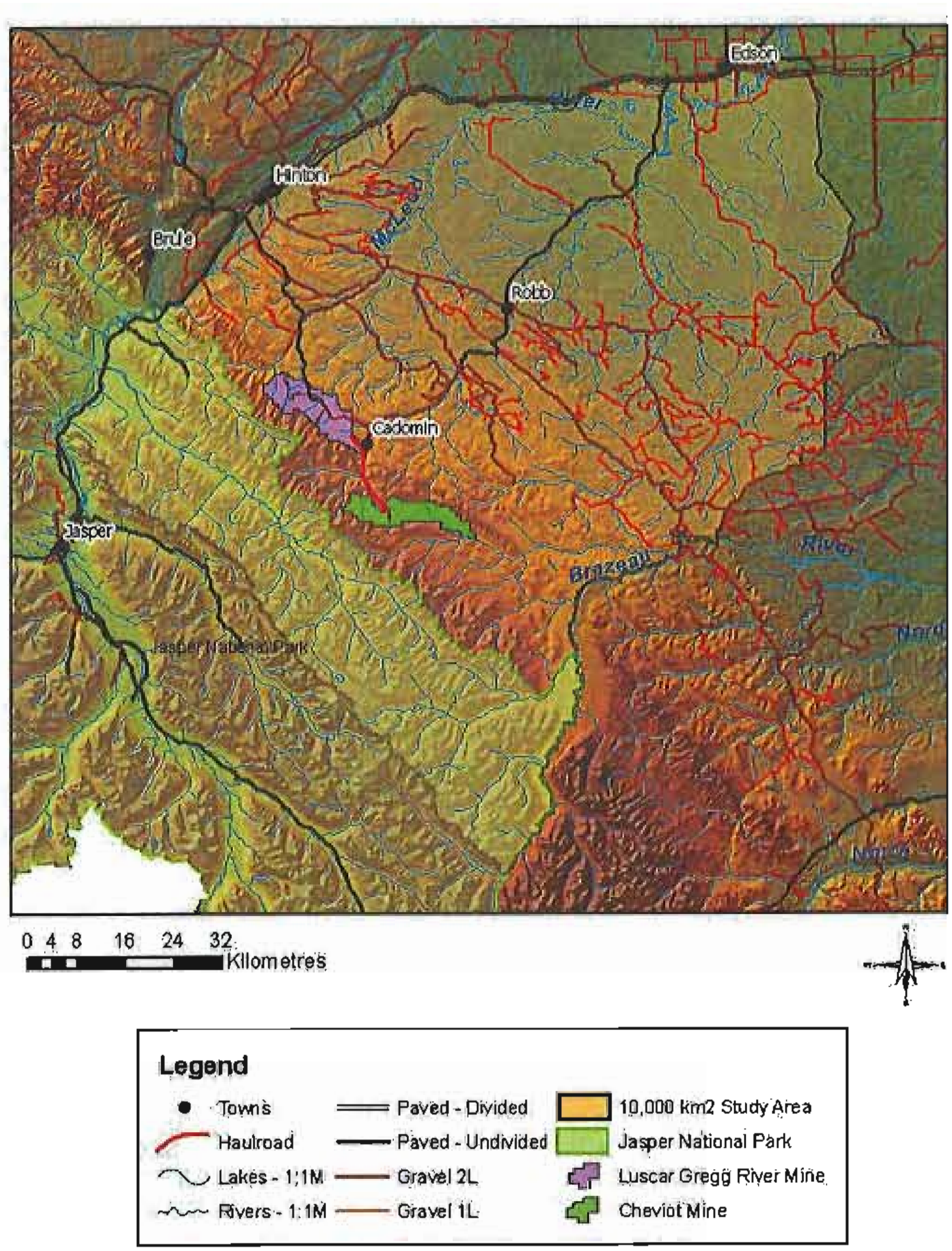


Figure 1-2. Foothills Model Forest Grizzly Bear Research Project study area (1999-2002).

Table 2-1. Demographics and annual home range size of 15 bears using the Cheviot lease area between 1999 and 2004.

Year	Sex/Age class	Bear ID	Home Range Area (km^2)	Reproductive Status
1999				
	Adult Female	003	234	0
		004	155	0
		016	81	0
	Adult Male	029	295	n/a
		006	644	n/a
		008	1018	n/a
2000				
	Adult Female	004	185	0
		016	43	2 coy
		027	1835	2 yrly
		028	219	0
	Adult Male	006	579	n/a
		029	1684	n/a
2001				
	Adult Female	003	263	0
		004	49	1 coy
		016	118	2 yrlg
		028	394	0
	Adult Male			
		029	1598	n/a
2002				
	Adult Female	003	312	1 coy
		027	487	0
	Subadult Female	035	71	n/a
	Adult Male	008	467	n/a
2003				
	Adult Female	003	331	1 yrlg
		023	124	1 coy
		028	132	3 yrlg
	Subadult Male	043	233	n/a
		044	304	n/a
		055	274	n/a
		058	957	n/a
	Adult Male			
		033	1526	n/a
2004				
	Adult Female	004	86	1 coy

Adult female bears displayed the smallest average home range size ($\bar{x}$ = 297km^2, SD=415, *n*=17) while adult males had the largest average home range ($\bar{x}$=976 km^2, SD=558, *n*=8), sub-adult male home ranges ranged between adult females and males ($\bar{x}$ =442 km^2, SD=344, *n*=4). The largest home range (1835 km^2) was an individual female (G027) with 2 yearlings in 2000, while the smallest home range (43 km^2) was adult female G016 with 2 cubs of the year (coy) in 2000. Bear G027's home range size was exceptionally large for a female with cubs, apart from all other bears of her cohort in the FMF study, thus we subsequently excluded her from further comparative analysis of home range size between cohorts. However, her data was included in the habitat, diet, and demographic/genetic analysis. Lone adult female grizzlies displayed the largest home range size ($\bar{x}$=252 km^2, SD=130, *n*=8) compared to females with yearlings ($\bar{x}$=194 km^2, SD=119, *n*=3) or females with coy ($\bar{x}$=123 km^2, SD=110, *n*=5).

2.12 Body condition

Body condition is often assessed as a reflection of nutrition and habitat/landscape condition. In biological studies of animal populations, it is important for monitoring long-term trends in the fluctuation of food availability, for addressing ecological issues and for assessing the health of individual animals (Cattet et al. 2002). A body condition index (BCI) is defined as a measure of the combined mass of fat and skeletal muscle in an animal relative to its body size (Cattet et al. 2001). During the handling of grizzly bears, measurements of straight-line body length and total body weight were obtained. The BCI is the standardized residual determined from the regression of total body mass and body length and its values range between –3.0 to +3.0 (Cattet et al. 2001).

Between 1999 and 2004 there were 16 capture episodes of female bears that used the Cheviot lease area and we obtained BCI data from 13 of those captures. The BCI for female bears ranged between –0.88 and +1.16 (Table 2-2). Adult females without cubs had a lower average BCI value (BCI= -0.3732, N=6) compared to females with cubs of the year (BCI= -0.1172, N=5). We speculate that in late summer/fall, pregnant females (or females with cubs) experience a physiological response which drives them to feed more, knowing their bodies will demand higher energetic output through the winter and following spring than infertile females, they therefore achieve higher body condition upon entering the den. In fact, biologists did find in previous analysis (using a small sample size across the FMF female grizzly population) that pregnant females in the fall had higher body weights and BCI than non-pregnant females (Stenhouse, pers comm.). Recognizing that the majority of captures were in the spring, it is reasonable to accept that females with cubs will exit the den in better body condition, if they in fact entered dens in better condition than non pregnant females. Greater reserves of stored energy upon den emergence is critical for females with cubs and it is well documented in other areas of Alberta and British Columbia, that these bears spend much of the spring and early summer, in marginally poor habitat more secure from conflict with other bears (Herrero 1985, McLellan and Shackleton 1988, McLellan and Hovey 2001). Thus, the spring BCI of bears not only reflects the food availability the previous fall, but also the energetic demands of rearing cubs until energy-rich foods are most abundant in mid-summer.

The average BCI for female bears captured in the spring was –0.5088 (N=9) compared to bears captured in the summer (BCI= +0.5238, N=3). This difference is reasonably

Table 2-2. Capture information and body condition indices for grizzly bears using the Cheviot Mine lease area between 1999 and 2004.

Sex	Bear ID	Capture Date	Age	BCI	Reproductive Status
Females	G003	5/09/99	5	-0.5064	0
		5/10/01	7	no data	0
		7/24/02	8	0.4046	1coy
	G004	5/10/99	5	-0.7149	0
		4/26/00	6	-1.0825	0
		5/26/01	7	-0.7859	1 coy
		7/05/04	10	0.0028	1 coy
	G016	5/28/99	5	-0.8801	0
		6/17/00	6	-0.8180	2 coy
		6/01/01	7	no data	2 yrlg
	G023	5/22/02	13	0.6518	2 yrlg
	G027	5/17/00	11	-0.1828	2 yrly
	G028	5/08/00	6	-0.2194	0
		7/20/01	7	1.1640	0
		5/11/02	8	0.6104	3coy
	G035	5/18/02	4	no data	n/a
Males	G006	5/11/99	16	no data	n/a
		5/11/00	17	2.1082	n/a
	G008	5/14/99	14	no data	n/a
		5/09/02	17	2.5686	n/a
	G029	5/11/99	11	-1.0423	n/a
		5/18/00	12	1.2968	n/a
		4/27/01	13	0.4267	n/a
	G033	5/24/03	6	0.1120	n/a
	G043	5/25/03	3	0.0113	n/a
	G044	4/30/03	3	-0.7267	n/a
	G055	5/19/03	4	0.4620	n/a
	G058	5/31/03	3	0.1734	n/a

expected, as body condition is poorest near the time of den emergence. We obtained BCI data for 10 out of 12 springtime captures of male bears using the Cheviot lease area; values ranged between –1.0423 and +2.5686 (Table 2-2). Adult males show a higher average BCI (+0.9117, N=6) compared to sub-adult males (BCI= -0.029, N=4).

Comparative studies of body condition across different grizzly bear populations during spring have shown that BCI indices vary between populations, which may relate to habitat (Cattet et al. 2002). The Eastern Slopes Grizzly Bear Project (ESGBP) was a 10-year study (1994-2003) within a 20,000-km2 area centered on the Bow River Watershed of Banff National Park and including surrounding jurisdictions. A comparison of spring BCI values between the Eastern Slopes and Foothills Model Forest Grizzly Bear Projects showed that Eastern Slopes bears tended to be in poorer body condition than FMF bears, most notably among adult males (Stenhouse et al. 2003). At a population level, East slope adult males had a mean BCI of +0.05 (N=12, SE□0.31) compared to FMF adult males whose mean BCI was +1.41 (N=13, SE□0.29) (Stenhouse et al. 2003). Diet has a significant influence on BCI and the two study areas differ in the availability of high quality habitats for grizzlies. The Eastern Slopes study area has been identified as one of the most intensively developed landscapes in the world where a grizzly bear population still survives (Gibeau 2000). Grizzly bear habitats not compromised by development have been identified as only moderately productive habitat, due to the high percentage of rock, ice and high elevation tundra in the study area (Gibeau 1996). The FMF study area by comparison includes significant areas of good quality habitats for bears in the foothills region, which although is still affected by human activities, it is less fragmented by rock and ice. Mattson (2000) determined that ungulate density also has a large bearing on BCI of grizzlies in Yellowstone National Park. Further investigation of the availability of ungulate biomass between the ESGBP and FMFGBRP study areas may explain the differences in BCI of bears in the two studies.

2.13 Blood chemistry

Blood was routinely collected from all bears captured during the FMF grizzly bear research program as part of grizzly bear health assessment and as a source of DNA. For this project we extracted DNA information from FMFs blood chemistry database, the blood DNA analysis helps to determine the genotype of individual bears (Cattet et al. 2001). The DNA data from blood samples supplemented hair and tissue DNA information and allowed us to examine genotypes (identify individuals) and assess the degree of relatedness between bears. In a laboratory, DNA is isolated from a sample of hair, tissue or blood (Paetkau 1998). Each DNA sample (2000-2003) was genotyped to 15 microsatellite loci. This allowed for identifying individuals and parent/offspring or sibling relationships.

Figure 2-1 illustrates a family schematic diagram showing the known genetic relationships of bears in the two study areas (Cheviot and Gregg/Luscar). The left hand column describes the birth year of the individual. The diagram also shows the number of loci that match parent, offspring or siblings, birth date of unmarked cubs of the year (coy) and known deaths. For some bears that were identified using the mine lease areas, their genotyping was not successful in identifying a relationship to any other known bear and therefore they do not appear in Figure 2-1.

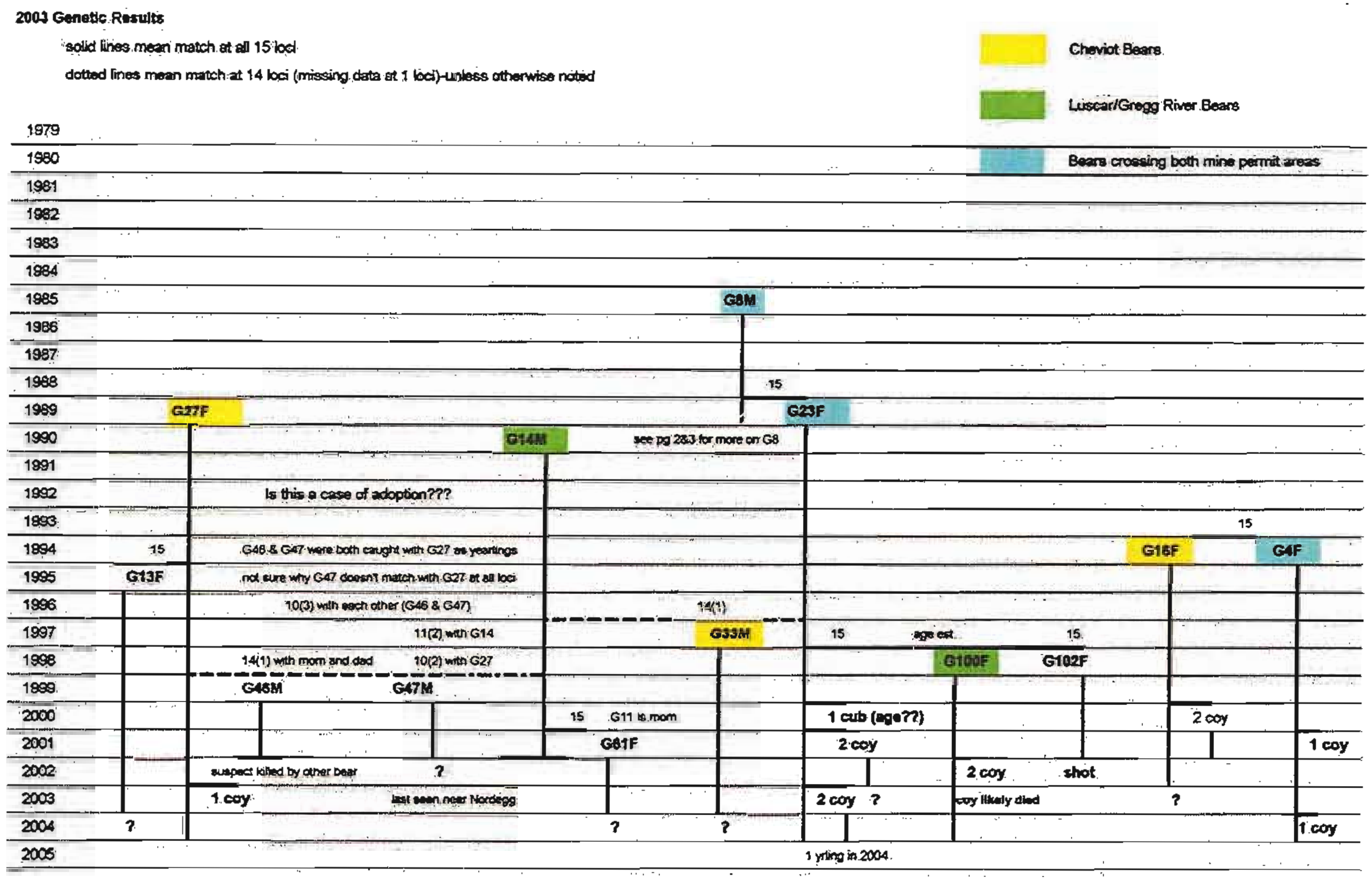


Figure 2-1. Family schematic diagram illustrating genetic relatedness, birth date and known fatalities of bears within the study areas, between 1999-2003. Genetics obtained from microsatellite DNA analysis.

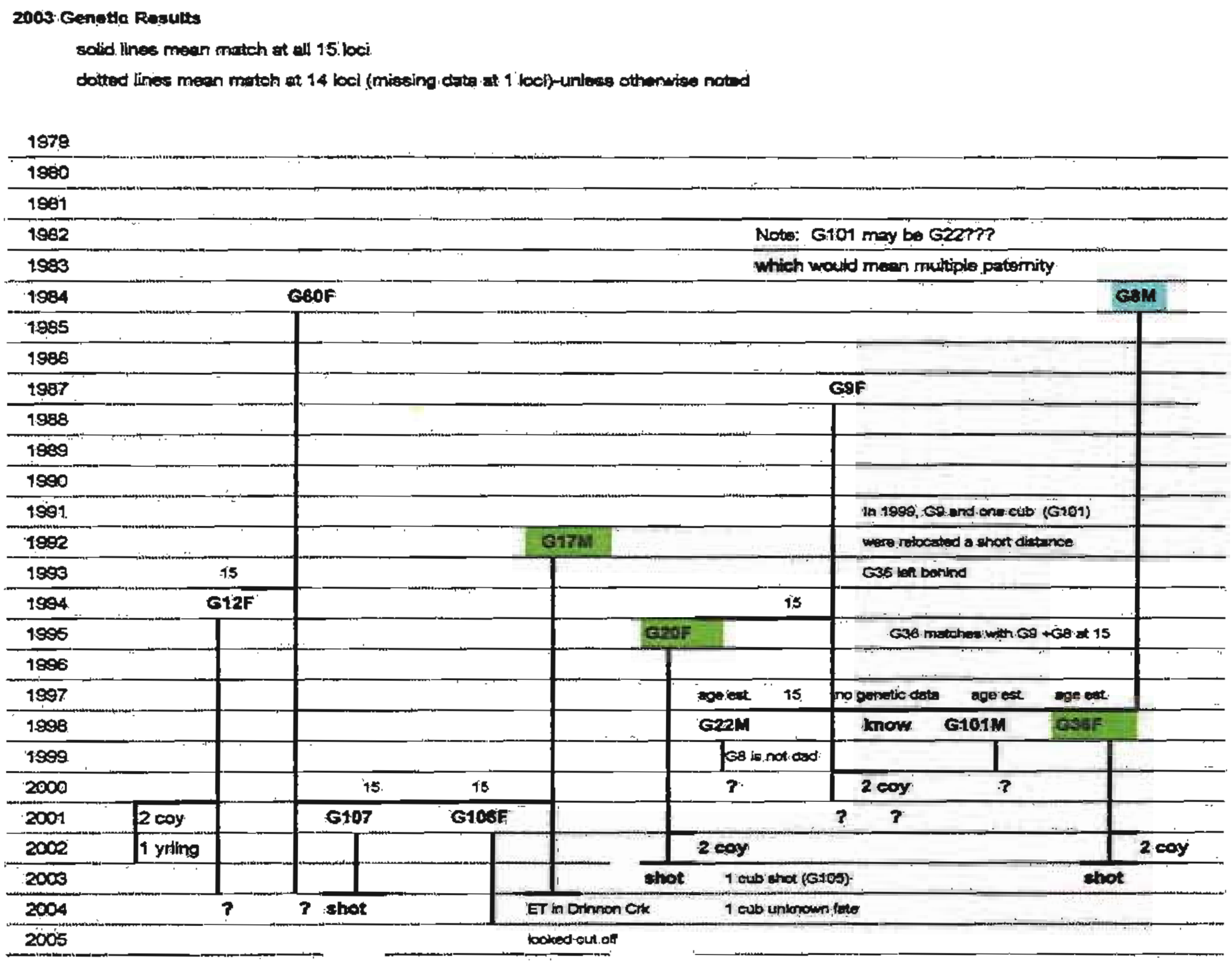


Figure 2-1. Continued.

2003 Genetic Results

solid lines mean match at all 15 loci

dotted lines mean match at 14 loci (missing data at 1 loci)-unless otherwise noted

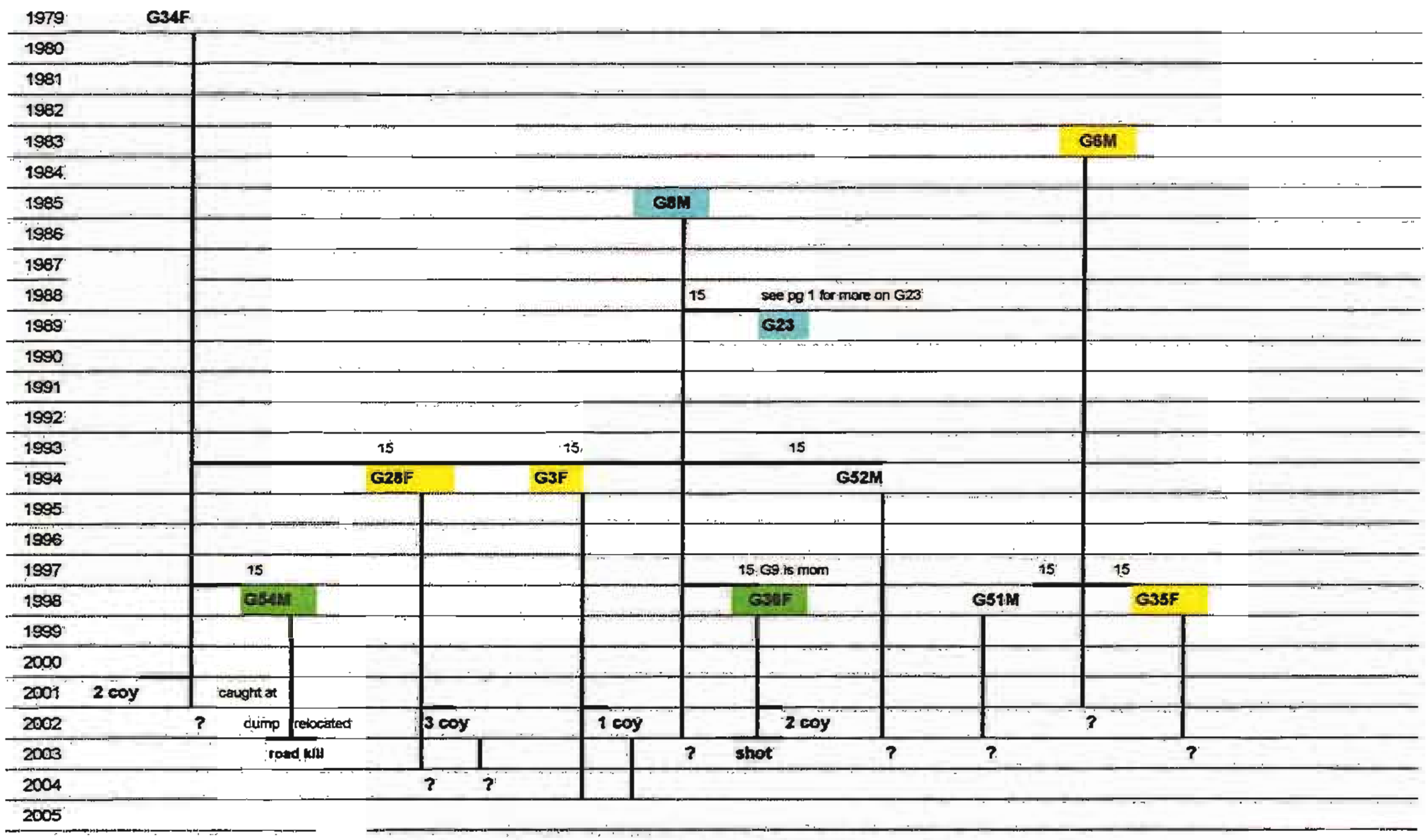


Figure 2-1. Continued.

Of the 7 females using the Cheviot area, only one adult female (G27) was not related to any other known male or female grizzly in the study area. Recollecting that she was also identified in section 2.11 as having an extremely large home range, unlike any other bear in her cohort, raises an interesting question about her history. Although, we cannot be certain, it leads one to question whether G027 has been displaced from her original territory and is exploring new habitat or dispersing into a different area with her cub. There were 4 sub-adult males (G043, G044, G055, G058) and one adult male (G029) who did not share any genetic relatedness with any other known grizzly bear in the BPU study area. Previous telemetry studies have shown that many of a grizzly bear's movements, habitat selection and foraging patterns are learned as a cub and are reinforced throughout their lives. Home range fidelity is strong as a result, especially for females (McLellan and Hovey 2001). The broader genetic diversity observed in sub-adult male grizzlies in the Cheviot area is likely related to their larger dispersal tendencies and transient strategy in response to avoidance of dominate adult males.

2.14 Mortality

Reproduction and mortality are 2 key elements in understanding grizzly bear population dynamics; a population can be threatened if bears are killed at a rate greater than their birth rate (Boyce et al. 2001). Knowing the status of the local grizzly bear population as well as how and why grizzly bears die is important in understanding the long-term health of the population. It is acknowledged that any stable wildlife population can sustain a certain level of mortality, however the threshold mortality rates where grizzly bear populations begin to decline are difficult to determine precisely without data of population estimates.

Early studies suggested that total human-caused mortality rates greater than 6.5 percent were not compatible with the long-term persistence of grizzly bears (Harris 1986). However, more recent studies suggest that reducing total annual human-caused mortality rates to 4.9 percent of the estimated population is required, otherwise declines in probability of persistence accelerate to unsatisfactory levels (McLaughlin 2003).

In addition to documenting known mortalities, managers must guess at the number and causes of undetected deaths. McClellan et al. (1999) estimated 49-54% of grizzly bear deaths might go undetected in areas where humans and grizzly bears share habitat. We highlight this to emphasize that in our proceeding summary of mortalities, the number of actual mortalities could be double to those we've identified.

Within the study area of the Bear Population Unit (BPU), effort is under way to develop DNA-based population estimates (Boulanger et al. 2003). Once available, these estimates can be used along with the following summary of mortalities to calculate the local rate of grizzly bear mortality.

We reviewed provincial government and FMFGBRP records, for known grizzly bear mortalities (1999-2004) of individuals using the Cheviot area and summarized incidents by demographics, cause of death, season, habitat quality and proximity of mortality to classified roads. We compare these mortality attributes with other known grizzly mortalities across the Bear Population Unit (BPU). This analysis however, excluded bears within the BPU who were associated with the active Gregg/Luscar mines, as these individuals will be considered in the mortality summary in part two of this report.

Mortality types (causes of death) were categorized according to official reports, evidence at kill site, investigations or known causes. Mortality types include legal hunt, illegal kill (poached), road kill, research capture, natural, unknown and unknown human-caused.

Mortality locations were overlaid with seasonal Resource Selection Function (RSF) models (Neilsen 2004) to determine a surrogate for habitat quality (during season of death) on a categorical scale of low, moderate or high. Resource selection function models incorporate both vegetative characteristics and anthropogenic features related to bear habitat use, to determine relative probability of grizzly bear occurrence across a landscape and have become a reasonable surrogate for current habitat quality (see section 2.4 for more on RSF's) (Nielsen 2004). The RSF habitat model represents the combination of resources bears select at a population level.

Mortality locations were also overlaid with a roads layer in GIS, to determine proximity of mortality site to nearest road. Road data was defined by the Alberta government and accurate to 2002 (Figure 2-2). Roads in this layer were classified into 6 types:

- Gravel 1L: gravel roads, 1 lane. Maintenance depends on use
- Gravel 2L: gravel roads, 2 lanes (ie. Robb Rd or Gregg River Rd). Usually maintained by forest company or other
- Unimproved: usually not maintained (grading etc.)
- Truck Trail: gravel/dirt road, 1 lane. Remnant of past roads.
- Paved-undivided
- Paved-divided

Of all collared bears using the Cheviot lease area between 1999 and 2004 we identified only a single known mortality. An adult male was legally hunted in spring 2002 (Table 2-3). There were no grizzly bear mortalities documented within the Cheviot lease area boundary. We identified 14 other mortalities across the BPU (excluding Gregg/Luscar area bears), 11 females and 3 males. Sixty-four percent of female mortalities and 33% of male mortalities across the BPU were adults. Previous research has shown mortality rates of sub-adult males to be most prevalent (McLellan et al. 1999) however in this area only a single sub-adult male mortality was documented. There were two mortalities of sub-adult females. Forty-three percent of mortalities within the BPU occurred in the spring, compared to 36% in fall and 21% in summer. Four mortalities were documented but their precise coordinates were not recorded, therefore we did not include them in the habitat quality or distance to road analysis. Fifty percent of mortalities occurred in areas of high habitat quality, 30 percent in moderate and 20 percent in low habitat quality. All human-caused mortalities occurred less than 100m from a road (Table 2-3).

2.15 Mortality risk

Human activities including mining, forestry, agriculture, residential development and recreation can degrade habitat quality for bears and increase mortality risk (McLellan 1989, Boyce et al. 2001, Benn and Herrero 2002). Modeling (using geographical Information systems) is one method to predict, evaluate and mitigate cumulative environmental effects on grizzly bears. A mortality risk model was developed by Nielsen et. al (2004) in response to the prevalent threat of human-caused mortality on grizzly bears. It is increasingly recognized that grizzly bear conservation cannot just focus on the spatial distribution of habitats or habitat selection. Areas that are identified as high quality habitats within habitat models can also be attractive sinks where risk of mortality

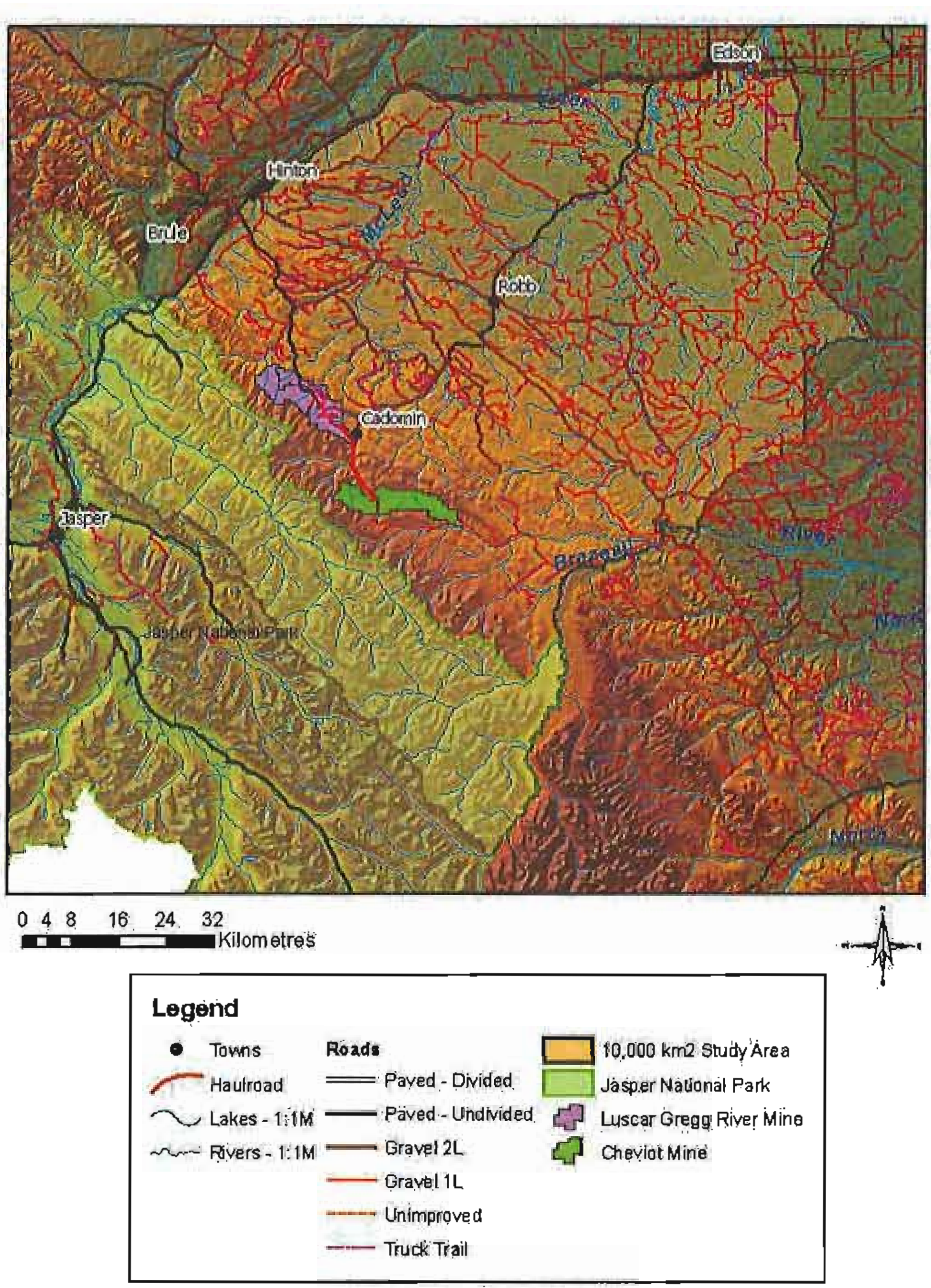


Figure 2-2. Classified roads established by Alberta Government circa 2002.

Table 2-3. Summary of grizzly bear mortalities (1999-2004) of bears occupying the Cheviot permit area and bears within the Bear Population Unit.

	Name	Sex	Age Class	Date	Season	Cause of Death	Habitat Quality	Nearest Road (km)	Road Type
Cheviot									
	G029	M	adult	5/28/02	spring	legal hunted	High	0.003	Truck Trail
BPU									
	GUNK002	F	coy	10/21/99	fall	road kill	Moderate	0.068	Gravel2L
	GUNK001	F	adult	9/11/99	fall	illegal	High	0.044	Unimproved Road
	GUNK005	F	adult	5/24/00	spring	illegal	High	0.016	Gravel2L
	GUNK004	M	coy	5/24/00	spring	illegal	High	0.11	Gravel2L
	G046	M	subadult	5/27/01	spring	natural	Low	0.32	Gravel2L
	G026	F	adult	10/19/00	fall	unknown	Low	0.027	Gravel1L
	G015	M	adult	5/16/99	spring	research	High	n/a	n/a
	G011	F	adult	7/15/02	summer	research	Moderate	n/a	n/a
	G105	F	subadult	9/28/02	fall	illegal	High	0.005	Gravel2L
	G057	F	adult	7/17/03	summer	unknown human	High	0.004	Gravel1L
	GUNK003	F	adult	10/01/00	fall	illegal			
	G102	F	subadult	5/16/01	spring	legal hunted			
	GUNK011	F	adult	9/24/99	summer	illegal			
	GUNK012	F	unk	5/31/00	spring	legal hunted			

is high (Nielsen et al. 2004). Managing for both high quality habitats and low mortality risk together is essential in maintaining viable future populations of grizzlies. The risk model Nielsen developed is a predictive model that estimates the relative probabilities of bear mortality (risk) given combinations of variables including land cover types (deciduous forest, grassland, non-vegetated, shrub), greenness, distance to edge, distance to water, distance to access and terrain variability (Nielsen et al. 2004). The distance to access variable is explained as the distance to the nearest linear human use feature (motorized or non-motorized), excluding exploratory seismic lines.

Nielsen et al. (2004) first modeled the distribution of grizzly bear mortalities relative to various landscape attributes within the Central Rockies Ecosystem, an area of about 30,000 km^2 in southern Alberta, bordered to the north by highway 11 and to the south by highway 3. Mortalities were positively associated with human access, water and edge features, while negatively associated with terrain ruggedness and greenness indices (Nielsen et al. 2004). These models developed for the CRE fit well with independent data from the FMFGBRP when tested. Subsequently, a model of relative risk of mortality for adult grizzly bears was developed, across the 10,000km^2 FMF study area, based on random versus known mortality locations using equations from Nielsen et al. (2004, p.117) and a quantile reclassification into 10 categories (1-low risk to 10-high risk). Figure 2-3 illustrates this mortality risk model across the BPU and mine lease areas.

Because this mortality risk model was developed using grizzly bear mortalities, human access, terrain and vegetation variables at a population scale it may not accurately reflect the true risk to grizzlies given the effects of all human use and management activities occurring specifically within the administrative mine lease boundaries. The model, as it is presented here, does not take into account any assumptions that there is increased control or restriction of human use of the landscape within mine lease areas, which may reduce mortality risk to bears. Similarly, the model does not reflect the effect of specific mining activities (eg. road density and traffic volume) within the lease areas as potential increases in risk of mortality to bears. The extent to which these factors affect grizzly bear populations will depend on the degree to which management interventions are successful at limiting mortality risk for grizzly bears.

In summarizing the mortality risk model for grizzly bears, within the Cheviot lease area, we re-classed the 10-category scale into low (category 1-3), moderate (category 4-7) and high risk (category 8-10) (Figure 2-4). We emphasize that our assessment of mortality risk to bears within the Cheviot area is previous to any mining disturbance or activity and addresses the current levels of human access circa 2002. As such, high risk of mortality exists within the western half of the Cheviot lease area, along the McLeod River, Thornton and Cheviot Creek (Figure 2-4). Previous research has shown that bears select edge habitats and streamside areas (Nielsen et al. 2002; Theberge 2002), but humans are also most likely to use these areas as well, therefore increasing the frequency of contact (and risk of mortality) between humans and bears (Mattson et al. 1996). The valley configurations lend well to be natural travel corridors for bears as well as having access/recreational trails used by humans. Another area of high mortality risk for bears within the Cheviot lease area occurs in the most southeast corner, along the Cardinal River drainage (Figure 2-4), another human access corridor. Within the Cheviot lease area (72km^2) seventy-eight percent is currently (pre development) considered low mortality risk to bears, 15 percent is moderate and 7 percent high risk of mortality.

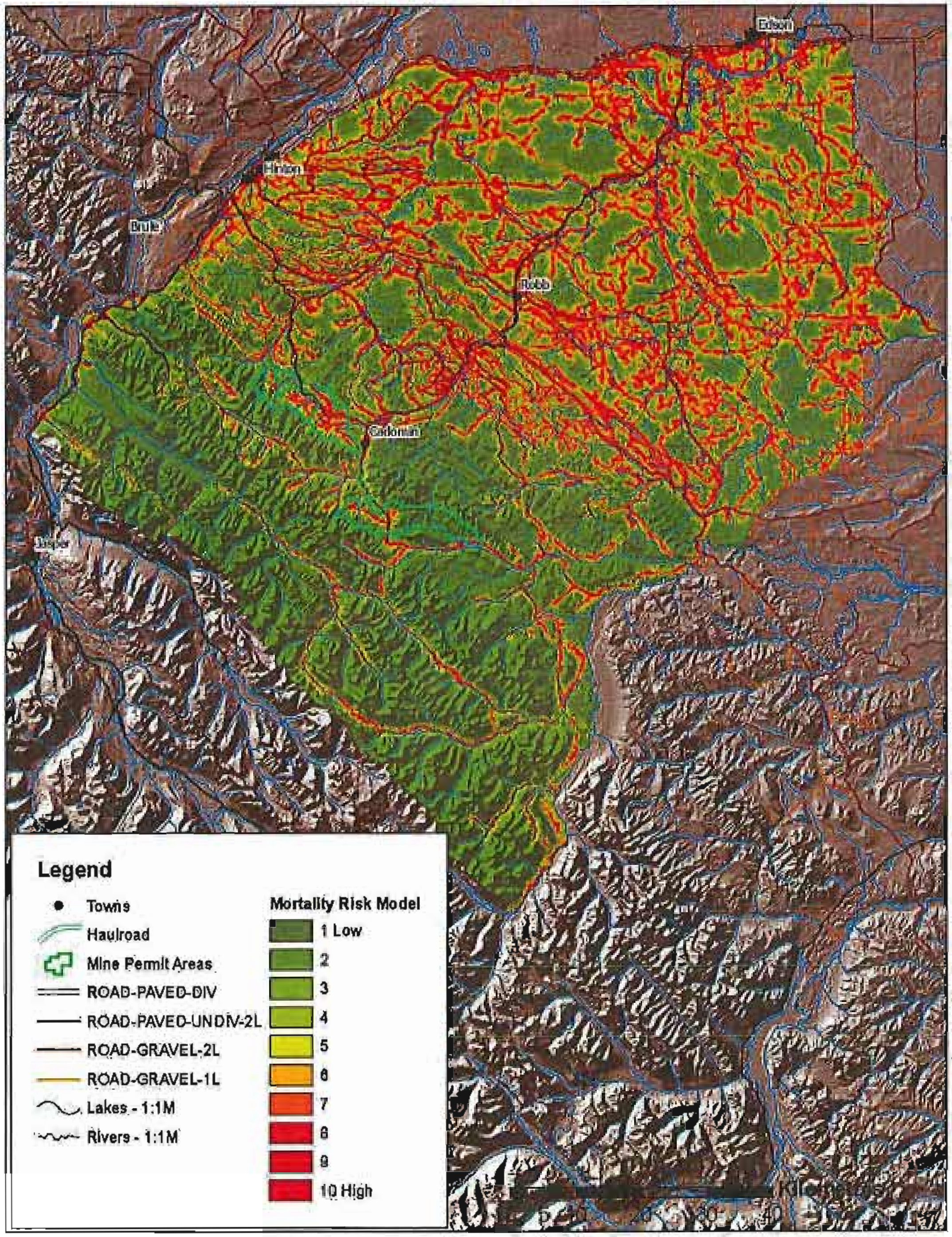


Figure 2-3. Mortality risk model across the BPU, illustrating ten categories of low to high probability of mortality.

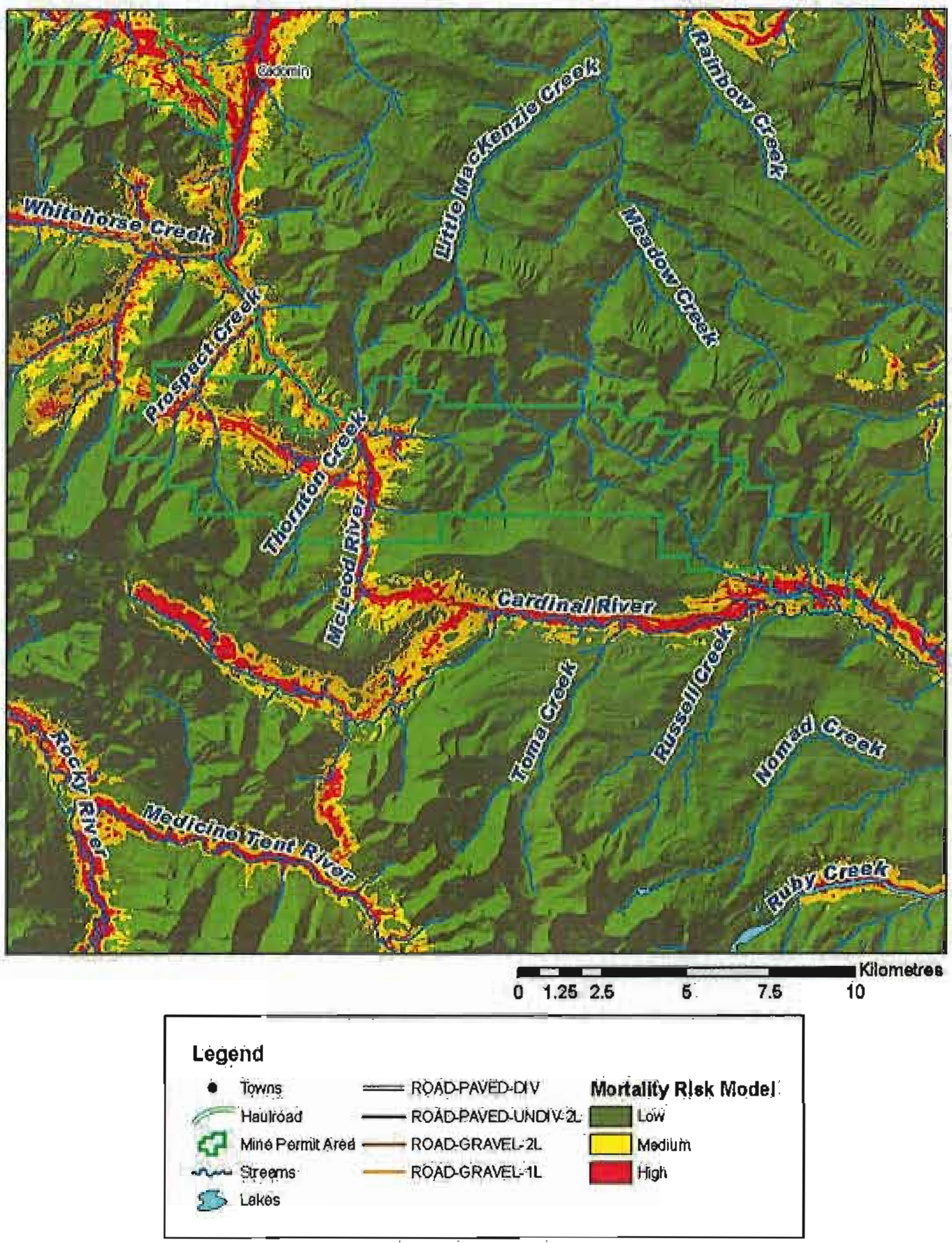


Figure 2-4. Areas of low, moderate and high probability of mortality within the Cheviot mine lease area (as of 2002 landscape conditions).

2.2 Seasonal and annual Grizzly bear movements

2.21 Seasonal home ranges

Annual and seasonal variations in grizzly bear movements are bound to occur as they respond to various resources in their environment. As the quality and quantity of seasonal foods vary across a landscape, one would expect selection by grizzly bears to vary (Nielsen 2004, Mace and Waller 1997). Selection often varies by individual bear and depends on its age, gender, reproductive status or its relation to adjacent bears (Nielsen 2004, Mace and Waller 1997). For these reasons we do not expect all bears to respond in the same way each year and should be cautious in land use planning approaches specific to individual animals. Home range size provides insights into the status of habitat quality for grizzly bears. The more concentrated the food source, the smaller the range necessary to maintain the animal. Habitat associations are strongly seasonal and typically reflect local phenology (Ross 2002). The size of the home range is extremely dynamic and varies from one geographic region to another, from one year to another, and one season to another. In this analysis we summarize seasonal home ranges of bears specific to the Cheviot and Gregg/Luscar regions to best understand bear use of the area across seasons.

Using grizzly bear telemetry data from 1999-2004, we calculated annual seasonal 95% fixed kernel home ranges, using the Animal Movement Extension (Hooge and Eichenlaub, 1997) for ARCVIEW GIS (ESRI Inc.). We stratified data into three seasons (spring, summer and fall) between May 1 and October 15. Nielsen et al. (2004) describes the spring season as the period occurring from 1 May to 15 of June, the summer season from 16 June to 15 August and the fall season from 16 August to 15 of October, each season defined from food habits and selection patterns for the region. We delineated 82 seasonal ranges for 7 individual female and 8 individual male bears using the Cheviot area over the 6-year period. Figure 2-5 and 2-6 are two examples of annual and seasonal home ranges we generated for each study animal (see report supplement document for all bear home range maps). We analyzed the size (km^2) differences between seasonal home ranges, summarized seasonal variations in grizzly bear movements and evaluated the percent of annual home range overlap with the Cheviot lease area. For some bears, a seasonal home range was not calculated because of insufficient location data (ie. dropped or malfunctioning collar), these are indicated in Table 2-4 as having 'no data'.

Seasonal home range sizes for female grizzlies ranged between 1860 km^2 and 11 km^2 (Table 2-4). Grizzly G027 had an exceptionally large spring home range (1860 km^2) compared to other females with cubs in the study area, so we excluded her from subsequent comparative analysis of home range sizes. Average spring home range size for females ($\bar{x}$=215km^2, SD=166, n=14) was larger than both female summer home range size ($\bar{x}$=193km^2, SD=110, n=18) and fall home range sizes ($\bar{x}$=150km^2, SD=144, n=17).

Seasonal home range sizes for males ranged between 1474 km^2 and 16 km^2. Average summer home range size for males ($\bar{x}$=637km^2, SD=453, n=12) was largest compared to spring home range size ($\bar{x}$=533km^2, SD=310, n=12) and fall home range size ($\bar{x}$=280km^2, SD=236, n=10).

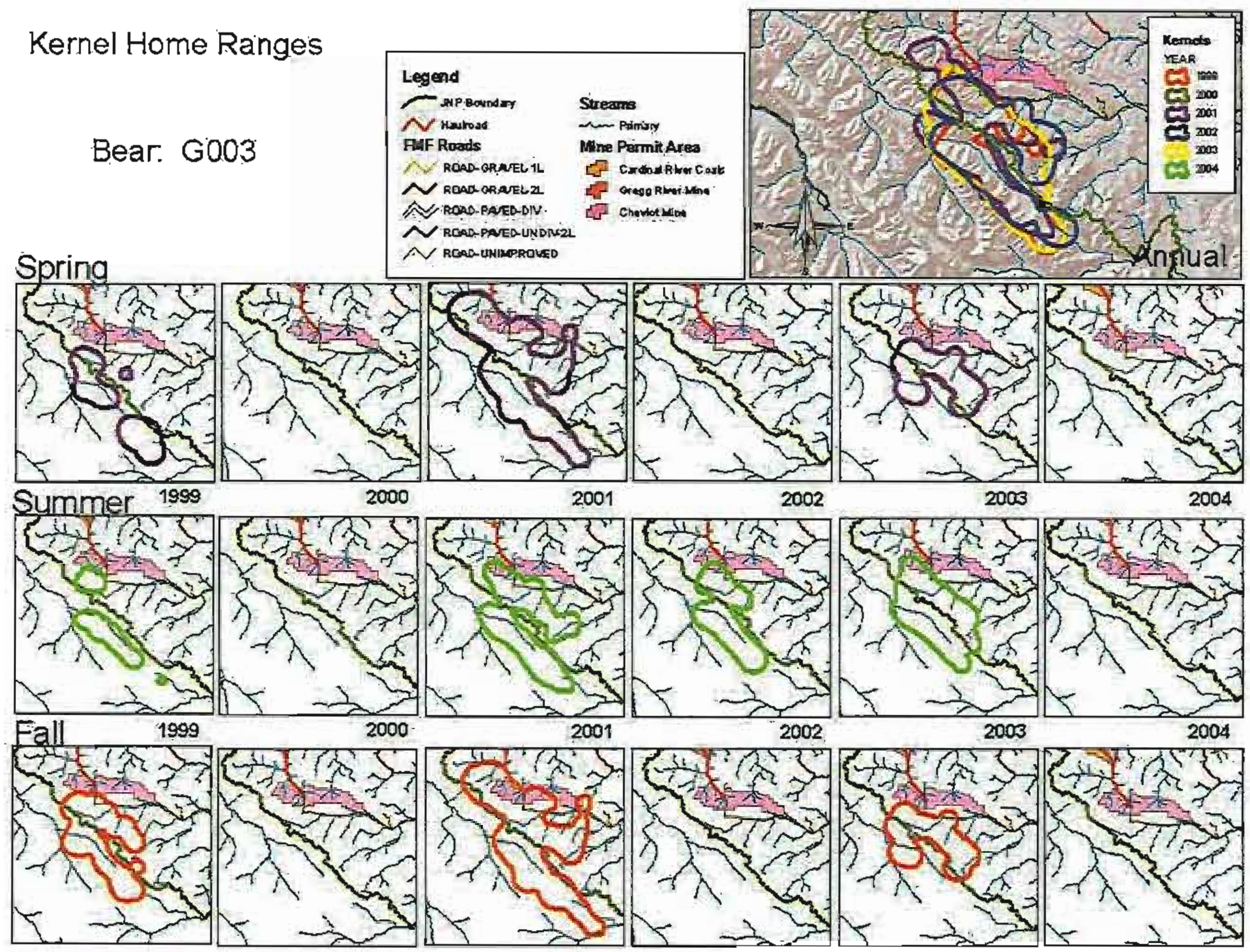


Figure 2-5. Annual and seasonal home ranges for an adult female grizzly bear using the Cheviot Mine lease area. (No data exists where windows do not illustrate a home range boundary)

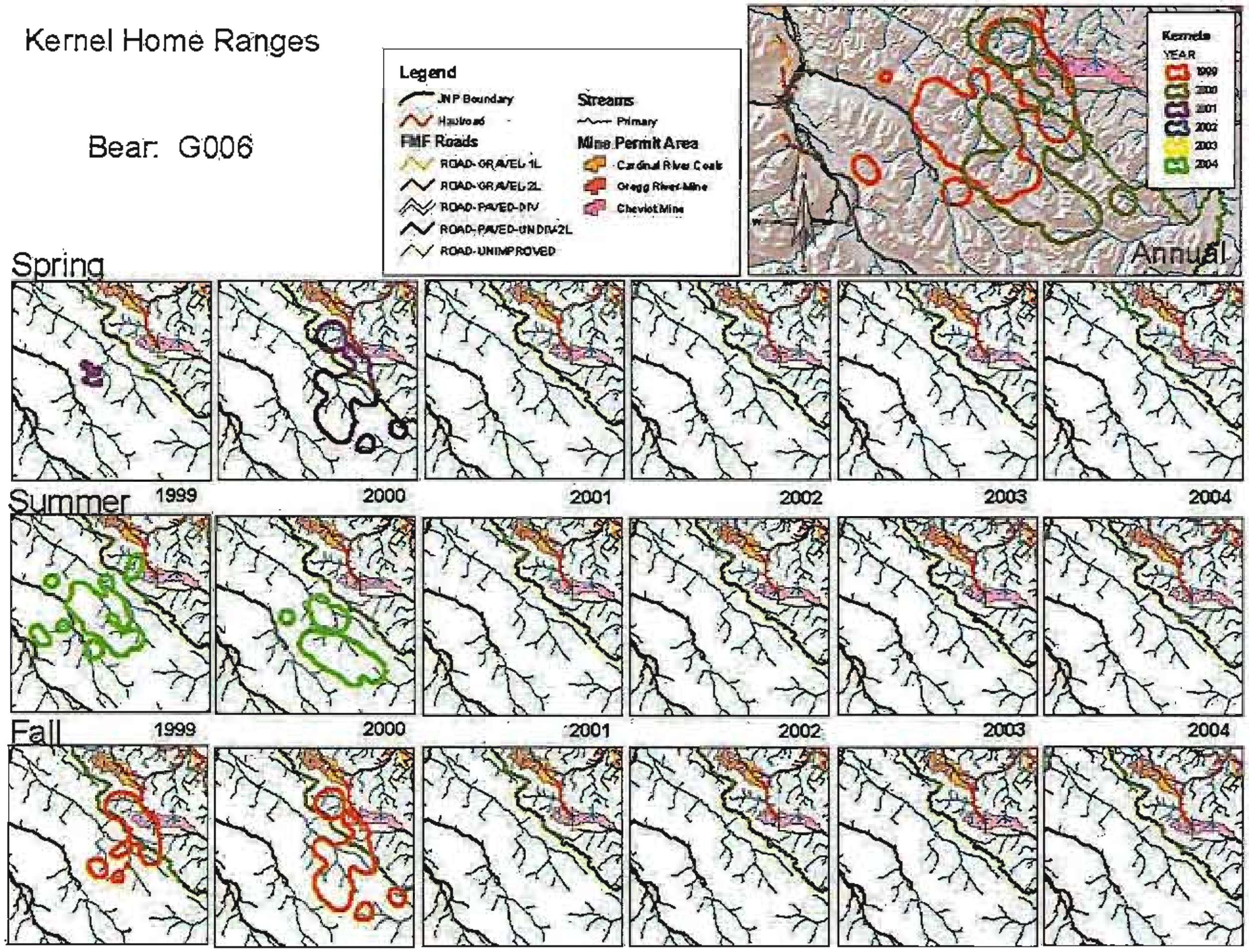


Figure 2-6. Annual and seasonal home ranges for an adult male grizzly bear using the Cheviot Mine lease area. (No data exists where windows do not illustrate a home range boundary)

Table 2-4. Seasonal home range sizes of grizzly bears occupying the Cheviot lease area between 1999 and 2004.

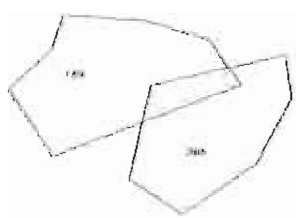
Bear ID	Sex	Year	Spring (km2)	Summer (km2)	Fall (km2)
003	F	1999	269	113	187
		2001	511	317	35
		2002	no data	209	310
		2003	217	300	256
004	F	1999	175	271	49
		2000	129	187	no data
		2001	28	70	11
		2004	no data	135	39
006	M	1999	285	460	16
		2000	481	428	no data
008	M	1999	701	838	255
		2002	231	856	169
016	F	1999	100	186	18
		2000	no data	62	17
		2001	64	52	119
023	F	2003	67	74	90
027	F	2000	450	1860	263
		2002	416	403	249
028	F	2000	143	192	563
		2001	no data	382	144
		2003	no data	372	146
029	M	1999	340	213	112
		2000	562	862	216
		2001	413	1474	661
033	M	2003	1113	883	no data
035	F	2002	33	47	65
043	M	2003	816	104	221
044	M	2003	428	106	101
055	M	2003	67	196	320
058	M	2003	953	1226	733

In effort to illustrate use of the mine lease relative to adjacent areas within a bears annual home range, we summarized the percent of each annual home range that overlapped the Cheviot lease area and also the Gregg/Luscar mine area when a bear occupied both areas in one year. We documented 28 annual home ranges that overlapped the Cheviot lease area between 1999 and 2004 (Table 2-5). The annual home ranges for grizzlies G027 (in 2002) and G028 (in 2000) bordered the Cheviot Mine lease area, but did not overlap it and consequently are not included in Table 2-5. There were 2 female and 7 male grizzlies whose annual home range overlapped both mine lease areas. Female annual home range overlap with the Cheviot mine lease area ranged between 18 percent and 0.01percent, with an average of 4.8 percent (N=18). The average male annual home range overlaps the Cheviot mine lease area by 4 percent (N=12), with a range between 14 percent and 0.01 percent.

2.22 Annual home range shifts

It is common for grizzly bear home ranges to shift across years as they respond to annual changes in food availability and abundance. Annual shifts may also occur as a consequence of reproductive status, where females adopt movement patterns to increase offspring survival.

Several individual bears were documented with telemetry to have used the Cheviot lease area for multiple (consecutive) years. For those individuals we assessed the shifts in their annual home range use across the years. We calculated two parameters (see diagram below), the percent of the previous home range not used in the consecutive year home range (yellow) and the percent of the more recent home range that overlaps with the previous year's home range (blue). Home range fidelity indicates that such ranges are stable, productive and traditionally used.



We identified 2 male and 4 female grizzly bears having used the Cheviot lease area over 2 or more consecutive years (Table 2-6). Female grizzlies made annual home range shifts that did not use an average of 39 percent (n=7) of their previous home range for a new home range in the consecutive year, compared to males who did not use an average of 35 percent (n=3) of their consecutive years range from the previous. Females averaged 38 percent of home range overlap between years and males averaged 56 percent.

Female grizzlies that had cubs of the year (coy), compared to no cubs the year previous, did not use on average 54 percent of their previous years' home range and their home ranges overlapped an average of 21 percent. Females with cubs over 2 consecutive years did not use an average of 16 percent of the previous years home range and

Table 2-5. Percent of total annual home range overlapping the mine lease areas for Cheviot area grizzly bears (1999-2004).

Bear ID	Year	Total HR Area (km2)	% Cheviot Overlap	% Gregg/Luscar Overlap
G003	1999	234	1.71	0.00
G003	2001	263	6.09	0.00
G003	2002	312	0.86	0.00
G003	2003	331	1.75	0.00
G004	1999	155	7.24	0.00
G004	2000	185	11.93	0.00
G004	2001	48	1.72	1.85
G004	2004	86	0.83	0.00
G006	1999	644	4.21	0.00
G006	2000	597	2.32	0.00
G008	1999	1018	5.53	8.42
G008	2002	467	5.03	8.27
G016	1999	82	14.87	0.00
G016	2000	43	7.04	0.00
G016	2001	118	10.86	0.00
G023	2003	124	0.01	33.92
G027	2000	1835	0.13	0.00
G028	2001	394	0.97	0.00
G028	2003	132	2.61	0.00
G029	1999	295	2.72	17.94
G029	2000	1684	0.17	5.09
G029	2001	1598	0.01	5.36
G033	2003	1567	0.03	0.00
G035	2002	71	18.41	0.00
G043	2003	653	10.34	0.00
G044	2003	304	13.83	0.00
G055	2003	274	0.98	6.02
G058	2003	957	2.15	0.22

overlapped an average of 45 percent. Females with no cubs across years did not use an average of 38 percent of their home range from one year to the next and overlapped an average of 56 percent. Our sample sizes for these analyses are small (2-3 samples for each group), but indicate that females without cubs have greater range fidelity (56% overlap), closely followed by females with cubs during consecutive years (45% overlap).

We conclude that home ranges do differ on a yearly basis, however bears aren't spending one year in around the Cheviot area and the next year somewhere completely different. There are consistent patterns to bears in this area that they continue to use portions of the Cheviot area on an annual basis. This knowledge offers some benefit to future monitoring work whereby monitoring bear presence in the area, whether by DNA or some other approach, one wouldn't expect to see bears disappear completely from the area.

Table 2-6. Annual home range shifts of bears occupying the Cheviot lease area over consecutive years between 1999 and 2004.

Bear ID	Sex	Year new	Year previous	% of previous HR not used	% of new HR overlap	Reproductive Status
G003	F	2002	2001	26.02	37.57	1coy in 2002
G003		2003	2002	15.76	20.54	1yrlg in 2003
G004	F	2000	1999	30.86	42.37	no cubs
G004		2001	2000	78.59	11.29	1coy in 2001
G016	F	2000	1999	56.32	13.77	2coy in 2000
G016		2001	2000	16.67	69.27	2yrlg in 2001
G028	F	2001	2000	45.45	68.82	no cubs
G006	M	2000	1999	49.70	45.80	n/a
G029	M	1999	2000	6.66	89.26	n/a
G029		2001	2000	49.64	33.54	n/a

2.23 Telemetry locations and road crossings

We summarized the number of grizzly bear telemetry locations (1999-2004) acquired within the Cheviot Mine lease area relative to the total number of telemetry locations for each bear on an annual and seasonal basis (Table 2-7). On average 5.3% of total annual telemetry locations for female grizzly bears (N=12) and 6.5% of male (N=10) annual locations occurred within the Cheviot boundary. The largest number of individual radio-collared bears were documented using the Cheviot Mine lease area during the summer season (N=18) when compared to the spring (N=12) or fall (N=11). However bears on average spent a greater proportion of their time in the mine boundary during the fall season ($\bar{x}$=3.76%, N=11, SD=3.8), relative to spring ($\bar{x}$=2.64%, N=12, SD=2.98) and summer ($\bar{x}$=2.84%, N=18, SD=2.98). In explanation of this finding, our habitat analysis in section 2.4 concludes that of all seasons, fall has the largest percent of high quality habitat within the Cheviot lease area. Habitat quality based on RSF modeling does not just reflect vegetation, but a combination of all resources that attract bears to an area. These resources may relate to human activity, disturbance/displacement, ungulates, carcasses etc. We emphasize that RSF modeling provides a surrogate for habitat quality based on the probability of bear occurrence across a landscape.

We examined the grizzly bear telemetry data to summarize the minimum number of times bears crossed the existing (circa 2002) Grave Flats road within a 10km buffer of the Cheviot lease area. There was no grizzly bear crossing data available for the haul road that was constructed in 2004 into the Cheviot lease area.

Only a minimum count of road crossings could be estimated due to the nature of GPS data acquisition. GPS telemetry locations were acquired at best every 4 hours, if a road bisected the straight-line path between two consecutive locations, we would consider it one crossing. If a bear crossed the road multiple times within the time period between

Table 2-7. Count of annual and seasonal telemetry locations occurring within the Cheviot Lease Area boundary relative to the total number of locations acquired annually per bear between 1999 and 2004.

Bear ID	Year	Total locations	# of locations within Mine boundary			
			Annual	Spring	Summer	Fall
G003	1999	619	6	1	5	0
G003	2001	724	34	22	12	0
G003	2003	518	5	0	5	0
G004	1999	793	47	5	33	9
G004	2000	321	38	11	27	0
G004	2001	542	5	4	1	0
G004	2004	1619	15	0	15	0
G006	1999	425	13	13	0	0
G006	2000	205	2	2	0	0
G008	1999	393	29	11	14	4
G008	2002	683	83	49	5	7
G016	1999	696	89	5	33	51
G016	2000	332	14	0	3	9
G016	2001	479	32	16	16	0
G028	2003	865	13	0	13	0
G029	1999	481	13	0	9	4
G029	2000	442	2	0	2	0
G035	2002	529	65	0	23	42
G043	2003	768	78	0	0	73
G044	2003	521	135	29	59	47
G055	2003	443	3	0	0	3
G058	2003	494	7	0	6	1

acquired GPS locations, we would not be able to determine this from our data. Similarly, we are unable to specify exact road crossing locations from GPS data, as we could not assess the path of a bear between known locations with certainty.

For each bear, annually between 1999 and 2004, we generated a path layer by joining consecutive GPS locations with a straight line. The path layer was overlaid onto the road layer (circa 2002, pre-development of mine roads), and at each intersection of a path with the specified roads, the two point locations at each end of the path were extracted. One point location was the 'from location' and the other a 'to location'. We consulted local sun tables to determine sunrise and sunset times for each calendar day and classified the road crossings as day or night. If the 'from' and 'to' locations were either consecutive day locations or consecutive night locations then the crossing event would be classified as a day or night crossing, respectively. We also identify whether the crossing occurred inside or outside (within 10km) the mine lease boundary.

There were 4 individual female bears that contributed 8 'years' (defined by number of annual home ranges) of crossing data and 6 individual male bears also contributing 8 'years' of crossing data (Appendix A). Male grizzlies crossed the Grave Flats road more frequently (minimum 52 crossings) than female grizzlies (minimum 28 crossings). Male grizzly bears crossed roads most frequently in the fall, compared to females who crossed roads most frequently in the summer. Fifty-eight percent of male crossings were in the fall compared to 23% in spring and 19% in summer. Seven percent of female crossings were in the fall compared to 39% in spring and 54% in summer.

For sixty-five percent of all crossings documented, we could not reliably determine whether the crossings were made during day or night because consecutive GPS locations overlapped day and night periods. Daytime crossings of roads were made 7 times by females and 14 times by males. Of all males, grizzly G008 crossed the most times during day (N=8) and G003 crossed most frequently (N=5) of all females. There were a total of 4 definitive night crossings, 3 times by males and once by a female. Seventy-five percent of all documented road crossings occurred outside (within 10km) of the Cheviot Mine lease area boundary.

2.24 Denning ecology

Grizzly bears in this region spend almost half of each year in winter dens. This denning behaviour is thought to be a response to adverse environmental conditions, primarily a seasonal lack of food (Mystrud 1983). Grizzly bears are sensitive to human disturbance at den sites (Craighead and Craighead 1972, Mace and Waller 1997) and consequently will abandon dens or suffer physiological stress. Understanding denning activity and characteristics can help in managing towards minimizing the impacts of human activities on grizzly bear denning ecology.

Of all radio collared grizzly bears using the Cheviot lease area between 1999 and 2004, we identified 10 den site locations (Figure 2-7). We documented no den sites of radio-collared bears within the Cheviot mine lease area. We used GPS data (when available) to estimate the date of den entry and emergence. Den entry was estimated based on the last known active date and first known date denned and den emergence estimated from the last known date denned and the first known date active. We converted the estimated dates of den entry and emergence into julian dates and calculated the difference between them to determine number of days denned. Each den location was plotted on a 25m digital elevation model (DEM) and elevation, aspect and slope measurements were recorded. Aspect was categorized as: northern (315°- 45°), eastern (45°- 135°), southern (135°- 225°), or western (225°- 315°). Den locations were overlaid with an integrated decision tree map (IDT) (Hansen 2000) to determine a broad land cover class relative to grizzly bear habitat. We summarized habitat class into open or forested habitat.

We obtained den characteristics for 8 adult female and 2 sub-adult male grizzlies (Table 2-8). No denning dates for adult male grizzlies using the Cheviot area were obtained over the 6-year period. No bears were documented as reusing their den sites from previous years, however 3 adult female bears showed fidelity to the same general location (<1km between den sites) across years (Figure 2-7). Sample sizes were not adequate to assess annual variation in denning attributes. Females entered their dens between October 15 and November 19. Sub-adult males entered dens between November 4 and November 8. GPS data for den emergence was only available for 5 females. These bears emerged from their dens in the spring between April 28 and May 12. 2 females emerged from their den with cubs of the year (coy), G016 on May 12,

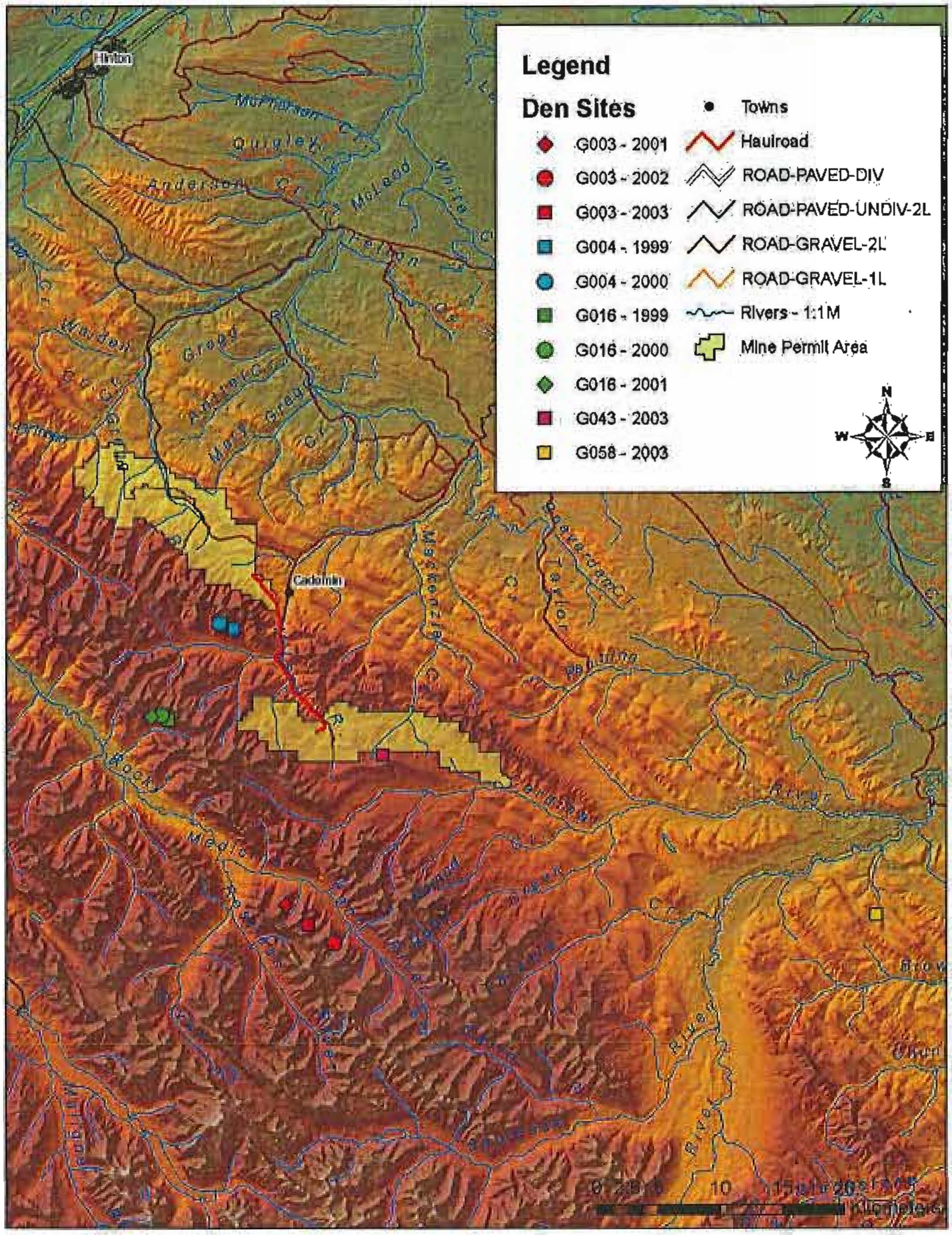


Figure 2-7. Known den sites of grizzly bears of the Cheviot area between 1999 and 2004.

Table 2-8. Den site characteristics of documented den locations for radio collared grizzlies in the Cheviot area, 1999-2003.

Year	Sex/Age Class	BEAR ID	Reproductive Status upon Den Emergence	Elevation (m)	Percent Slope	Aspect	Den Entry	Den Emergence	# Days Denned	Landcover Class
1999										
	AD Female	004	0	2167	54	E	28-Oct-99	28-Apr-00	183	Snow
		016	2 coy	2030	42	W	09-Nov-99	12-May-00	184	Rock
2000										
	AD Female	004	0	2058	68	W	7-Nov-00	11-May-01	185	Shadow
		016	2 yrlg	2182	92	S	19-Nov-00			Rock
2001										
	AD Female	003	1 coy	2140	53	E	20-Oct-01	30-Apr-02	192	Rock
		016	unknown	1910	43	S	15-Oct-01	07-May-02	204	Rock
2002										
	AD Female	003	1 yrlg	2093	40	E	13-Nov-02			Alpine/subalpine
2003										
	AD Female									
		003	unknown	2110	27	E	5-Nov-03			Open coniferous
	SubAD Male									
		043	n/a	1934	54	E	4-Nov-03			Alpine/subalpine
		058	n/a	1596	28	E	8-Nov-03			Conifer

2000 and G003 on April 30, 2002.

Den elevations across the pooled sample ranged between 1596m and 2182m. The average elevation for females was 2086m (N=8) and 1765m for sub-adult males (N=2). Grizzly bears selected a variety of aspects for denning, although most (60%) were located on easterly aspects (Table 2-8). Females used eastern aspects 50% of the time and sub-adult males 100%. Grizzly bears denned on relatively steep slopes; mean slope for the pooled sample was 50%. Average slope for females and males was 52% and 41% respectively. Bears denned both in open (50%) and forested (40%) habitats. Shadow coverage in the map imagery prevented the classification of one den site. Sub-adult males were consistently in forested cover type, whereas females selected both forest (N=2) and open canopy (N=5).

2.3 Distribution of collared and un-collared grizzlies in the Cheviot area

In effort to better describe the distribution of the bear population across the Cheviot area, we summarized data from FMF's 1999 DNA mark-recapture project, which identified individual bears *not* fitted with GPS radio-collars in addition to collared bears.

In 1999 and 2004 DNA mark-recapture projects were conducted within the Foothills Model Forest Grizzly Bear Project study area (including the CRO mine permit areas). DNA lab results from the 2004 collection period were not available at the time of writing this report. We recommend that when the 2004 DNA population census results are available, these data be compared to the 1999 DNA data set in an effort to better describe the distribution of grizzly bears and key habitats.

In 1999, a 5,350 km2 study area was divided into 64 9x9 km grid cells, where in each cell a single hair trap was placed for 3 14-day sampling sessions (Boulanger et al. 2003). For each session (between May 19 and July 9, 1999), the hair capture site was moved >1km. The hair trap consisted of a strand of barbed wire fence to snag hair, encircling a liquid scent lure used to attract bears to the site (Mowat and Strobeck 2000, Poole et al. 2001, Stenhouse and Munro 2000, Woods et al. 1999). Hair samples were collected and sorted by species, and then all grizzly bear samples were DNA microsatellite fingerprinted in the lab. Each grizzly bear hair sample was genotyped at 6 microsatellite loci to identify individuals (Stenhouse and Munro 2000). At the time, technology limited researchers to genotyping up to 6 loci, which did not allow for accurate determination of parent/offspring or sibling relationships. Technology has since advanced and now researchers can genotype to 15 loci, allowing for analysis of genetic relatedness between individuals.

In the 1999 DNA field season, 28 of 64 cells had sites that caught grizzly bear hair (Figure 2-8). Sites within the Cheviot mine permit area were not successful at capturing any hair samples. Across the DNA study area, a total of 67 grizzly bear hair samples were collected, identifying 40 different individual bears (Table 2-9). Grizzly bears were often captured at multiple hair traps during the course of DNA sampling. Twenty of the 40 individuals were live trapped by crews for collaring purposes (13 females, 7 males), 18 of which were actually fitted with a GPS radio-collar. Six of those radio-collared bears had home ranges overlapping the Cheviot lease area between 1999 and 2004 (see italics in table 2-9). Twenty individual bears (12 female, 6 male, 2 unknown) were identified through hair DNA fingerprinting, and were never radio collared. Figure 2-8

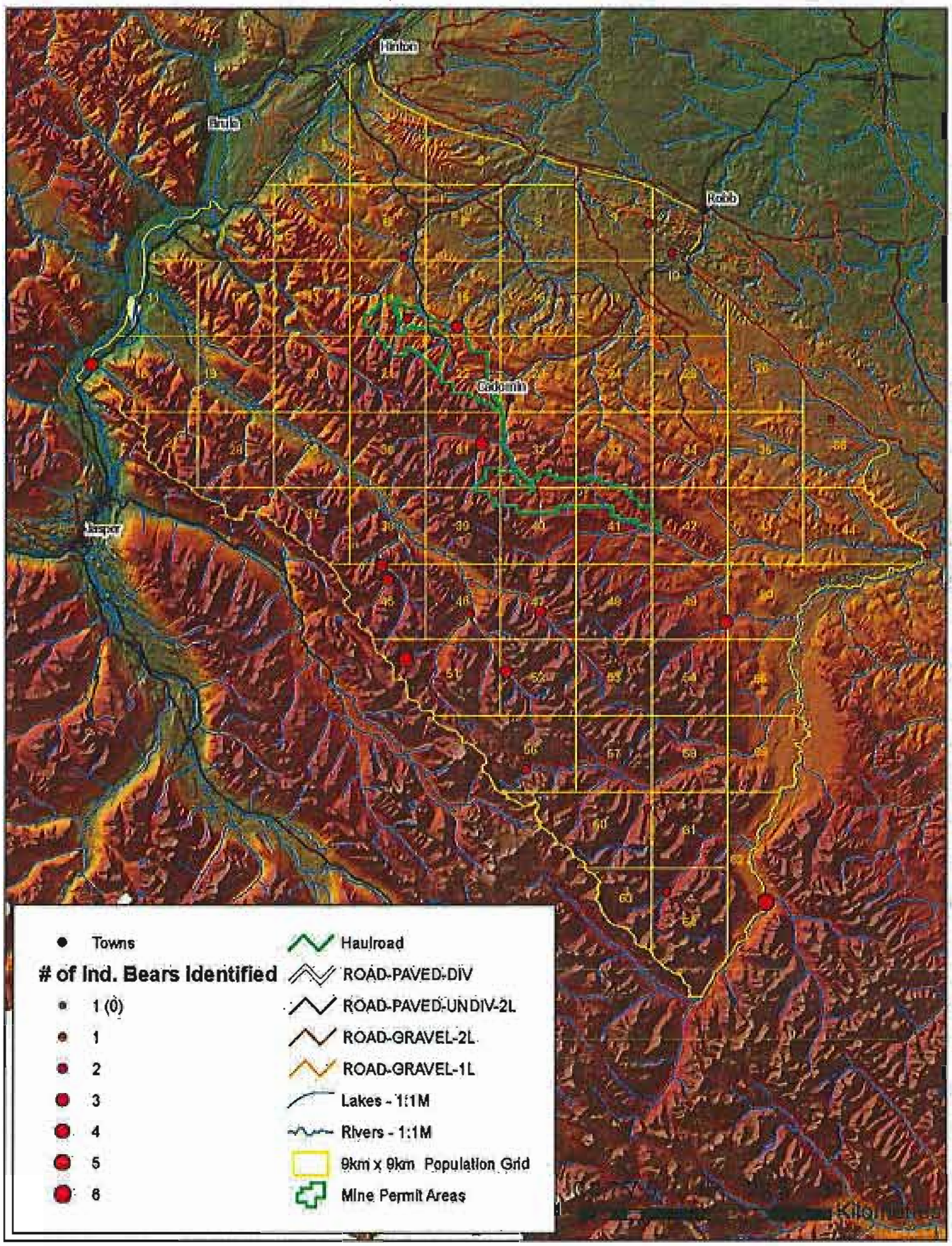


Figure 2-8. Locations of individual grizzly bear hair samples obtained in the 1999 DNA hair snag census.

Table 2-9. Capture location of hair samples obtained from the 1999 DNA Hair snaring census. Individuals genotyped as known GPS collared bears or un-collared (DNA) bears and by sex.

	Bear ID	Sex	Captured in cell number
GPS Bears			
	G033	M	6
	G017	M	6,9,15
	G060	F	9
	G020	F	14,15
	G029	M	14
	G100	F	15
	G001	M	29,38,45,47,51
	G004	F	30.31,64
	G016	F	31,64
	G006	M	37,45,51
	G104(not collared)	M	38,62
	G003	F	39,47
	G010	F	46,47,51,52,56
	G054	M	49
	G007	F	49
	G034	F	49
	G028	F	49
	G065	F	50
	G019(not collared)	F	51,52,56,60
	G002	F	62
DNA Bears			
	J	F	10,24,36
	X	F	10
	B	M	18,37
	AB	F	18
	AC	F	18
	AO	F	18
	W	F	31,62,64
	AH	M	31,62
	O	F	33
	D	F	38
	GUNK17	F	42
	BE	unk	44
	AM	F	45
	BD	unk	46
	K	M	50
	F	F	51
	Q	M	52
	BC	M	62
	I	F	62
	AQ	M	64

illustrates the distribution of DNA bears (bears that were only identified using the DNA hair traps).

Boulanger et al. (2003) investigate the efficiency of hair traps to sample bears and examine the biological causes of unequal capture probabilities in bear populations. It is expected that bears have individual capture probabilities based on sex, age, body size, reproductive status, home range size and recent live capturing (Boulanger et al. 2003). Their results suggest that sex and whether a bear was radio collared potentially affected capture probabilities at hair trap sites. Performing encounter rate analyses using the 1999 census data, Boulanger et al. (2003) estimated that 63% of bears that encountered hair traps were snagged, leaving behind a sample of hair, and that males encountered more traps than females. We emphasize that not all individual bears occurring within an area being sampled with barbed wire hair traps are snagged. Our summary, of one season of hair snagging data, highlights that there are certainly a compliment of individual grizzlies using the landscape around (and possibly within) the Cheviot mine lease in addition to the individuals that have been documented with radio telemetry. Future analysis of 2004 hair DNA data would allow us to determine genetic relatedness between collared and un-collared bears in the Cheviot area and in understanding grizzly bear distribution within the entire population unit.

2.4 Seasonal habitat quality and Grizzly bear diet in the Cheviot area

2.41 RSF modeling and habitat mapping

Maps depicting grizzly bear habitat quality are important management and conservation tools that allow managers to identify critical areas effectively. Many researchers have used GIS data and satellite remote sensing imagery to classify grizzly bear habitats (Mace et al. 1996, Mace et al. 1999, Carroll et al. 2000, Gibeau 2000, Franklin et al. 2001, Nielsen 2004). Land cover and landscape attributes are classified from GIS and remote sensing sources then grizzly bear selection for these attributes is modeled using Resource Selection Functions (RSF). RSF defines the probability of use of a resource unit (Manly et al. 1993) and facilitates statistical modeling of grizzly bear habitat (Mace et al. 1999, Boyce et al. 2002, Nielsen 2004). Empirically based habitat probability models are the most current, best available tools and have proven better at predicting relative occurrence of grizzly bears than traditional habitat effectiveness modeling (Nielsen et al. 2003).

Researchers with the Foothills Model Forest Grizzly bear Research Project have generated population level RSF models that are probability surfaces that reflect the relative attraction of a particular location to a bear. The RSF classifies land cover according to vegetation, elevation, slope, aspect, distance to edge habitats, terrain variables, anthropogenic feature etc. (Nielsen 2004) and assigns a selection coefficient to each polygon based on a comparison of the number of points predicted to randomly fall inside it, with the actual distribution of bear locations (Cranston 2004). Since resource selection varies by age, sex and season (Nielsen 2004), RSF maps have been generated separately for each sex and age group (adult female, adult male and sub-adult) and for each season (spring, summer, fall and mean annual). Mean annual habitat was ranked for each pixel across the map by averaging the 3 seasonal scores within sex-age groups. Nielsen (2004) found differences in habitat selection between sub-adult, adult male and adult female grizzly bears; therefore specific RSF models were generated for each.

The resulting RSF maps are categorized into 10 ordinal classes, providing a relative assessment of bear occurrence ranging from a low value of 1 (low relative probability of occurrence) to a high value of 10 (high relative probability of occurrence). For each seasonal RSF model of adult male and adult female bears (8 models total), we extracted a window within the BPU, which includes the Cheviot and Gregg/Luscar mine lease areas as well as a reasonable buffer (see Figure 2-9 as example). These spatial models will be provided to CRO as raster grid data sources for Arc View 3.2 (ESRI, 2002), for their benefit in future mine planning and spatial analyses.

We caution however, this RSF model does not accurately predict probability of grizzly bear use within the Gregg/Luscar Mine lease areas. The RSF model was designed at a population level to be applied over a large scale and therefore caution should be given in the use of this model for fine scale analysis and interpretation of mine activities. In the development of the RSF model, all pixels within the mine lease identified from the landsat image were described as active mining and a priori given a low RSF score of 1. The implications of this will be discussed further in the Gregg/Luscar analysis in section 3.0 of this report.

Managing habitat for adult female grizzly bears is a recognized priority by many resource management agencies. Female grizzly bears are the reproductive engine and their success is fundamental to sustaining populations for the long term (Knight and Eberhardt 1985, Mattson 1993, Boyce et al. 2001). Often too, managers will choose to focus conservation activities around the fall season (16 August to 15 October) as it is often considered the most critical foraging period for grizzly bears, as it corresponds with the ripening of berries (Nielsen 2004). We assess the annual and seasonal RSF models for adult female grizzlies and summarized results at two different scales. First we calculated the mean annual RSF score by individual watersheds identified across the BPU. Watersheds are often a scale used for regional bear management, as they typically approximate the size of an adult female annual home range (Gibeau 1998). We also calculated the percent area of high, moderate and low probability of grizzly bear occurrence (surrogate to habitat quality) within the Cheviot lease area. We performed an equal interval classification of the original 10-category models, to illustrate high, moderate and low habitat quality (see Figure 2-10 as example).

The Cheviot Mine lease area spans across two separate watersheds; the Upper Macleod 4 and the Cardinal (Figure 2-11). The mean annual RSF values for these two watersheds indicate that they are among some of the highest quality grizzly bear habitats across the BPU. The Upper McLeod 4 watershed, in which over two thirds of the Cheviot area occurs, is in the top three (of 27) highest mean annual RSF classifications.

The fall season RSF model for adult females illustrates eighty-three percent of the Cheviot lease area is considered high quality habitat (Table 2-10). This is the greatest percent area of high quality habitat when compared to all seasons. High quality habitat is noticeably concentrated in the western half of the permit area and decreases in quality towards the southeast boundary (see Figure 2-10). The spring has the largest area (3.4

percent) of low quality habitat across all seasons within the Cheviot lease area (Table 2-10).

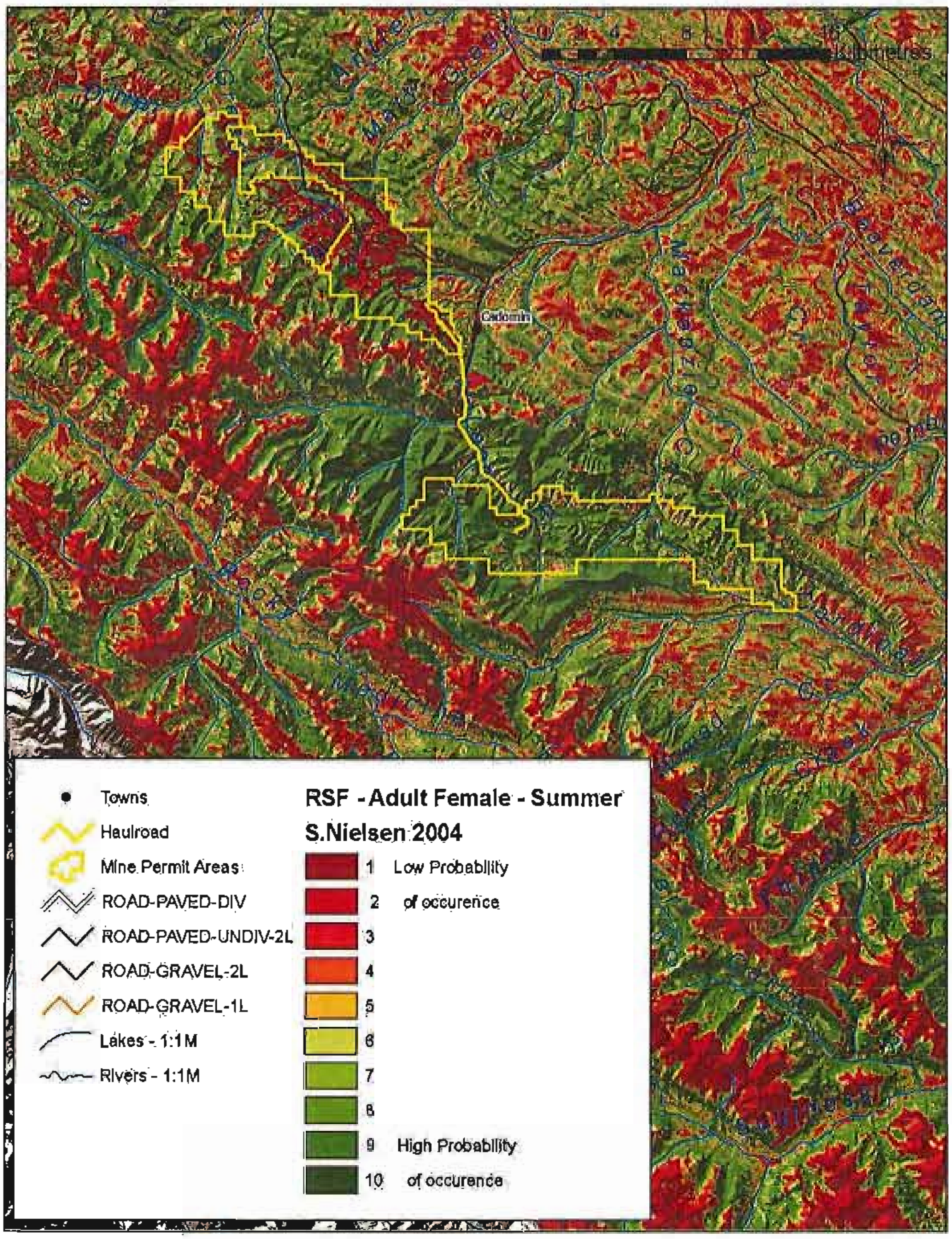


Figure 2-9. Resource Selection Function model for adult female grizzly bears in spring, classified in 10 categories ranging from low to high probability of grizzly bear occurrence.

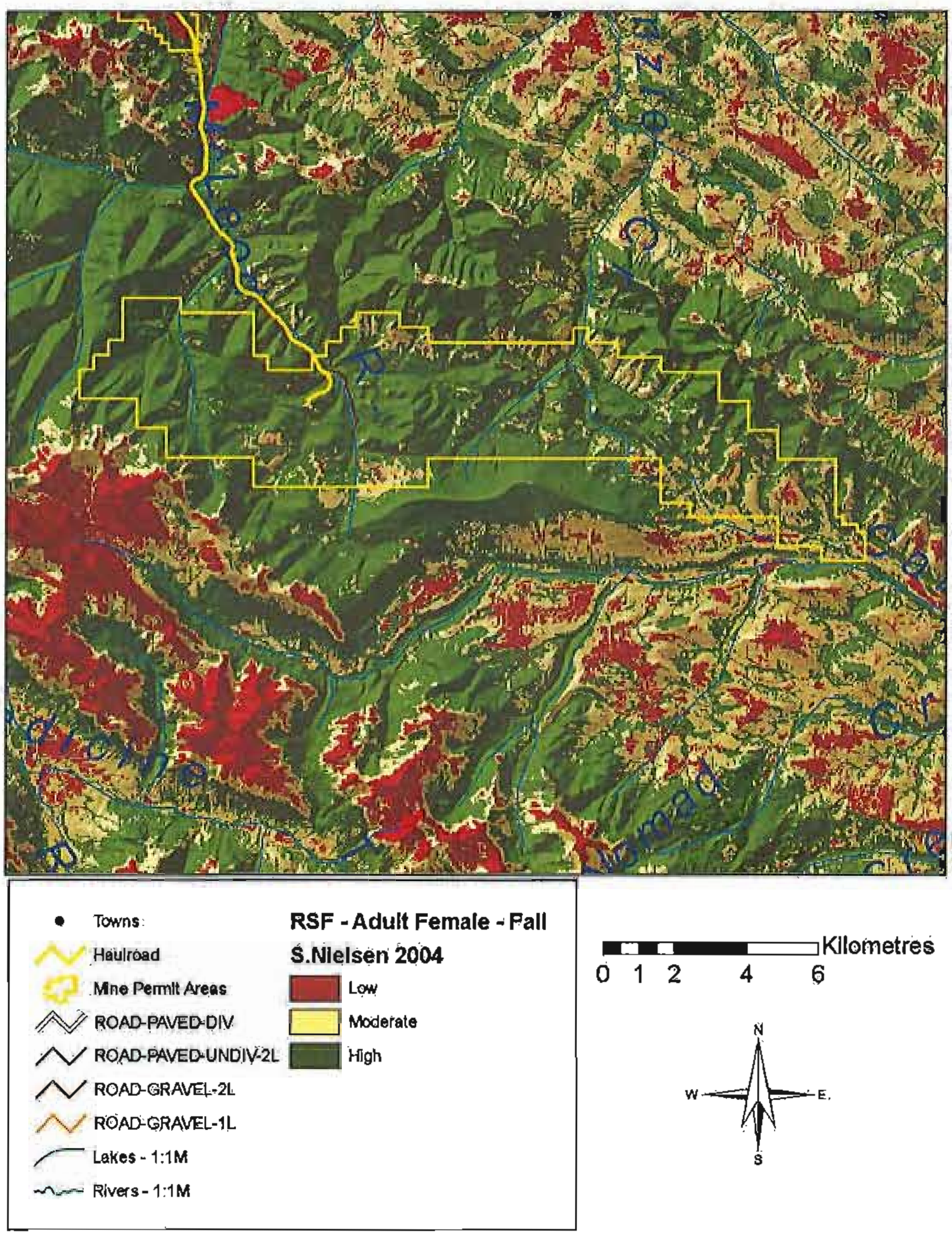


Figure 2-10. Low, moderate and high habitat qualities within the Cheviot lease area, developed from the re-classification of the adult female, fall season RSF model.

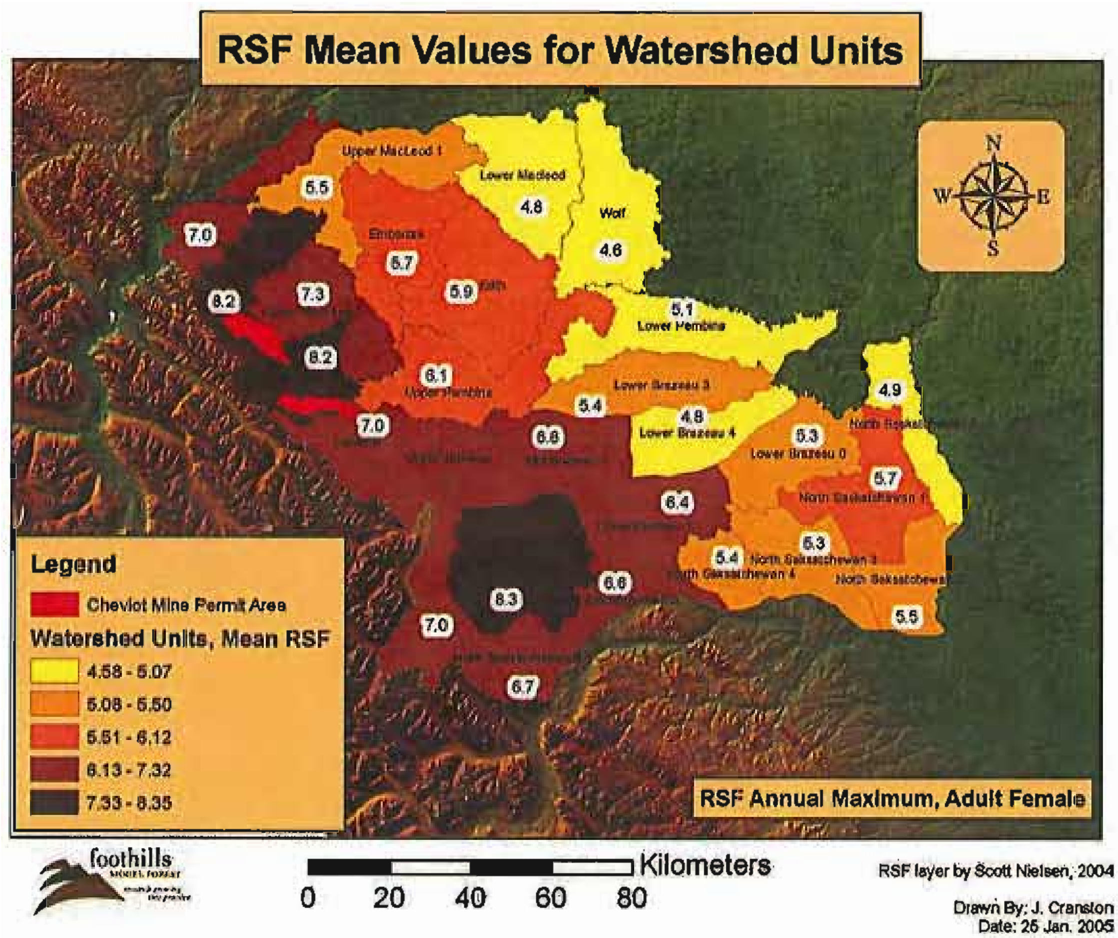


Figure 2-11. Mean annual RSF values across watersheds within the Bear Population Unit, summarized from the adult female RSF model.

Table 2-10. Percent of Cheviot Mine lease area categorized as low, moderate and high RSF habitat quality for seasonal and mean annual adult female models.

Season	Low	Moderate	High
Spring	3.44	23.49	73.08
Summer	1.32	17.81	80.87
Fall	0.71	15.89	83.40
Mean Annual	1.62	23.48	74.91

2.42 Diet analysis of Cheviot area Grizzly bears

Habitat use varies with the availability, distribution and abundance of preferred foods across seasons (Mattson et al. 1991, McLellan and Hovey 1995). The collection and analysis of fecal matter is one method to help quantify important food items in a bears diet for specific areas and various times of year. Between 2001 and 2003, researchers with the FMFGBRP collected scats from radio-collared grizzly bears during field investigations of GPS radiolocation sites. Scat samples were washed and filtered through screens to separate biomass. When possible, food items were identified, classified by species and percent volumes were estimated. Some researchers note that different foods are digested at varying rates and to different degrees. Meat and berries are more easily digested compared to vegetal items (Knight et al. 1992). To accommodate these different rates of digestion and accurately assess relative proportions of ingested items, correction factors (Hewitt and Robbins 1996) were applied to estimates of % volumes (Munro 2003).

We summarized diet results for male and female grizzlies (from Munro et al. in prep) whose home ranges overlapped the Cheviot lease area between 2001 and 2003. We categorized all the different identified food items into 9 classes and summarized their % volumes at three temporal scales (biweekly, seasonal and multi-annual). For biweekly analysis, scat samples were grouped, according to their estimated date of deposit, into 2-week periods between April 15 and October 15, consequently each monthly 2-week period is labeled 'early' or 'late' (Table 2-11). Seasonal analysis describes the average % volume for spring (15 Apr - 15 June), summer (16 June - 15 Aug) and fall (16 Aug - 15 Oct) scat samples (Table 2-12). Samples were also averaged across all seasons to summarize the multi-annual diet of bears according to food items (Table 2-12). We did not summarize diet differences among years because of the small sample sizes this division would have created.

We examined diet results for 7 Cheviot area bears, including 4 males (G008, G033, G055, G058) and 3 females (G003, G023, G035). A total of 230 scats, 115 each for males and females were identified. There were some obvious differences in seasonal diet selection between males and females. Most notably, males had a large percent of animal protein from early May through to early September (Figure 2-12a) compared to female diets where animal matter appeared at smaller volumes, primarily in May and early July (Figure 2-12b). Munro et al. (in prep.) comment that although their scat analysis was inefficient at distinguishing between different species of ungulates, their overall site investigations revealed the primary prey was moose (83%), particularly neonates (54%). Other prey species identified across all surveyed sites included deer, sheep, elk, rodents and birds (Munro et al. in prep). Other research shows that larger bears,, such as males, require meat to sustain their large body mass. Females are more able to meet their energy requirements on vegetative diets (Rode et al. 2001, Jacoby et al. 1999).

There was a significant proportion of roots in the diet of Cheviot area female grizzlies, especially from early May to late August, when their diet shifted to consuming a greater proportion of berries (Figure 2-12b). Males consumed roots also, largely up to late May and again in August, complementing a diet of berries through until early September (Figure 2-12a). The average dietary volume of roots across years for females was 39%, compared to 22% for males (Table 2-12). The unclassified food data indicates the predominant root species was sweet vetch (*Hedysarum* spp.) and predominant berries were buffaloberry (*Shepherdia Canadensis*) and mountain huckleberry (*Vaccinium membranceum*).

Grass and forbs occurred in the next highest proportions in both male and female seasonal diets. Green vegetation accumulated to nearly 25% of the average multi-

Table 2-11. Bi-weekly comparison of major food items (percent diet volume) contained within female (F) and male (M) grizzly bear scats collected between 2001 and 2003 (Munro et al. in prep).

Season	# Scats		Grass		Equisetum		Carex		Forbs		Berry		Roots		Insect		Animal		Misc.	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Late April	0	2	-	1	-	9	-	0	-	88	-	0	-	0	-	0	-	0	-	0
Early May	3	8	0	0	0	0	0	0	0	0	0	0	67	98	0	0	33	1	0	0
Late May	13	15	8	0	0	0	0	0	7	0	1	0	66	62	0	0	17	37	0	0
Early June	5	14	0	18	0	5	0	0	0	1	1	0	98	0	0	3	1	78	0	0
Late June	8	12	55	33	1	4	0	0	9	14	0	2	32	2	1	0	0	45	0	0
Early July	17	17	15	32	7	3	0	0	49	18	0	0	6	1	0	0	11	42	6	0
Late July	11	18	12	13	9	1	0	0	20	34	0	27	43	1	0	1	0	24	0	0
Early Aug	25	21	13	7	1	0	0	0	31	29	9	35	35	12	5	0	3	13	1	2
Late Aug	18	7	2	2	1	0	0	0	11	6	61	38	12	38	4	0	0	14	7	0
Early Sept	10	1	1	5	0	0	0	0	0	0	85	0	3	3	0	0	2	96	9	0
Late Sept	2	0	1	-	0	-	0	-	0	-	88	-	0	-	0	-	0	-	11	-
Early Oct	3	0	8	-	0	-	0	-	0	-	27	-	67	-	0	-	0	-	0	-

Table 2-12. Seasonal comparison of major food items (percent diet volume) contained within female (F) and male (M) grizzly bear scats collected between 2001 and 2003 (Munro et al. in prep).

Season	# Scats		Grass		Equisetum		Carex		Forbs		Berry		Roots		Insect		Animal		Misc.	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Spring	21	39	3	5	0	3	0	0	2	22	1	0	77	40	0	1	17	29	0	0
Summer	61	69	24	21	5	2	0	0	27	24	2	16	29	4	2	0	4	31	2	1
Fall	33	7	3	3	0	0	0	0	3	3	65	19	21	21	1	0	1	55	7	0
Annual Avg.	115	115	10	11	2	2	0	0	12	19	25	10	39	22	1	0	6	35	3	0

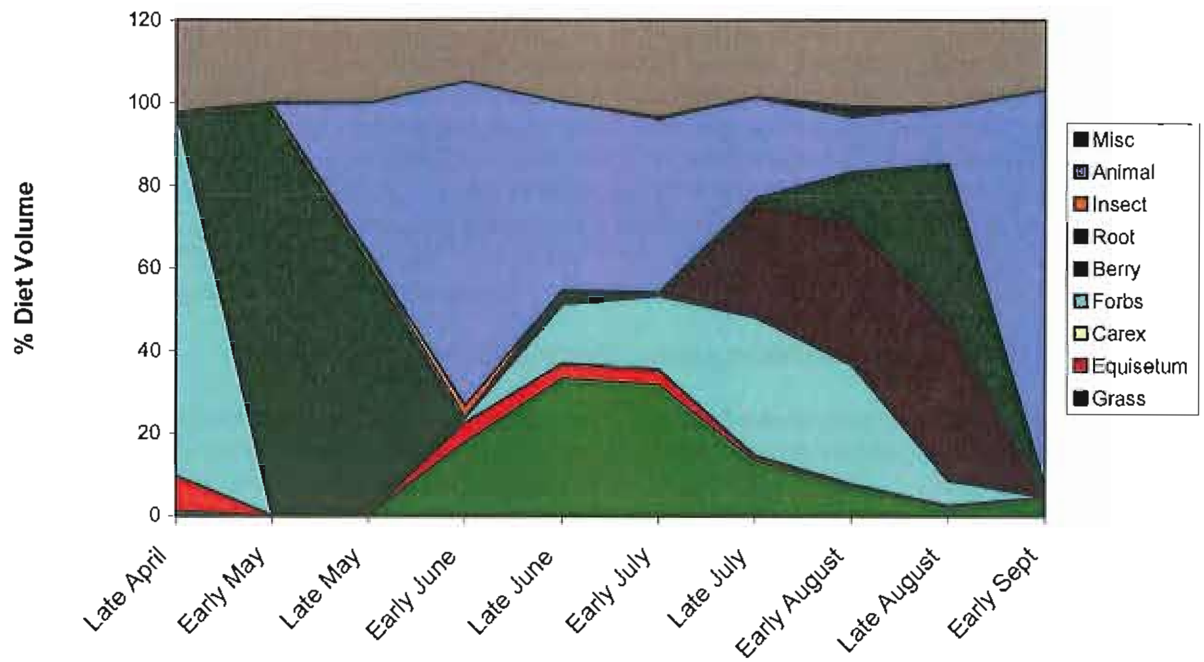


Figure 2-12a. Proportionate contribution of major food classes to bi-weekly diet volume of male grizzly bears in the Cheviot area, 2001-2003.

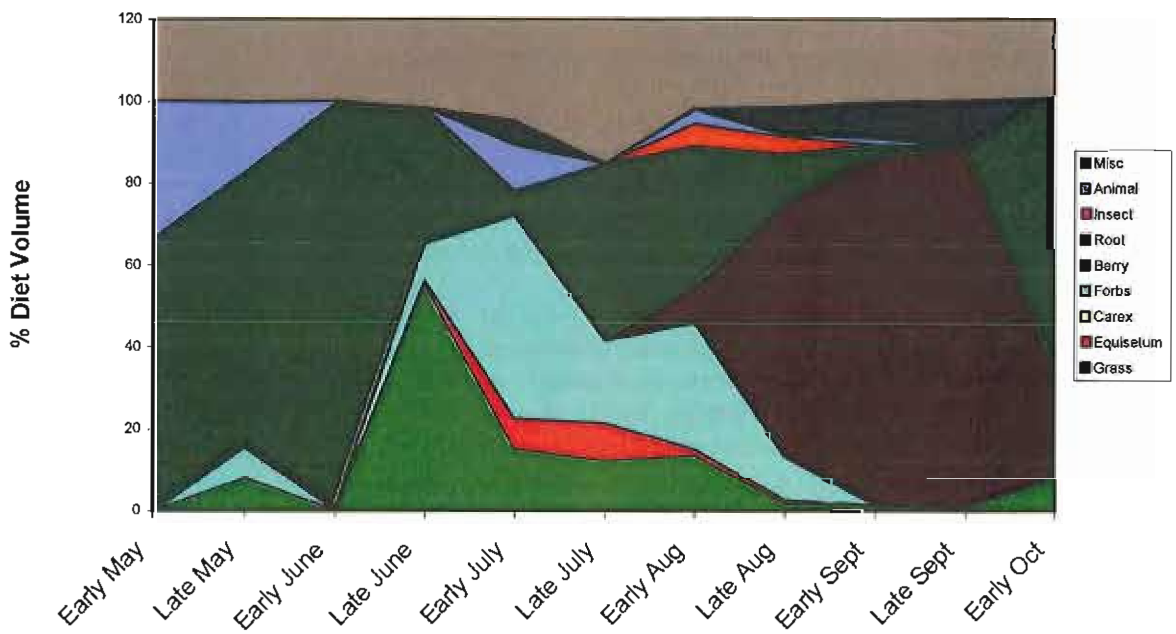


Figure 2-12b. Proportionate contribution of major food classes to bi-weekly diet volume of female grizzly bears in the Cheviot area, 2001-2003.

annual diet of female bears and berries another 25% (Figure 2-13a). The average multi-annual diet of male bears consisted of 32% green vegetation and 10% berries (Figure 2-13b). Predominant forb species included cow parsnip (*Heracleum lanatum*), clover (*Trifolium* spp.), peavine (*Lathyrus ochroleucus*) and alfalfa (*Medicago sativa*). The latter 3 species were observed prevalently on disturbed land; in clear cuts, roadsides, abandoned well sites and reclaimed mine slopes (Munro et al. in prep), all of which occur within the home ranges of the sample of bears. Overall, the diet analysis of Cheviot Mine area grizzly bears (male and female combined) between 2001 and 2003 averaged 30% roots, 21% animal, 18% berry, 15% forb and 11% grass (Figure 2-13c). The remainder 5% diet was split between equisetum, insect and miscellaneous.

2.5 Movement corridors across the Cheviot mine lease area

Human disturbances cause fragmentation of natural habitats resulting in smaller and more isolated wildlife populations. Fragmented populations are subjected to deleterious effects such as insularization, reduced population viability and loss of genetic variability (Wilcox and Murphy 1985, Oehler and Litvaitis 1996). The effects of habitat fragmentation are particularly evident in areas that are heavily influenced by human activity, where habitat persists only in patches within heterogeneous landscapes. To maintain connections between sub-populations, animals need to be able to move freely between habitat patches. This is largely the case with grizzly bears, as they require connections for movement on a daily to seasonal basis within home ranges and across large landscapes (Noss et al. 1996). However, movement between patches becomes compromised as different land uses (such as roads and industrial developments) limit the use of potential travel routes (Paquet et al. 1996). The loss of physical habitat compromises the connectivity of the landscape and reduces the ability of some animals to complete their daily requirements (Paquet et al 1996). Preserving movement corridors across fragmented landscapes is especially important for the long-term conservation of grizzly bear populations (Schwab 2003).

Researchers with the FMFGBRP (Schwab 2003) have developed models using Graph Theory Analysis to help identify corridors for grizzly bear movement across the landscape. Such tools aid our ability to predict bear movement and can allow resource managers to better plan road development and other activities in ways that can minimize impact to grizzly bear movement corridors and areas of good quality habitat.

Schwab (2003) developed a graph theory model, which describes landscape connectivity and movement paths for adult female grizzly bears. Graph Theory builds on remote sensing classified landscape habitats, where it identifies connections between individual patches of good quality grizzly bear habitat. These connections are established using a least-cost path model; least cost path is the path that takes the least amount of time, distance or effort, for a grizzly bear to travel from one area of quality habitat to another (Schwab 2003). Graph theory models can account for both structural connectivity (physical linkages between habitat patches) and functional (movement patterns and distances of movement paths between such patches) connectivity (Schwab 2003). GPS location points from adult female grizzly bears (without cubs) in 1999 and 2000 were used to build RSF habitat and graph theory models, while 2001 and 2002 GPS data were used for model validation. The RSF habitat model represented habitat quality averaged across all seasons for female bears. Overall results demonstrated that the graph theory landscape structure spatially and functionally does represent female

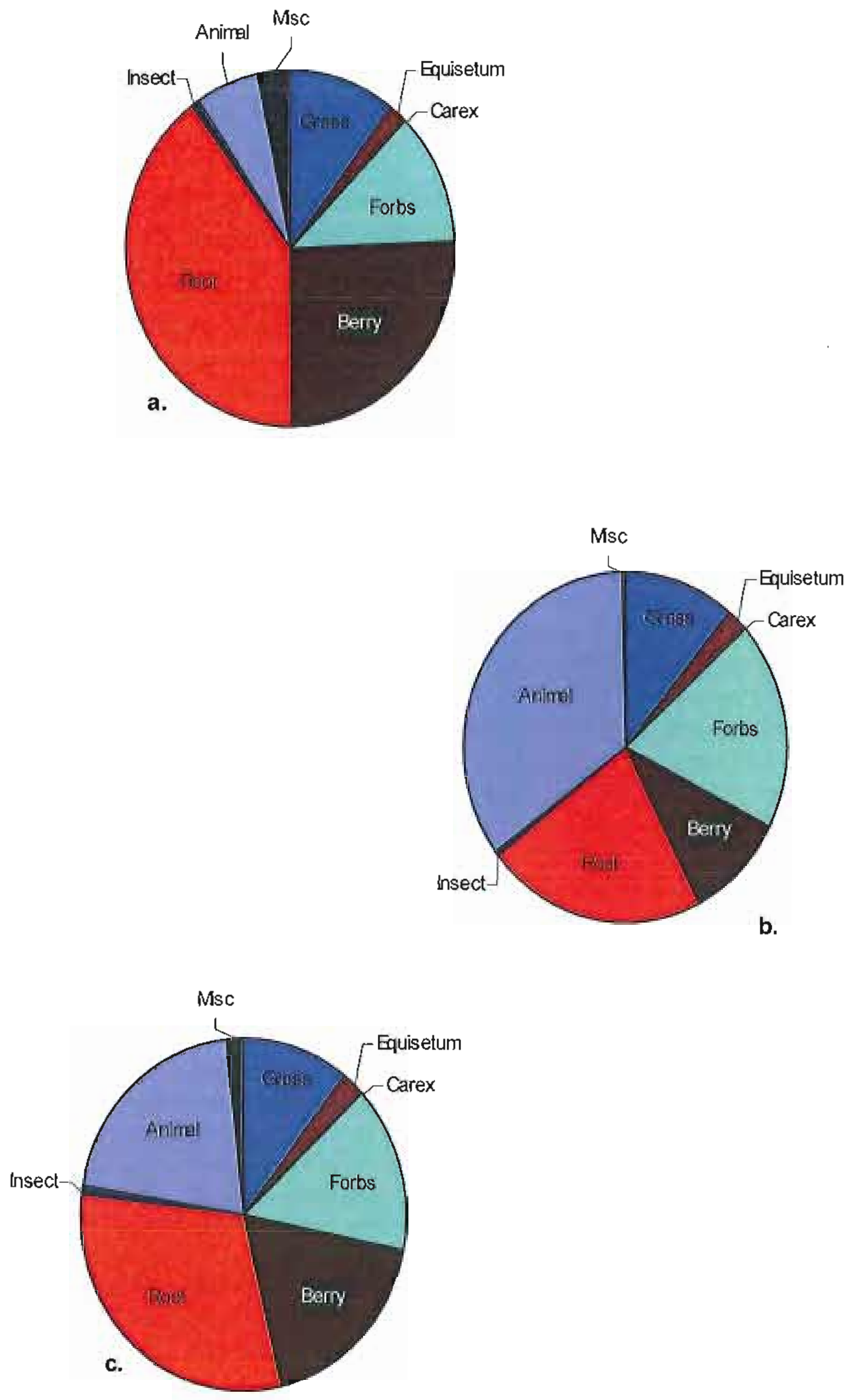


Figure 2-13. Proportionate contribution of major food classes to the total multi-annual diet volume of (a) female (b) male and (c) all bears combined, in the Cheviot area as determined by fecal analysis, 2001-2003.

grizzly bear data (movement and/or habitat use) within the FMFGBRP study area (Schwab 2003).

The resulting graph is comprised of straight-line connections. Thick lines represent connections with higher probabilities for movement between patches, while thin lines represent connections with lower probabilities. These straight-lines do not represent actual movement paths on the landscape; instead they are appropriate estimations for general movement and functional distance between habitat patches (Schwab 2003). We classified the original Graph Theory Model, using equal intervals into 3 categories; low, moderate and high probability of grizzly bear movement (Figure 2-14). We calculated 61km of movement corridors within the Cheviot lease area boundary. Figure 2-14 illustrates that there is an inclination for bears to cross the Cheviot area to access habitats along the east boundary of Jasper National Park, the Redcap range and further east into the foothills. This large amount of grizzly bear movement to habitats on both east and west sides of the Cheviot lease area emphasizes the importance of these areas to bears and consequently the importance for their access to these habitats.

In trying to interpret what bear behaviors are modeled with the graph theory approach, Schwab (2003) emphasizes that the model includes aspects of both general foraging or habitat selection and movement behaviors specific to female grizzlies. Schwab (2003) found that the iterative removal of habitat patches was shown to affect both spatial dispersal patterns and resulting connectivity rates. As habitat patches were removed from the home range a bear's ability to traverse the landscape was shown to decrease. However, this was dependant on habitat patch size and placement within the landscape (Schwab 2003). According to Rosenberg et al. (1997) and Beier and Noss (1998), habitat loss and fragmentation are among the most pervasive threats to grizzly bear population viability. Because grizzly bears are long living with large home ranges, they are sensitive to the cumulative impacts of human activity and development and it is particularly important that access and connectivity be maintained for travel and habitat accessibility.

The graph theory model as presented could be a useful analytical tool for conservation planning. The model has the ability to identify habitat patches and movement paths most sensitive to development within the study area landscape (Schwab 2003). This model of movement corridors could be useful in planning for mine site developments. Planners could either preserve identified functional corridors, or if disturbance is inevitable they could plan to avoid mass disturbance to multiple corridors in the same area at the same time. Studies on corridors and habitat fragmentation emphasize that it is easier to maintain existing corridors than to re-create them once they have been lost (Noss et al. 1996, Paquet et al. 1996). Priority should be given to conserve natural corridors and the habitat patches they connect to ensure the ecological integrity of the area is sustained over the long-term.

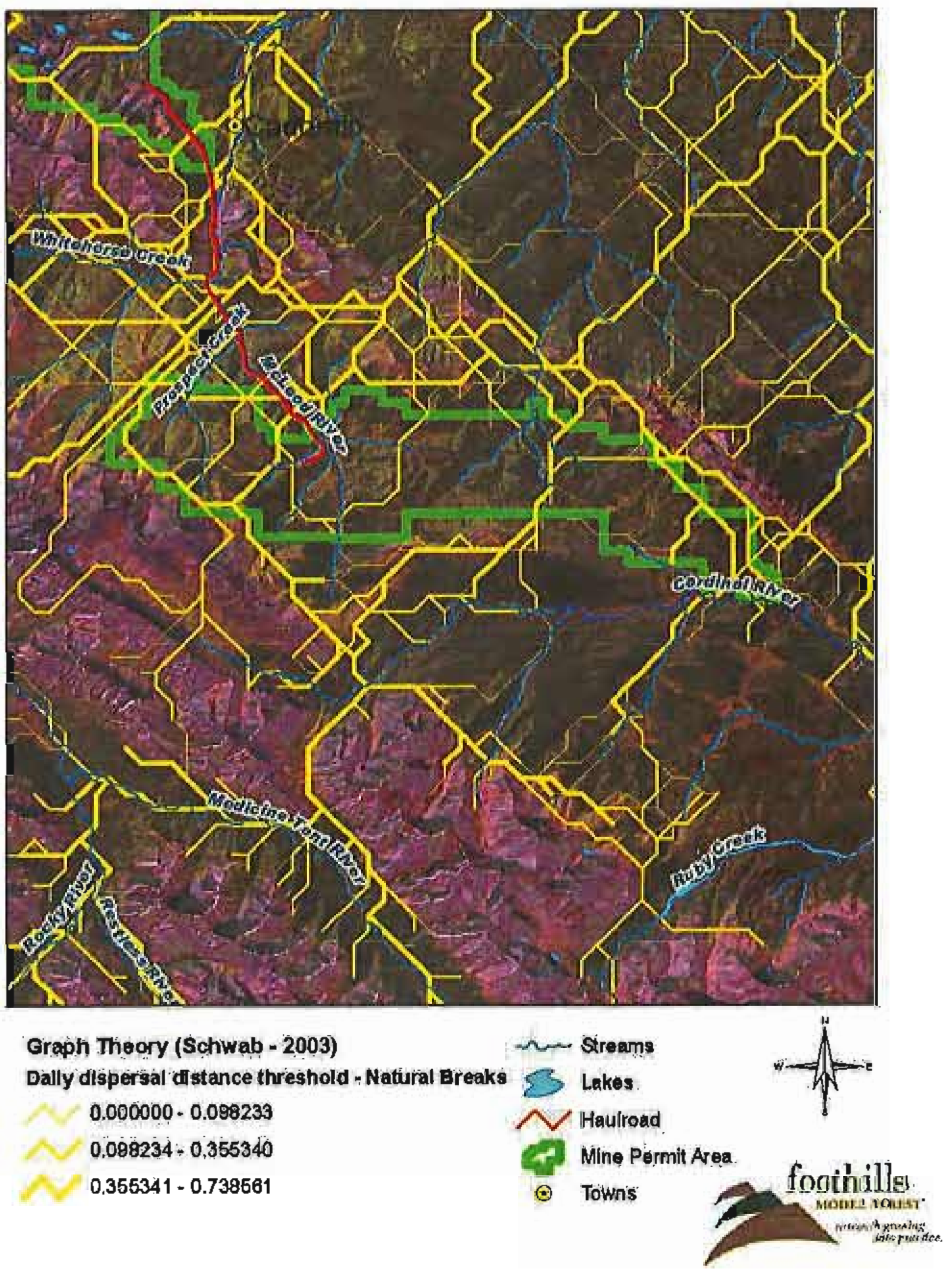


Figure 2-14. Graph Theory model illustrating paths of low, moderate and high probability of grizzly bear movement corridors across the Cheviot lease area.

2.6 Conclusion

We have analyzed and summarized data obtained from 6 years of grizzly bear research conducted by the FMFGBRP, across the landscape within and around the Cheviot mine lease area (pre-develepoment). The intention of this summary was to provide an understanding of grizzly bears and their use of the Cheviot area, preliminary to mining development and activities. Some of the foremost conclusions from our analyses are that grizzly bears in this area have average annual home ranges almost half the size of their neighboring population in the Bow River Watershed to the south. The Eastern Slopes Grizzly Bear Project reports that annual home range size for adult females is 520km^2 (Gibeau and Stevens 2003), compared to 297km^2 for females across this study area. Similarly, adult males in the East Slopes average 1405km^2, compared to 976 km^2 in our sample. Smaller home range sizes may indicate that bears in the Cheviot area do not have to travel as far to access high quality habitats to meet their energetic demands. Our analysis of habitat quality from RSF modeling across the Cheviot lease area certainly indicates that much of the land within the Cheviot lease area is of high habitat quality for bears, most notably in the fall. Habitat quality as determined from the RSF model speaks to all resources used by bears including vegetation, ungulates/carcasses, human activity etc. High habitat quality as defined by the RSF model relates to a high probability of grizzly bear occurrence based on the presence of a combination of resources. Our results substantiate that bears using the Cheviot area are spending the greatest proportion of their time within the permit area during the fall compared to other seasons. Further research identifying presence and location of bear foods in the area, including seasonal ungulate counts, would be useful in managing important seasonal habitat patches for bears.

Given the high RSF values (ie. high probability of grizzly bear occurrence) within the Cheviot area, we emphasize the importance of minimizing potential for human caused mortality during and post mine development and operations. This may involve adapting speed limits to vehicle traffic, restricting human access/use of the landscape within the mine lease and curtailing the use of firearms.

In analyzing road crossings of the Grave Flats road, pre haul road development, we can substantiate that bears did move across during day and night. We were unable to correlate these crossings with levels of human use along the road in the absence of detailed human use data or speculate how bears adapt their crossing behavior to changes in traffic volume. We emphasize that grizzly bear data was not gathered over the past 6 years for this specific project nor with these specific questions in mind. To answer some of these important questions, a rigorous study design with relevant bear and human use data must be collected.

We summarized denning characteristics from known den sites in the area, which may assist mine planners in identifying possible denning habitats and mitigate development or activities that may conflict with these sensitive areas. Our diet summary from fecal analysis indicates that ungulates are a significant food item in the diet of bears across this area. Managing for ungulates and their habitats could be beneficial to sustaining bear populations in the area. Some of the other specific food items preferred by bears, particularly some species of forbs and fruit could guide re-vegetation standards in pit reclamation.

DNA analysis of hair samples obtained through hair snagging studies is a useful and non-invasive way to monitor grizzly bear activity across an area. Our summary of just one season of hair capture data shows that there is a significant proportion of the grizzly bear population not radio-collared and who are using the local landscape.

We have also provided CRO with several scientifically vetted models that could be applied in their mine planning process to help mitigate impacts of development on grizzly bears and their habitats. These models include seasonal RSF habitat models, mortality risk models and grizzly bear movement corridor models.

3.0 GRIZZLY BEAR USE OF THE GREGG RIVER AND LUSCAR MINE AREAS

In this section, we compiled and summarized data on grizzly bears that used the Gregg River and Luscar Mine areas between 1999 and 2004. Unless specified, the analytical methods in this chapter are the same as in corresponding sub-sections in the preceding Cheviot chapter (section 2.0 in this report).

Although we make some comparisons of grizzly bear ecological parameters between the Cheviot (no mining) and the Gregg/Luscar (active mining) sites, we caution the reader that any differences in bear use are not necessarily attributed to mining versus non mining activity. The two study areas are distinctly different in habitat and differences in bear activity could be a function of the different resources bears have access to.

3.1 Geographical range and physiological characteristics of Grizzly bears

3.11 Home ranges

We identified radio-collared grizzly bears occurring annually within the Gregg River and Luscar mine lease areas. For each bear we calculated annual home ranges by means of the 95% fixed kernel technique with an adhoc smoothing parameter, using the Animal Movement Extension (Hooge and Eichenlaub, 1997) for ARCVIEW GIS (ESRI Inc.). Between 1999 and 2004, 35 annual home ranges overlapped or bordered the Gregg/Luscar lease area. Bears from each cohort were identified, including 13 adult female, 13 adult male, 7 sub-adult female, and 2 sub-adult males (Table 3-1). These were all represented by 8 individual female bears and 8 individual male bears. Adult bears were defined as 5 years old or older while radio tracking, while sub-adult bears were defined as those being 2-4 years old.

Adult female bears displayed the smallest average home range size ($\bar{x}$ = 235km^2, SD=165, *n*=13) while adult males had the largest average home range ($\bar{x}$=1071 km^2, SD=555, *n*=13), sub-adult female home ranges averaged 339 km^2 (n=7, SD=246) compared to sub-adult males ($\bar{x}$ =616 km^2, SD=483, *n*=2).

Female grizzlies with yearlings averaged the largest home range size ($\bar{x}$=360 km^2, SD=160, *n*=3) compared to females without cubs ($\bar{x}$=282 km^2, SD=181, *n*=5) or females with coy ($\bar{x}$=113 km^2, SD=52, *n*=5).

Home range sizes of grizzly bears in the vicinity of Gregg/Luscar were very similar to those in the Cheviot area (Table 3-2). Adult female ranges and females with cub ranges were on average smaller in the Gregg/Luscar area. These findings imply that resources for the bears monitored in the areas surrounding the Gregg/Luscar mine may be comparable to those for the bears monitored in the Cheviot area.

3.12 Body condition

Body condition index (BCI) of grizzly bears as measured by length to weight ratios provides insights into food energy consumption as well as landscape quality. Higher BCI values imply that bears are ingesting and benefiting from higher quality food sources.

Table 3-1. Demographics and annual home range size of bears using the Gregg/Luscar Mine lease area between 1999 and 2004.

Year	Sex/Age class	Bear ID	Home Range Area (km^2)	Reproductive Status
1999	Subadult Female			
		020	265	n/a
	Adult Male			
		029	295	n/a
		008	1018	n/a
		017	864	n/a
2000				
	Adult Female	020	538	0
		023	189	1 yrlg
	Adult Male	014	1680	n/a
		017	1042	n/a
		024	1808	n/a
		029	1684	n/a
2001				
	Subadult Female	036	833	n/a
		040	110	n/a
		100	264	n/a
	Adult Female	004	48	1 coy
		020	120	2 coy
		023	189	2 coy
		038	238	0
	Adult Male	024	1417	n/a
		017	305	n/a
		029	1598	n/a
2002				
	Subadult Female	037	445	n/a
		040	330	n/a
		100	129	n/a
	Adult Female	020	507	2 yrlg
		023	384	2 yrlg
	Adult Male	008	467	n/a
		017	466	n/a
		054	1282	n/a
2003				
	Adult Female	037	32	0
		040	84	1 coy
		100	312	0
		023	124	1 coy
	Subadult Male	055	274	n/a
		058	957	n/a
2004				
	Adult Female	100	291	0

Table 3-2. Comparisons of mean annual home range size (km^2) between grizzly bear cohorts in the Gregg/Luscar and Cheviot areas.

	Gregg/Luscar		Cheviot	
Cohort	Mean (km^2)	N	Mean (km^2)	N
Adult Female	235	13	297	17
Adult Male	1071	13	976	8
Subadult Male	616	2	442	4
Subadult Female	339	7	n/a	n/a
Female with no cubs	282	5	252	8
Female with yearlings	360	3	194	3
Female with cubs of year	113	5	123	5

Between 1999 and 2004 we identified 33 capture episodes of bears that used the Gregg/Luscar lease area and we obtained BCI data from 27 of those captures. There were 17 capture episodes of female bears, 14 of which provided BCI data. The BCI for female bears ranged between –0.89 and +2.03 (Table 3-3). Adult females without cubs had a lower average BCI (BCI= -0.1286, N=3) compared to females with cubs (BCI = -0.0159, N=5).

The average BCI for female bears captured in the spring was +0.1481 (N=11) compared to bears captured in the summer/fall (BCI= +1.3284, N=3). This difference is reasonably expected, as body condition is poorest near the time of den emergence.

We obtained BCI data for 13 of 16 spring captures of male bears using the Gregg/Luscar lease area; values ranged between –1.0426 and +2.6438 (Table 3-3). Adult males show a higher average BCI (+1.3538, N=11) compared to sub-adult males (BCI= 0.3177, N=2).

On average, BCI values for bears in the Gregg/Luscar area were higher than bears in the Cheviot area. Average BCI for 14 female grizzly bears in the Gregg/Luscar was +0.401, compared to the average BCI value of –0.181 for 13 female grizzly bears in the Cheviot area. Average BCI for male grizzlies (+1.194, n=13) were also higher in the Gregg/Luscar area than in the Cheviot area (+0.539, n=10). These results may be attributed to the diet of bears in the Gregg/Luscar area (see section 3.43), where it is apparent that bears in the Gregg/Luscar area are consuming 2.5 times more animal protein than bears in the Cheviot area.

Table 3-3. Capture information and body condition indices for grizzly bears using the Gregg/Luscar area between 1999 and 2004.

Sex	Bear ID	Capture Date	Age	BCI	Reproductive Status
Females	004	5/26/01	7	-0.7859	1 coy
	020	6/13/99	4	no data	n/a
	020	4/11/00	5	-0.8875	0
	020	10/20/00	5	1.4867	0
	020	10/19/01	6	no data	2 coy
	023	4/28/00	11	0.0864	1 yrlg
	023	10/4/01	12	2.0317	2 coy
	023	5/22/02	13	0.6518	2 yrlg
	036	5/5/01	3	-0.2115	n/a
	037	5/20/02	4	0.1998	n/a
	037	5/16/03	5	0.9354	0
	038	5/12/01	15	no data	0
	040	5/17/01	3	-0.3430	n/a
	040	4/30/02	4	1.3139	n/a
	100	5/18/01	3	1.1030	n/a
	100	7/10/02	4	0.4669	n/a
	100	5/10/03	5	-0.4338	0
Males	029	5/11/99	12	-1.0426	n/a
	029	5/18/00	13	1.2968	n/a
	029	4/27/01	14	0.4267	n/a
	008	5/14/99	14	no data	n/a
	008	5/9/02	17	2.5686	n/a
	017	5/28/99	7	no data	n/a
	017	5/23/00	8	1.9873	n/a
	017	5/8/01	9	1.8295	n/a
	017	5/2/02	10	2.6438	n/a
	014	5/16/00	10	2.1915	n/a
	024	5/9/00	6	-0.0354	n/a
	024	5/4/01	7	no data	n/a
	054	5/28/02	4	0.8113	n/a
	054	9/22/02	4	2.2145	n/a
	055	5/19/03	4	0.4620	n/a
	058	5/31/03	3	0.1734	n/a

3.13 Blood chemistry

We assessed blood DNA results from 2000-2003 to determine parent/offspring or sibling relationships.

Figure 2-1 illustrates a family schematic diagram showing the genetic relationships of bears in the two study areas (Cheviot and Gregg/Luscar). The left hand column describes the birth year of the individual. The diagram also shows the number of loci that match parent, offspring or siblings, birthdate of cubs of the year (coy) and known deaths. For some bears that were identified using the mine permit areas, their genotyping was not successful in identifying a relationship to any other known bear and therefore they do not appear in Figure 2-1.

Of the 8 females using the Gregg/Luscar area, one adult (G038) and two sub-adults (G040, G037) were not related to any other known male or female grizzly in the BPU study area. There were two adult males (G024, G029) and two sub-adult males (G055, G058) who did not share any genetic relatedness with any other known grizzly bear in the BPU study area.

3.14 Mortality

There were 7 known mortalities of grizzly bears documented as having used the Gregg/Luscar lease area between 1999 and 2004 (Table 3-4). None of these mortalities occurred within the mine permit boundary. Four bears were killed illegally (3 males and 1 female), an adult male and sub-adult female were legally hunted and a vehicle hit one male. Illegal mortalities account for almost half (48%) of all known mortalities across the BPU. Legal hunting of bears was the second most common cause of bear mortalities within the BPU (19%). Seventy-one percent of mortalities of bears that were known to have used the Gregg/Luscar area occurred within high quality habitats; similarly the majority (60%) of mortalities of bears not associated with mines within the BPU were killed in high quality habitat. The majority (71%) of mortalities of Gregg/Luscar area bears occurred within 250m of a road and all human caused mortalities within the BPU occurred within 150m of a road.

3.15 Mortality risk

Using the 10-bin mortality risk model developed by Nielson et al. (2004) (Figure 2-3), we reclassified mortality risk across the Gregg/Luscar Mine permit area into categories of low, moderate and high (Figure 3-1).

As discussed in section 2.15, this mortality risk model was developed at a broad population scale, meaning that all the known grizzly bear mortalities for the 10,000 km2 FMF study area, along with a random generation of data points across the same area were used to develop and validate the model. Based on this data, the predictive probability of bears dying was characterized by landscape and human access parameters across the entire FMF area. Consequently, the risk model as it appears in Figure 3-1 does not take into consideration the probability of bear mortality according to any human use restrictions enforced within Gregg/Luscar Mine lease area. Issues such as the restricted public access, hunting bans and reduced likelihood of poaching

Table 3-4. Summary of grizzly bear mortalities (1999-2004) of Gregg/Luscar area bears and bears within the Bear Population Unit.

	Name	Sex	Age Class	Date	Season	Cause of Death	Habitat Quality	Nearest Road (km)	Road Type
Gregg/Luscar									
	G024	M	adult	10/25/01	fall	illegal	Moderate	0.224	Gravel1L
	G029	M	adult	5/28/02	spring	legal hunted	High	0.003	Truck trail
	G036	F	subadult	5/27/02	spring	legal hunted	High	0.008	Truck trail
	G020	F	adult	9/20/02	fall	illegal	Moderate	0.056	Paved Undivided
	G054	M	adult	10/12/02	fall	road kill	High	0.357	Gravel2L
	G017	M	adult	9/13/03	spring	suspected illegal	High	0.227	Truck trail
	G014	M	adult	10/15/01	fall	suspected illegal	High	1.866	Gravel2L
BPU									
	GUNK002	F	coy	10/21/99	fall	road kill	Moderate	0.068	Gravel2L
	GUNK001	F	adult	9/11/99	fall	illegal	High	0.044	Unimproved Road
	GUNK005	F	adult	5/24/00	spring	illegal	High	0.016	Gravel2L
	GUNK004	M	coy	5/24/00	spring	illegal	High	0.11	Gravel2L
	G046	M	subadult	5/27/01	spring	natural	Low	0.32	Gravel2L
	G026	F	adult	10/19/00	fall	unknown	Low	0.027	Gravel1L
	G015	M	adult	5/16/99	spring	research	High	n/a	n/a
	G011	F	adult	7/15/02	summer	research	Moderate	n/a	n/a
	G105	F	subadult	9/28/02	fall	illegal	High	0.005	Gravel2L
	G057	F	adult	7/17/03	summer	unknown human	High	0.004	Gravel1L
	GUNK003	F	adult	10/01/00	fall	illegal			
	G102	F	subadult	5/16/01	spring	legal hunted			
	GUNK011	F	adult	9/24/99	summer	illegal			
	GUNK012	F	unk	5/31/00	spring	legal hunted			

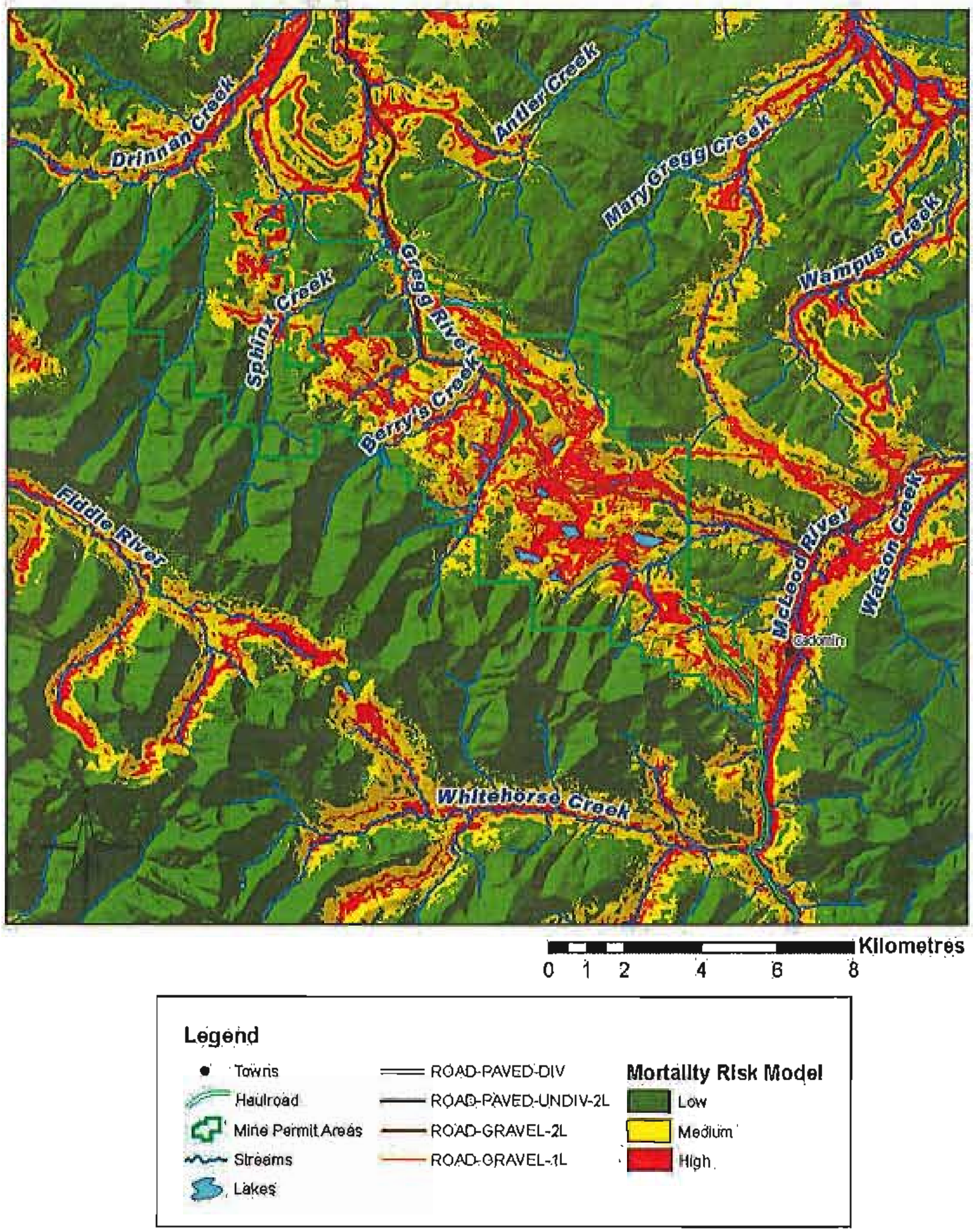


Figure 3-1. Areas of low, moderate and high probability of mortality within the Greg/Luscar Mine lease area.

because of presence of mine personnel are all potential controls that may reduce mortality risk to bears within the lease area.

Without considering any management attributes that reduce mortality risk within the Gregg/Luscar lease area, the mortality risk model (Figure 3-1) identifies 37.7% of the area as low mortality risk to bears, 38.2% moderate probability of mortality and 24.1% high probability of mortality. However, since development of this risk model, mining operations have shifted away from active mining to reclamation of disturbed areas and road deactivation. These actions directly influence the habitat and access parameters within the model, which will be significant factors in the reduction of mortality risk to bears.

3.2 Seasonal and annual Grizzly bear movements

3.21 Seasonal home ranges

Habitat associations are strongly seasonal and typically reflect local phenology (Ross 2002). The size of the home range is extremely dynamic and varies from one geographic region to another, from one year to another, and one season to another. In this analysis we summarize seasonal home ranges of bears specific to the Gregg/Luscar and Cheviot regions to best understand bear use of the area across seasons.

Using grizzly bear telemetry data from 1999-2004, we calculated seasonal 95% fixed kernel home ranges, using the Animal Movement Extension (Hooge and Eichenlaub, 1997) for ARCVIEW GIS (ESRI Inc.). We stratified data into three seasons (spring, summer and fall) between May 1 and October 15. Nielsen et al. (2004) describes the spring season as the period occurring from 1 May to 15 of June, the summer season from 16 June to 15 August and the fall season from 16 August to 15 of October, each season defined from food habits and selection patterns for the region. We delineated 89 seasonal ranges for 8 individual female and 9 individual male bears using the Gregg/Luscar lease area over the 6-year period. Figure 3-2 and 3-3 are two examples of annual and seasonal home ranges we generated for each study animal (see report supplement document for all bear home range maps). We analyzed the size (km^2) differences between seasonal home ranges, summarized seasonal variations in grizzly bear movements and the percent of each annual home range that overlapped the Gregg/Luscar lease area and also the Cheviot mine area when a bear occupied both areas in one year. For some bears, a seasonal home range was not calculated because of insufficient location data (ie. dropped or malfunctioning collar), these are indicated in Table 3-4 as having 'no data'.

Seasonal home range sizes for female grizzlies ranged between 856 km^2 and 11 km^2 (Table 3-5). Average summer home range size for females ($\bar{x}$=203km^2, SD=153, n=19) was larger than both female spring home range size ($\bar{x}$=189km^2, SD=147, n=17) and fall home range sizes ($\bar{x}$=195km^2, SD=168, n=14). Seasonal home range sizes for males ranged between 2253 km^2 and 17 km^2. Average summer home range size for males ($\bar{x}$=980km^2, SD=528, n=12) was largest compared to spring home range size ($\bar{x}$=579km^2, SD=461, n=15) and fall home range size ($\bar{x}$=441km^2, SD=608, n=12).

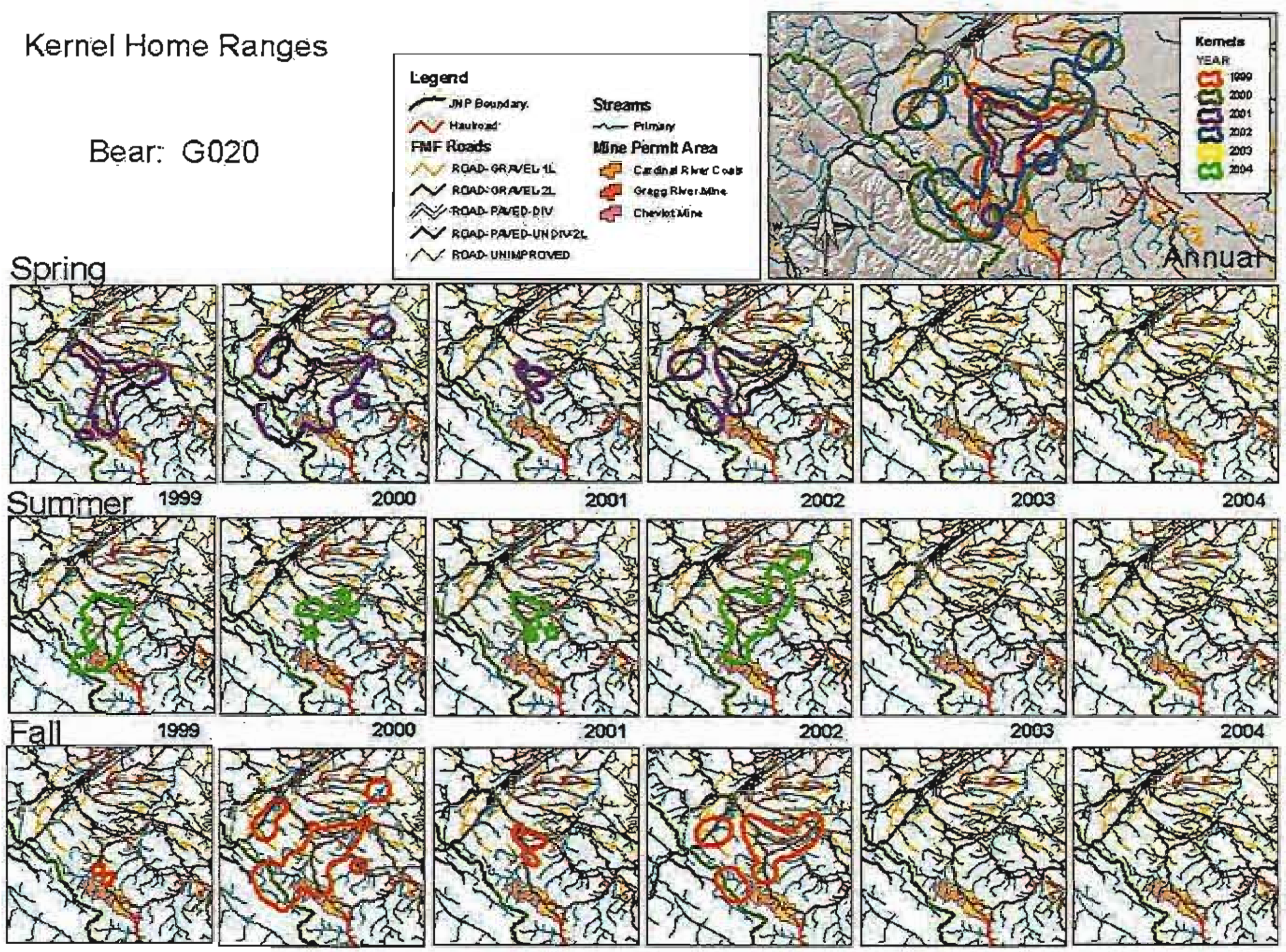


Figure 3-2. Annual and seasonal home ranges for and adult female grizzly bear using the Gregg/Luscar Mine lease area. (No data exists where windows do not illustrate a home range boundary)

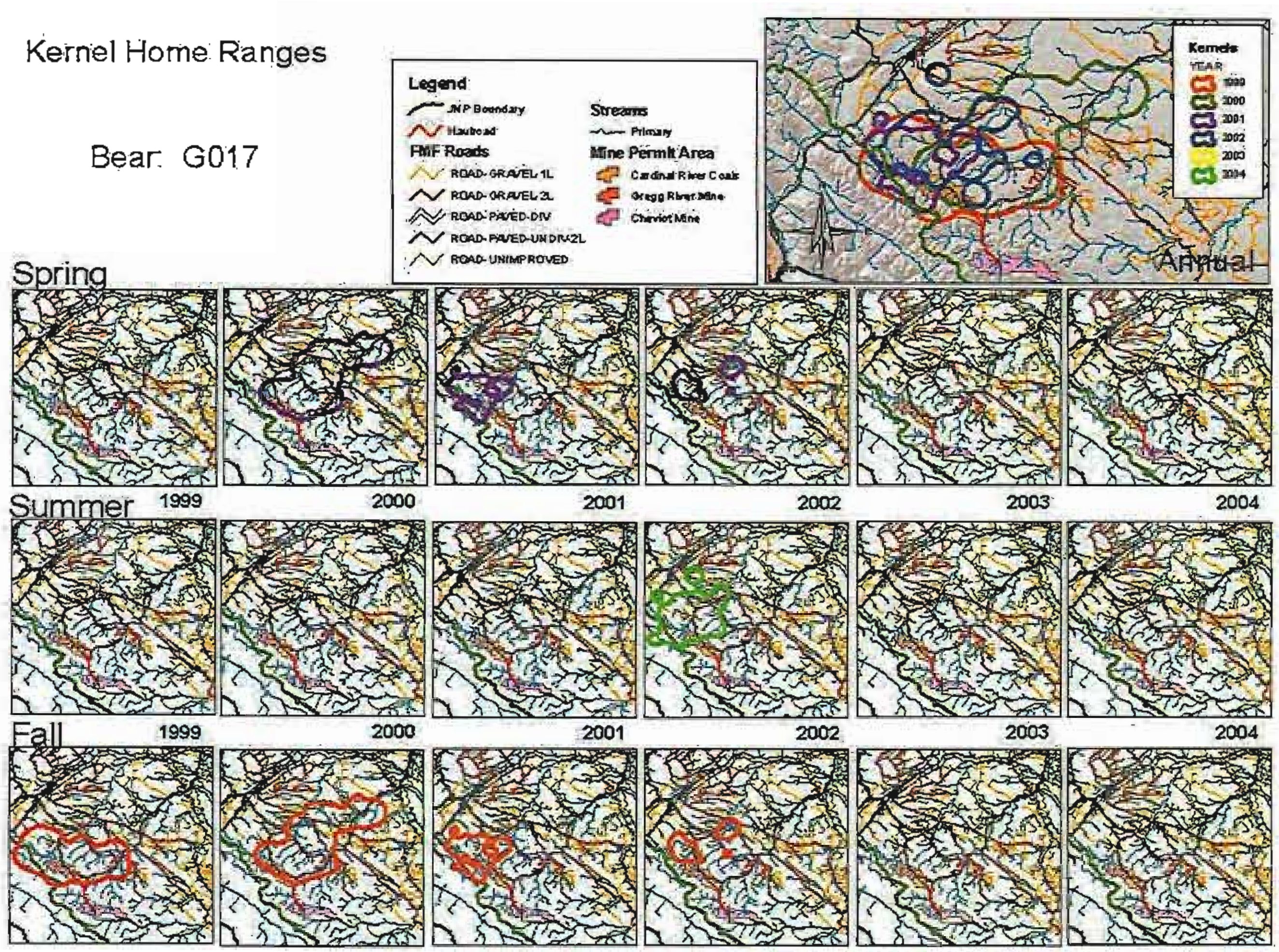


Figure 3-3. Annual and seasonal home ranges for an adult male grizzly bear using the Gregg/Luscar Mine lease area. (No data exists where windows do not illustrate a home range boundary)

Table 3-5. Seasonal home range sizes of grizzly bears occupying the Gregg/Luscar lease area between 1999 and 2004.

Bear ID	Sex	Year	Spring (km^2)	Summer (km^2)	Fall (km^2)
004	F	2001	28	70	11
008	M	1999	701	838	255
		2002	231	856	169
014	M	2000	1869	1079	190
017	M	1999	864	no data	no data
		2000	1042	no data	no data
		2001	305	no data	no data
		2002	186	642	17
020	F	1999	16	243	255
		2000	543	73	no data
		2001	55	81	no data
		2002	402	342	no data
023	F	2000	216	335	87
		2001	no data	191	163
		2002	236	320	192
		2003	67	74	90
024	M	2000	511	1343	2253
		2001	215	2098	148
029	M	1999	340	213	112
		2000	562	862	216
		2001	413	1474	661
036	F	2001	124	612	592
037	F	2002	274	329	523
		2003	no data	32	no data
038	F	2001	179	192	51
040	F	2001	45	118	140
		2002	170	354	95
		2003	37	55	166
054	M	2002	429	927	223
055	M	2003	67	196	320
058	M	2003	953	1226	733
100	F	2001	336	226	225
		2002	no data	15	no data
		2003	245	190	141
		2004	245	no data	no data

We documented 35 annual home ranges that overlapped the lease area between 1999 and 2004 (Table 3-6). There were 2 female and 4 male grizzlies whose annual home range overlapped both mine lease areas. Female annual home range overlap with the Gregg/Luscar mine lease area ranged between 63 percent and 0.5 percent, with an average of 20 percent (N=20). The average male annual home range overlaps the Gregg/Luscar mine lease area by 6 percent (N=15), with a range between 18 percent and 0.2 percent.

Table 3-6. Percent of total annual home range overlapping the mine lease areas for Gregg/Luscar area grizzly bears (1999-2004).

Bear ID	Year	Total HR Area (km2)	% Gregg/Luscar Overlap	% Cheviot Overlap
G004	2001	48	1.85	1.72
G008	1999	1018	8.42	5.53
G008	2002	467	8.27	5.03
G014	2000	1680	4.32	0.00
G017	1999	864	8.85	0.00
G017	2000	1042	5.38	0.00
G017	2001	305	9.15	0.00
G017	2002	466	3.55	0.00
G020	1999	265	13.72	0.00
G020	2000	538	6.72	0.00
G020	2001	120	8.86	0.00
G020	2002	507	6.04	0.00
G023	2000	189	12.39	0.00
G023	2001	189	33.55	0.00
G023	2002	384	13.82	0.00
G023	2003	124	33.92	0.01
G024	2000	1808	1.64	0.00
G024	2001	1417	0.29	0.00
G029	1999	295	17.94	2.72
G029	2000	1684	5.09	0.17
G029	2001	1598	5.36	0.01
G036	2001	833	0.46	0.00
G037	2002	445	12.95	0.00
G037	2003	32	50.62	0.00
G038	2001	238	2.28	0.00
G040	2001	110	60.46	0.00
G040	2002	330	25.69	0.00
G040	2003	84	63.38	0.00
G054	2002	1282	4.99	0.00
G055	2003	274	6.02	0.98
G058	2003	957	0.22	2.15
G100	2001	264	7.70	0.00
G100	2002	129	32.07	0.00
G100	2003	312	9.34	0.00
G100	2004	291	6.32	0.00

3.22 Annual home range shifts

Home range fidelity indicates that such ranges are stable, productive and traditionally used. Several individual bears were documented with telemetry to have used the Gregg/Luscar lease area for multiple (consecutive) years. For those individuals we assessed the shifts in their annual home range use across the years. We calculated the percent of the previous home range not used in the consecutive year home range and the percent of the more recent home range that overlaps with the previous year's home range.

We identified 3 male and 5 female grizzly bears having used the Gregg/Luscar area over 2 or more consecutive years (Table 3-7). Female grizzlies made annual home range shifts that did not use an average of 43 percent (n=12) of their previous home range for a new home range in the consecutive year, compared to males who did not use an average of 55 percent (n=7). Females averaged 40 percent of home range overlap between years and males averaged 51 percent.

Female grizzlies that had cubs of the year (coy), compared to no cubs the year previous, did not use on average 68 percent of their previous years' home range and their home ranges overlapped an average of 21 percent. Females with cubs over 2 consecutive years did not use an average of 10 percent of the previous years home range and overlapped an average of 78 percent. Females with no cubs across years did not use an average of 38 percent of their home range from one year to the next and overlapped an average of 35 percent.

Average (year to year) home range overlap for females was slightly higher in the Gregg/Luscar area (40%) than the Cheviot area (38%). Males in the Cheviot area (56%) showed more home range fidelity than in the Gregg/Luscar area (51%). Overall, home range fidelity was similar between areas.

3.23 Telemetry locations and road crossings

We summarized the number of grizzly bear telemetry locations (1999-2004) acquired within the Gregg/Luscar lease area relative to the total number of telemetry locations for each bear on an annual and seasonal basis (Table 3-8). On average 23% of total annual telemetry locations for female grizzly bears (N=19) and 6% of male (N=14) annual locations occurred within the Gregg/Luscar boundary. More radio-collared bears were documented using the Gregg/Luscar lease area during the summer season (N=25) when compared to the spring (N=24) or fall (N=11). Bears on average also spent the greatest proportion of their time in the mine boundary during the summer season ($\bar{x}$=12.3%, N=24, SD=15), relative to spring ($\bar{x}$=5.27%, N=24, SD=9) and fall ($\bar{x}$=3.7%, N=12, SD=4.3). Of all radio-collared grizzly bears, female G040 spent the greatest proportion of her time (51%) within the mine lease area.

We examined grizzly bear telemetry data and summarized the minimum number of times bears crossed Highway 40 both inside and outside the Gregg/Luscar mine lease area between 1999 and 2004. Bear crossings of highway 40 outside of the lease area were assessed within a 10km buffer of the lease area. Within the mine lease area boundary, there were 6 individual female bears that contributed 15 'years' (defined by number of

Table 3-7. Annual home range shifts of bears occupying the Gregg/Luscar lease area over consecutive years between 1999-2004.

Bear ID	Sex	Year new	Year previous	% of previous HR not used	% of new HR overlap	Reproductive Status
G017	M	2000	1999	43.23	52.92	n/a
G017		2001	2000	91.04	69.41	n/a
G017		2002	2001	32.60	55.81	n/a
G020	F	2000	1999	7.21	54.21	0
G020		2001	2000	80.47	12.40	2coy in 2001
G020		2002	2001	5.29	96.92	2yrlg in 2002
G023	F	2001	2000	38.77	38.76	2coy in 2001
G023		2002	2001	15.57	58.46	2yrlg in 2002
G023		2003	2002	76.91	28.57	1coy in 2003
G024	M	2001	2000	66.36	55.03	n/a
G029	M	2000	1999	6.66	89.26	n/a
G029		2001	2000	49.64	33.54	n/a
G029		2002	2001	96.24	0.00	n/a
G037	F	2003	2002	92.82	0.00	0
G040	F	2002	2001	11.02	70.61	n/a
G040		2003	2002	77.36	3.16	1coy in 2003
G100	F	2002	2001	63.36	25.00	n/a
G100		2003	2002	20.54	67.18	0
G100		2004	2003	29.51	24.45	0

annual home ranges) of crossing data and 4 male grizzlies that contributed 8 'years' of crossing data (Appendix B). Females crossed highway 40 within the lease boundary a minimum of 156 times. The majority of female crossings were made during the summer (52%), compared to spring (19%) and fall (29%). Male grizzlies crossed highway 40 within the lease area boundary a minimum of 28 times, with the majority occurring during spring (64%) compared to 36% in summer. We also examined day vs. night crossings of highway 40 within the mine lease area. For forty-six percent of all crossings documented, we could not reliably determine whether the crossings were made during day or night because consecutive GPS locations overlapped day and night periods. We were able to confidently identify 65 daytime crossings by females and 7 daytime crossings by males. There were 8 night crossings by females and 4 by males. Fifty-seven of the 65 daytime crossings documented were made by female G040.

Outside of the Gregg/Luscar mine lease boundary, there were 7 individual female bears that contributed 17 'years' of crossing data and 4 male bears that contributed 10 'years' of crossing data (Appendix C). Females crossed highway 40 a minimum of 377 times. The majority of female crossings were made during the fall (50%), compared to spring (17%) and summer (33%). Female grizzly G020 crossed highway 40 the most

Table 3-8. Count of annual and seasonal telemetry locations occurring within the Gregg/Luscar Mine lease area boundary relative to the total number of locations acquired annually per bear between 1999 and 2004.

Bear ID	Year	Total locations	# of locations within Mine boundary			
			Annual	Spring	Summer	Fall
G004	2001	542	7	0	0	7
G008	1999	393	23	8	15	0
G008	2002	683	21	2	19	0
G014	2000	283	9	6	3	0
G017	1999	66	6	6	0	0
G017	2000	77	1	1	0	0
G017	2001	150	9	9	0	0
G017	2002	869	14	5	9	0
G020	1999	683	107	0	55	45
G020	2000	446	9	8	0	0
G020	2001	627	45	0	0	0
G020	2002	394	7	0	4	0
G023	2000	623	54	18	31	5
G023	2001	707	353	10	309	29
G023	2002	349	69	3	48	0
G023	2003	399	159	29	102	4
G024	2000	586	7	3	4	0
G024	2001	919	5	0	1	4
G029	1999	481	133	51	82	0
G029	2000	442	34	7	27	0
G029	2001	1525	53	17	36	0
G037	2002	459	60	0	12	29
G037	2003	35	13	0	13	0
G038	2001	438	8	3	5	0
G040	2001	173	124	70	50	4
G040	2002	689	218	79	82	41
G040	2003	660	436	107	176	99
G054	2002	124	1	1	0	0
G055	2003	443	23	0	22	1
G100	2001	760	44	16	26	2
G100	2002	122	60	0	57	0
G100	2003	516	21	14	6	0
G100	2004	153	4	4	0	0

frequently of all radio-collared bears. Male grizzlies crossed highway 40, outside the mine lease area a minimum of 114 times. Forty-eight percent of male crossings occurred in summer, followed by 47% in spring and 5% in fall. For fifty-one percent of all crossings documented, we could not reliably determine whether the crossings were made during day or night because consecutive GPS locations overlapped day and night periods. We were able to confidently identify 152 daytime crossings of highway 40 (123 female, 29 male) and 85 night crossings (66 female, 19 male).

3.24 Denning ecology

Of all radio collared grizzly bears using the Gregg/Luscar lease area between 1999 and 2004, we identified 17 den site locations. We documented 4 den sites within the Gregg/Luscar mine lease area and 1 den site on the periphery (Figure 3-4).

We obtained den characteristics for 8 adult female, 5 subadult female and 4 adult male grizzlies (Table 3-9). Between 2001 and 2003, four adult female bears denned within the lease area. A sub adult female grizzly denned on the periphery of the lease area in 2000, but was legally harvested the spring of 2001 shortly after emerging from the den. No bears reused den sites from previous years. Females entered their dens between October 27 and November 29. Adult males entered dens between November 5 and November 28. GPS data for den emergence was only available for 8 females. These bears emerged from their dens in the spring between April 11 and May 12. Three females emerged with cubs of the year, but we could only estimate emergence dates for two of the three; G020 emerged on 19 April 2001 and G023 emerged the 11 April 2001, each with 2 cubs.

Den elevations across the pooled sample ranged between 1124m and 1960m. The average elevation for females was 1763m (N=13) and 1612m for adult males (N=4). Grizzly bears selected various aspects for denning, an equal proportion (41%) of bears selected both east and west aspects, the remaining 18% denned on northern aspects. Fifty percent of male dens were on north aspects and 50% were on east aspects. Females denned on each of east, north and west aspects. Bears denned on a mean slope of 37%. Average slope for females and males was 39% and 28% respectively. Overall, bears in the Gregg/Luscar area denned mostly (77%) in forested habitats. Females denned predominantly in forested cover type (85%), whereas males equally selected both forest (50%) and open canopy (50%).

We summarized den site characteristics for an additional 19 known den sites within the BPU, of bears who were documented as not having used the Gregg/Luscar or Cheviot mine lease areas (Table 3-10). Den elevations for these bears ranged between 1222m and 2287m. The average elevation for females was 1735m (N=16) and 1824m for males (N=3). Bears across the BPU selected all aspects for denning. Thirty-eight percent of female dens were on east aspects, 25% denned on north aspects and 19% denned both on south and west aspects. The 3 sub-adult male dens were all on north aspects. The average percent slope of all dens was 31%. The majority of dens were in closed coniferous forest habitat, including 63% of female dens and 100% of male dens.

In addition to the 19 den sites within the BPU, we identified another 27 in the Cheviot and Gregg/Luscar areas (46 total den sites). Five of 46 dens occurred within the Gregg/Luscar lease area, belonging to 3 individual bears that have been monitored as spending a significant proportion of their time in the vicinity of the mine (G020, G023 and G040). It appears that these bears have possibly adapted to take advantage of accessible spring food sources (ie. ungulates and early spring herbaceous green-up) that the mine area has to offer.

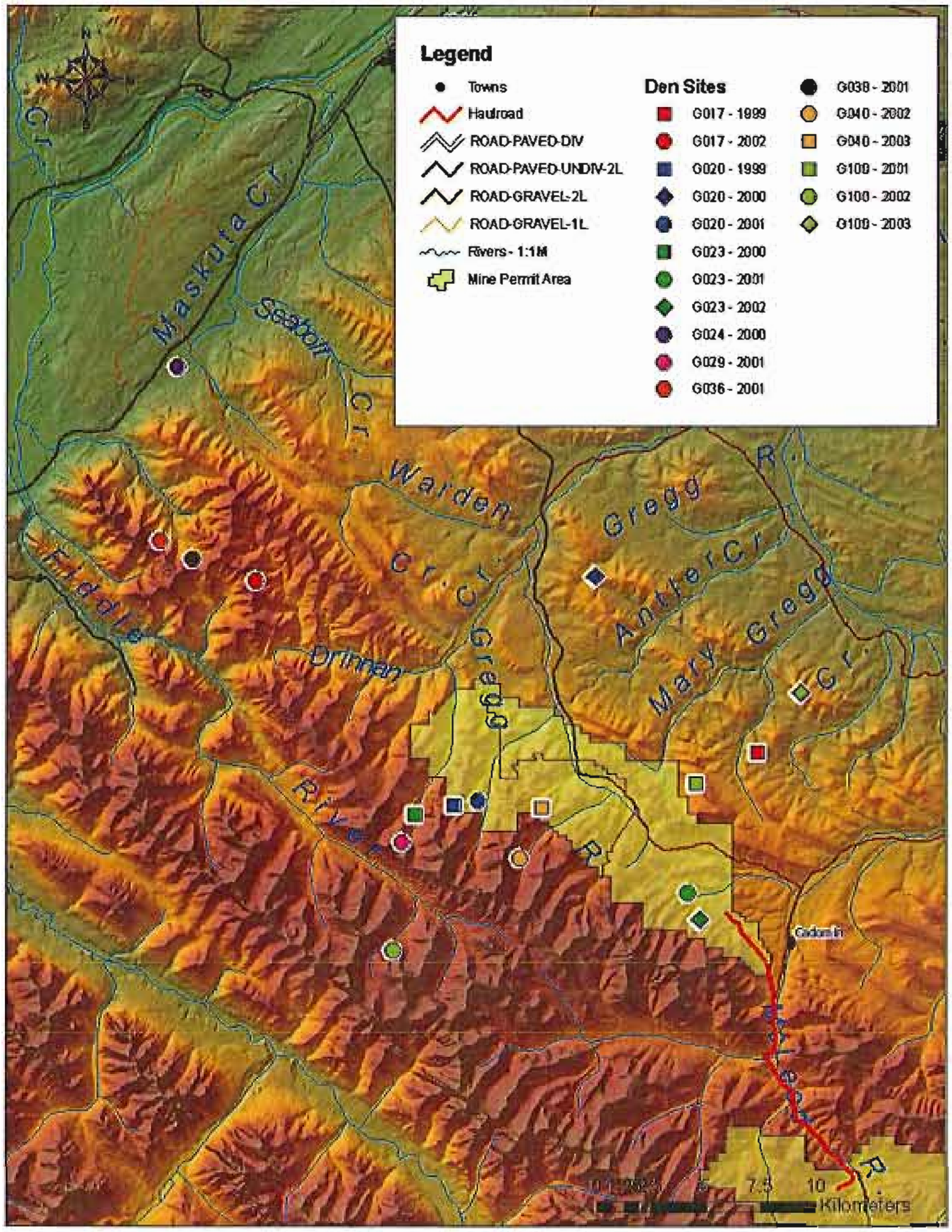


Figure 3-4. Known den sites of grizzly bears using the Gregg/Luscar area between 1999 and 2004.

Table 3-9. Den site characteristics of documented den locations for radio collared grizzlies in the Gregg/Luscar area, 1999-2003.

Year	Sex/Age Class	Bear ID	Reproductive Status upon Den Emergence	Elevation (m)	Percent Slope	Aspect	Den Entry	Den Emergence	# Days Denned	Landcover class
1999	Subadult Female	020	n/a	1954	41	E	29-Nov-99	11-Apr-00	134	Closed Conifer
	Adult Male	017	n/a	1528	25	N	05-Nov-99	17-Apr-00	164	Closed Deciduous
2000	Adult Female	020	0	1478	12	N	7-Nov-00	24-Apr-01	168	Closed Conifer
		023	1yrlg	1761	38	E	20-Nov-00	26-Apr-01	157	Closed Conifer
	Adult Male	024	n/a	1124	6	E	28-Nov-00	23-Apr-01	146	Cut > 12 yrs
2001	Subadult Female	036	n/a	1807	59	N	14-Nov-01	07-May-02	174	Closed Conifer
		100	n/a	1678	31	W	27-Oct-01	08-May-02	193	Closed Conifer
	Adult Female	020	2coy	1763	27	N	19-Nov-01	19-Apr-02	151	Closed Conifer
		023	2coy	1706	35	N	10-Nov-01	11-Apr-02	152	Closed Conifer
		038	0	1755	42	E	14-Nov-01	12-May-02	179	Closed Conifer
	Adult Male	029	n/a	1960	56	E	14-Nov-01	16-Apr-02	153	Alpine/subalpine
2002	Subadult Female	040	n/a	1905	67	E	11-Nov-02			Closed Conifer
		100	n/a	1914	26	W	21-Nov-02			Alpine/subalpine
	Adult Female	023	2yrlg	1822	47	N	7-Nov-02			Closed Conifer
	Adult Male	017	n/a	1835	25	N	13-Nov-02			Closed Conifer
2003	Adult Female	040	1coy	1803	43	E	4-Nov-03			Conifer
		100	0	1574	43	W	10-Nov-03			Shrub

Table 3-10. Den site characteristics of documented den location for radio collared grizzlies across the Bear Population Unit study area, 1999-2003.

Year	Sex/Age Class	Bear ID	Reproductive Status upon Den Emergence	Elevation (m)	Percent Slope	Aspect	Den Entry	Den Emergence	# Days Denned	Landcover class
1999	Adult Female	002	2 2yr olds	2160	28	E	9-Nov-99	27-Apr-00	170	Alpine
		012	0	1222	9	W	09-Nov-99	3-Apr-00	146	Closed Conifer
2000	Adult Female	002	2 3yr olds	2194	43	E	07-Nov-00	20-Apr-01	164	Rock
		007	1 coy	1434	19	N	28-Nov-00	19-Apr-01	142	Closed Conifer
		012	2 coy	1303	7	N	04-Nov-00	4-May-01	181	Closed Conifer
		034	2 coy	2287	72	E	28-Oct-00	7-May-01	191	Rock
	Subadult Female	102	n/a	1928	45	E	15-Nov-00	23-Apr-01	159	Closed Conifer
	Subadult Male	033	n/a	1693	55	N	28-Nov-00	27-Apr-01	150	Closed Conifer
2001	Adult Female	002	0	2254	57	S	1-Nov-01	08-May-02	188	Rock
		012		1303	39	E	29-Oct-01	16-Apr-02	169	Closed Conifer
		027	0	1771	20	N	10-Nov-01	29-Apr-02	170	Closed Conifer
	Subadult Male	033	n/a	1891	19	N	15-Nov-01	05-Apr-02	141	Closed Conifer
2002	Adult Female	012	0	1327	8	S	12-Dec-02			Closed Conifer
		028	0	2131	46	S				Rock
		042	0	1960	40	E	26-Oct-02			Closed Conifer
		007	0	1279	16	N	13-Nov-02			Closed Conifer
	Subadult Male	033	n/a	1889	20	N	11-Nov-02			Closed Conifer
2003	Adult Female	012	0	1335	20	W	07-Nov-03			Closed Conifer
		070	0	1878	36	W	07-Nov-03			Shadow

3.3 Distribution of collared and un-collared Grizzlies in the Gregg/Luscar area.

The 1999 hair DNA research, as described in section 2.3, resulted in the capture of 5 hair samples belonging to 4 individual bears within the Gregg/Luscar lease boundary (Figure 2-8). Two of these bears (G017 and G020) were also live captured and fitted with GPS collars during the 1999-capture season. The other two bears (G029 and G100) were not live captured and radio collared until spring 2000 and 2001 respectively. The hair-snagging program thus confirmed that these bears were using the Gregg/Luscar area prior to being radio-collared.

Grizzly G004 was the only other radio collared bear that used the Gregg/Luscar area and also sampled during the hair-snagging program. Hair samples of this bear were captured at three different sites (cells 30, 31 and 64) (Table 2-10). Interesting to note that she was hair snagged in cell 64, quite a distance further south than any of her GPS locations ever documented her to travel in the four years she was monitored.

3.4 Grizzly bear proximity to mining activity in the Gregg/Luscar mine area.

<u>3.41 Annual status of mining activity and corresponding bear use</u>

As mentioned in section 2.41, existing RSF models for grizzly bear habitat quality within the boundaries of the Gregg/Luscar mine lease area are poor in their capacity to accurately predict probability of bear use around the active mine sites. RSF habitat models are developed in part using Landsat satellite imagery to classify landcover. From these images, Nielsen (2005) a priori assigned a low RSF score (low probability of grizzly bear occurrence) when developing the regional scale model. However, in mining practices, there is a rotating cycle of site-specific disturbances whereas the whole permit area is not impacted by mining activity at one time. This rotating pattern of mining disturbance maintains undisturbed and reclaimed habitats accessible to wildlife and therefore are misrepresented by the assigned low RSF score within the model.

We investigated grizzly bear use of the mine lease area relative to annual mining activity data provided by CRO. We obtained spatial data that summarized mine activities on the Gregg/Luscar lease area for each year between 1999 and 2004. All pits, dumps, major roads, facilities etc. within the lease area were mapped into polygons and categorized annually as areas of active mining, inactive mining, reclaimed or undisturbed (Figure 3-5). Active mining did not occupy the entire area within the management boundary of the mine lease so we described unaffected areas as "mine lease" land. Inactive mining polygons refer to all lands where mining and hauling activity has ceased during that period of "inactivity" and may include lands that are in various stages of reclamation, but where vegetation has not been established on the site within the past two years (C. Brinker, pers. Comm.). Reclaimed polygons consist of mined lands that have final reclamation activities completed and re-vegetation that is at least two years old (ie. grasses and legumes, but not necessarily trees/shrubs) (C. Brinker, pers. Comm.). Undisturbed polygons are lands that were effectively left intact or untouched from any nearby mining activity.

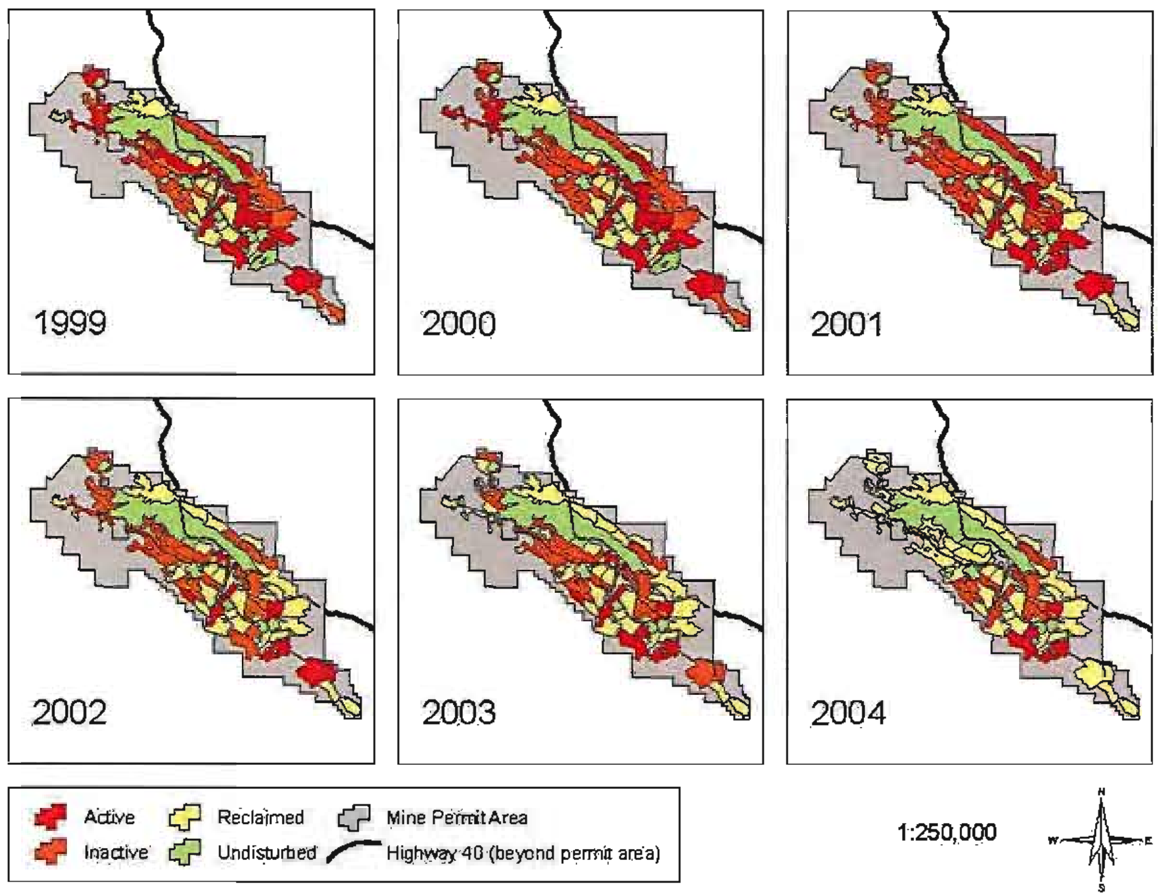


Figure 3-5. Annual status of mine activity within the Gregg/Luscar Mine lease area, 1999-2004.

We assessed 2101 grizzly bear GPS locations (1999-2004) occurring within the mine lease area and summarized the percent of bear occurrences within each category of mining status per year. Each year, nearly 50% of all bear locations in the lease area, were documented on mine lease land, outside the core footprint of all mining activity (Figure 3-6). An average of 25% of all bear locations, between 1999 and 2004, occurred within areas of undisturbed land, compared to 20% on reclaimed lands, 8% within inactive mine areas and 6% on active mine areas.

We also assessed the use of mine areas by individual bear as some bears were documented to frequent the area more often than others. All GPS locations within the mine lease area, between 1999 and 2004, were from 11 individual grizzly bears (7 females, 4 males). Two females, G40 and G23 were accountable for 68% of all GPS locations within the lease area (Table 3-11). On an individual basis, the greatest proportion of each bears locations were found within mine lease habitats, beyond the core area of mine activities (Figure 3-7). G40 and G100 occurred in undisturbed areas in greater proportion than other bears, and G38 proportionally spent the most time within reclaimed areas relative to other individuals (Figure 3-7). Male grizzly G17 occupied both active and inactive mine areas in greater proportion than any other bear.

Overall, bears in the Gregg/Luscar area are using mostly undisturbed habitats adjacent to active mines and in some situations are found within active mine sites. Some bears will occasionally take risks to cross through developed areas or have adapted to human disturbance/activity to access good foods, suggesting that obtaining resources may outweigh some disturbances. Bears are also using the reclaimed mine areas, possibly because of the abundance of ungulate carrion and neonates on and near the reclamation sites or to access the more abundant grass and forbs on these sites.

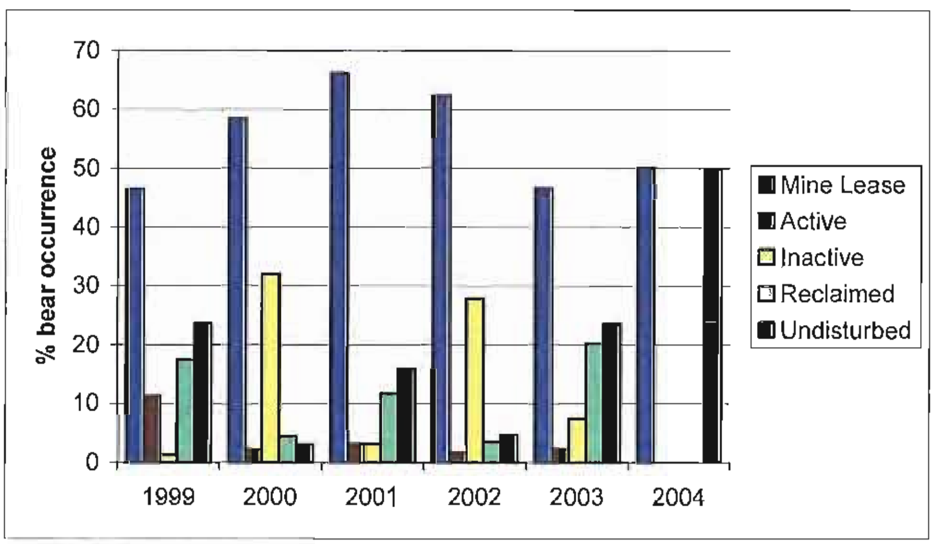


Figure 3-6. Annual average bear use of areas of designated mining status within the Gregg/Luscar Mine lease area, 1999-2004.

Table 3-11. Proportion of grizzly bear GPS locations within the Gregg/Luscar Mine lease area, occurring within designated categories of mining status between 1999 and 2004.

Bear ID	Total # GPS locations	% Mine Lease	% Active	% Inactive	% Reclaimed	% Undisturbed
4	7	86	0	0	14	0
8	44	69	2	5	2	22
14	9	78	0	11	0	11
17	30	35	8	25	6	25
20	165	83	1	3	9	3
23	635	48	5	10	21	16
29	220	61	3	4	19	12
37	73	66	1	4	14	15
38	8	75	0	0	25	0
40	778	38	6	10	16	31
100	129	45	0	9	12	34

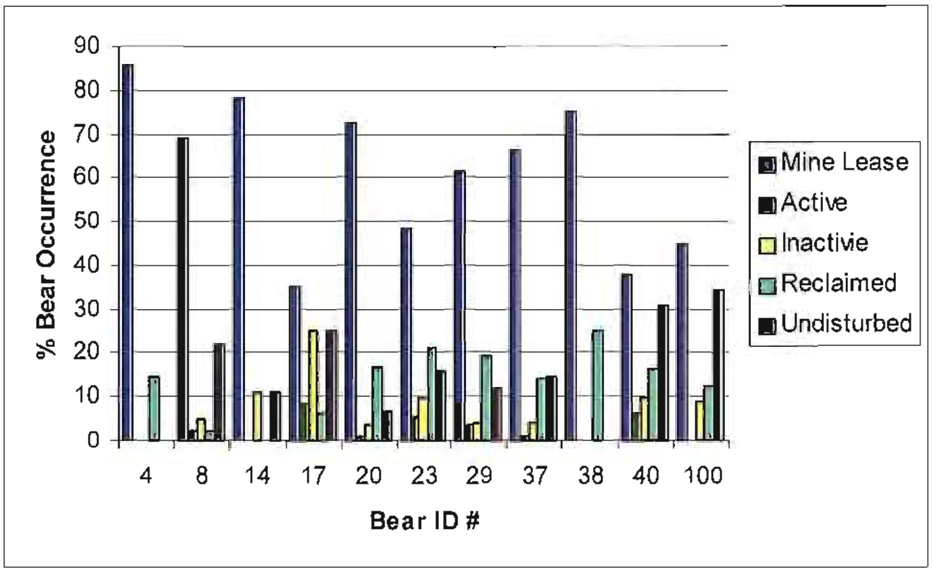


Figure 3-7. Percent of individual grizzly bear locations occurring within designated categories of Gregg/Luscar mining activity status between 1999 and 2004.

3.42 Grizzly bear occurrence in proximity to seasonal ungulate census data

We obtained a summary of ungulate data collected within the Gregg/Luscar Mine lease area between 1999 and 2004 (Godsalve and McCallum. 2005), and overlaid grizzly bear GPS locations to assess the proximity of bears to ungulate distributions. Areal distributions using the harmonic mean method for bighorn sheep, mule deer and elk across the mine permit area were used to identify whether areas designated as active, inactive, undisturbed or reclaimed fell outside of the 95% distribution, inside the 95% distribution or within a core home range area for each species and season (Godsalve and McCallum. 2005). Distribution of bighorn sheep nursery herd and bighorn sheep ram bands was mapped for three seasons and mule deer and elk were mapped annually (Godsalve and McCallum. 2005). Ungulate seasons were identified as winter/early spring (January 19-April 30), lambing/summer (May1-August 10) and pre-rut (August 11-November 14).

Eight seasonal ungulate distributions were summarized annually based on species cohort and were described as:
NW: Nursery winter/spring
RW: Ram winter/spring
NS: Nursery lambing/summer
RS: Ram lambing/summer
NP: Nursery pre-rut
RP: Rams pre-rut
MD: Mule deer annual
ELK: Elk annual

The defined ungulate seasons differ from defined grizzly bear spring, summer and fall seasons. For example, the lambing/summer ungulate season encompasses both the spring and summer bear season. Bear response to ungulate abundance could be more informative if described on a monthly basis. This may be considered for future analysis if more detailed date-sensitive datasets were accessible.

We proceeded in using grizzly bear GPS locations to determine the proportion of seasonal bear locations occurring within each of the ungulates 95% and core home ranges or outside of the home range. We performed 3 types of analysis; first we assessed spring bear locations in relation to the annual core home range of NW and RW distributions. This analysis could potentially capture the possibility of bears seeking winter killed ungulate carcasses upon emergence from their dens in spring. Second, we determined the proportion of spring and summer grizzly bear locations relative to NS, RS, MD and ELK distributions. Lastly, we determined the proportion of fall grizzly bear locations relative to NP, RP, MD and ELK distributions.

There were no spring grizzly bear locations within the core home ranges of NW or RW during 1999, 2000 or 2004. In 2001, 24% of spring grizzly bear locations occurred within the core home range of RW and 10% within core home range of NW. In 2002, 4% of spring grizzly bear locations occurred within the core home range of RW and none within NW. In 2003, 8% of spring grizzly bear locations occurred within the core home range of RW and 20% within the core home range of NW. A total of 61 spring grizzly bear locations were identified within the core home ranges of RW and NW, 92% of which were of female G40. The remaining 8% of locations were of females G100 and G23.

Between 1999 and 2004, there were 1054 grizzly bear locations during spring and summer within the mine polygons. Table 3-12 shows the proportion of those locations occurring outside of ungulate home ranges, within the 95% home range distribution and within the core home range distribution. Similarly, table 3-13 shows the proportion of 172 fall grizzly bear locations.

This summary of bear location data in proximity to ungulate distributions across the mine lease area does not effectively determine whether grizzly bear movements are potentially related to concentrations of ungulates within the lease area. Such analysis could be possible by correlating spatially specific, monthly ungulate counts with monthly grizzly bear location data. However, the following diet analysis suggests ungulate protein is a major food source for grizzly bears in this area and it would be worthy to further investigate whether bears are attracted to or seeking this food source within mining areas.

Table 3-12. Proportion of spring and summer grizzly bear locations in relation to ungulate distributions within the Gregg/Luscar Mine lease area, 1999-2004.

Seasonal Ungulate Distribution	% bear locations not within Home Range	% bear locations within 95% home range area	% bear locations within core home range area
NS	50	24	26
RS	43	42	15
MD	20	21	59
ELK	58	31	11

Table 3-13. Proportion of fall grizzly bear locations in relation to ungulate distributions within the Gregg/Luscar Mine lease area, 1999-2004.

Seasonal Ungulate Distribution	% bear locations not within Home Range	% bear locations within 95% home range area	% bear locations within core home range area
NP	40	32	28
RP	34	27	38
MD	26	25	49
ELK	70	20	10

3.43 Diet analysis of Grizzly bears using the Gregg/Luscar mine lease area.

We examined diet results for 11 Gregg/Luscar area bears, including 5 males and 6 females. A total of 344 scats, 113 from males and 231 from females were collected between 2001 and 2003. The multi annual average dietary volume of foods shows that animal protein was the most predominant food (30% of diet) selected by male grizzlies compared to females whose diet was largely of roots (34%) (Table 3-14).

A biweekly analysis of food habits indicates that male grizzlies consumed animal protein from early May through to late July (Figure 3-8a) compared to female diets where animal matter appeared at smaller volumes, primarily in May and June (Figure 3-8b). The average annual dietary volume of animal matter for females was 15% (Table 3-15).

Female grizzlies in the Gregg/Luscar area consumed roots from early May to early June, at which point their diet shifted to consuming a greater proportion of forbs and berries (Figure 3-8b). Females appeared to shift back to a diet of roots by early September as their consumption of berries declined. Roots composed 52% of female diets in the spring and 44% in the fall (Table 3-14). Males consumed roots also, largely up to early June and again in late August, complementing a diet of forbs and berries through until early September (Figure 3-8a). The multi annual average dietary volume of roots for males was 27% (Table 3-16) or 55% of their spring diet and 38% of their fall diet (Table 3-14). The unclassified food data indicates the predominant root species was sweet vetch (*Hedysarum* spp.) and predominant berries were buffaloberry (*Shepherdia Canadensis*) and mountain huckleberry (*Vaccinium membranceum*) (Munroe et al. in prep).

Grass and forbs occurred in the next highest proportions in both male and female seasonal diets (Table 3-14). Grass and forbs accumulated to 29% of the average multi-

Table 3-14. Seasonal comparison of major food items (percent diet volume) contained within female (F) and male (M) grizzly bear scats collected between 2001 and 2003 (Munro et al. in prep).

Season	# Scats		Grass		Equisetum		Carex		Forbs		Berry		Roots		Insect		Animal		Misc.	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Spring	49	32	11	6	9	2	0	0	4	1	1	0	52	55	0	1	22	36	0	0
Summer	116	74	27	28	1	2	2	0	31	30	9	6	5	2	5	0	17	30	0	1
Fall	66	7	8	2	0	0	0	0	7	6	32	38	44	38	2	0	6	14	1	0
MultiAnnual Avg.	231	113	15	17	3	2	1	0	14	16	14	8	34	27	2	1	15	30	0	0

Table 3-15. Bi-weekly comparison of major food items (percent diet volume) contained within female (F) and male (M) grizzly bear scats collected between 2001 and 2003 (Munro et al. in prep).

Season	# Scats		Grass		Equisetum		Carex		Forbs		Berry		Roots		Insect		Animal		Misc.	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Late April	2	0	0	-	0	-	0	-	0	-	0	-	99	-	0	-	0	-	0	-
Early May	8	6	6	0	18	0	0	0	1	0	0	0	50	98	0	0	25	1	0	0
Late May	21	12	20	0	9	0	0	0	8	0	1	0	43	61	0	1	18	38	0	0
Early June	18	14	17	18	9	5	0	0	7	1	3	0	17	7	1	3	45	70	0	0
Late June	24	17	42	26	2	3	0	0	23	11	4	0	3	1	4	0	22	60	0	0
Early July	36	16	36	34	3	4	0	0	27	20	0	0	0	1	6	0	25	39	0	0
Late July	23	17	13	30	0	1	7	0	44	48	12	5	0	1	10	1	8	14	0	0
Early Aug	33	24	17	23	0	2	0	0	30	40	21	17	16	6	1	0	13	8	0	2
Late Aug	22	7	5	2	0	0	0	0	17	6	38	38	26	38	6	0	5	14	0	0
Early Sept	28	0	18	-	0	-	0	-	1	-	62	-	5	-	0	-	11	-	3	-
Late Sept	6	0	4	-	0	-	0	-	9	-	17	-	67	-	0	-	0	-	0	-
Early Oct	10	0	5	-	0	-	0	-	0	-	10	-	79	-	0	-	8	-	0	-

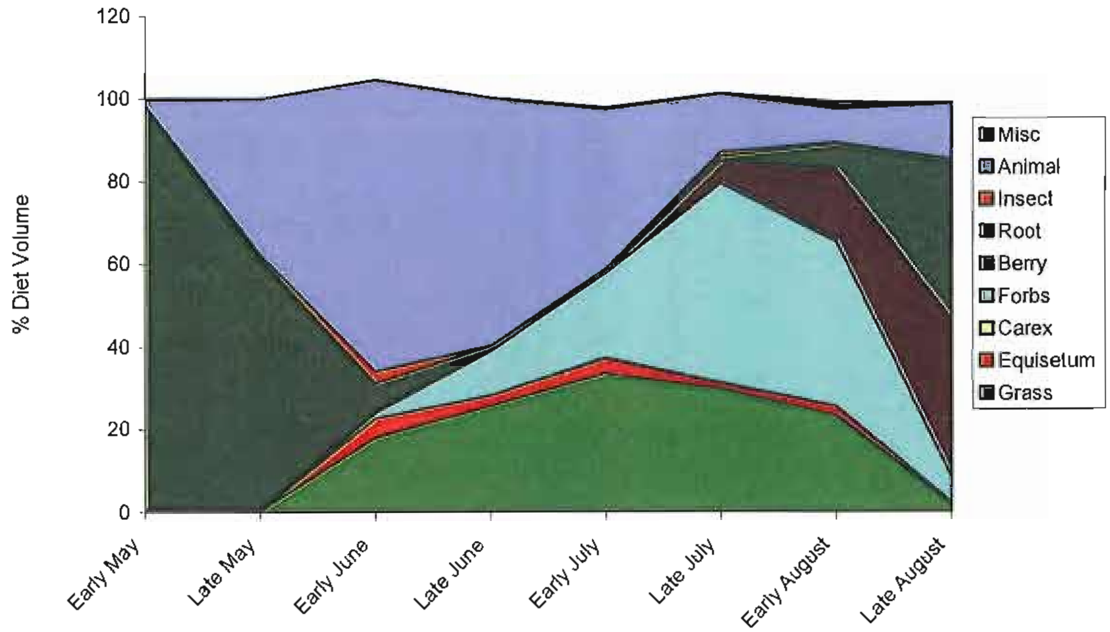


Figure 3-8a. Proportionate contribution of major food classes to bi-weekly diet volume of male grizzly bears in the Gregg/Luscar area, 2001-2003.

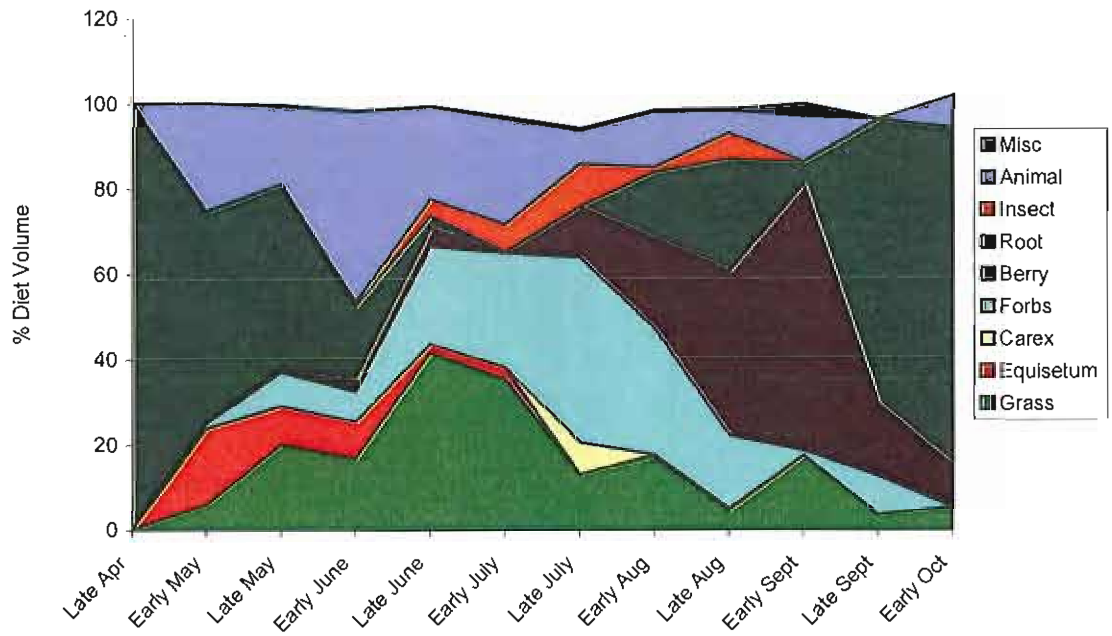


Figure 3-8b. Proportionate contribution of major food classes to bi-weekly diet volume of female grizzly bears in the Gregg/Luscar area, 2001-2003.

annual diet of female bears (Figure 3-9a). The average multi-annual diet of male bears consisted of 33% of grass and forbs combined (Figure 3-9b). Predominant forb species included cow parsnip (*Heracleum lanatum*), clover (*Trifolium* spp.), peavine (*Lathyrus ochroleucus*) and alfalfa (*Medicago sativa*). Overall, the diet analysis of Gregg/Luscar area grizzly bears (male and female combined) between 2001 and 2003 averaged 30% roots, 23% animal, 11% berry, 15% forb and 16% grass (Figure 3-9c). The remainder 5% of diet was split between equisetum and insects.

We also examined diet result for bears occurring within the Bear Population Unit (BPU), who were not associated with mine sites. There were 3 female grizzlies from which a total of 159 scat samples were collected and analyzed across the BPU. No data was available from male grizzlies across this area. A biweekly analysis of food habits for females concluded that bears selected mostly roots from late April through to late May (Figure 3-10) which contributed 51% of dietary volume in spring (Table 3-16). Berries composed the highest percent of dietary volume during summer (36%) and fall (65%) (Table 3-16), exceeding volumes of all other food classes between early July and late September (Table 3-17). Animal protein contributed an average of 13% to annual dietary volume (Table 3-16) and was consumed from late April through to late August (Figure 3-10). Annual diets also consisted of grass (14%) and forbs (10%) and were selected primarily between early June and late July (Figure 3-10).

In comparing the diet of female bears from the Gregg/Luscar area with female bears across the BPU, they differed mostly in the percent diet volume of berries (Figure 3-11). Females in the BPU had a multi annual average of 34% diet volume of berries compared to 14% in Gregg/Luscar female diets (Figure 3-11a). Gregg/Luscar females selected higher proportions of roots, forbs and animal protein (Figure 3-11b) compared to females sampled within the BPU.

A comparative scat analysis between the Cheviot and Gregg/Luscar areas shows that female grizzly bears are consuming more (2.5 times) animal protein in the Gregg/Luscar area and most animal protein ingested was in the spring season. This might be related to the abundance of ungulate carrion and neonates on and near the reclaimed mine areas during this time period. Grass and forb volumes in grizzly bear diets were 31.8% and 10% higher respectively for Gregg/Luscar area bears than Cheviot area bears. This may also be related to reclaimed mine vegetation. There was much lower contribution of berries in the diet of female grizzly bears in Gregg/Luscar (14%) compared to the Cheviot area (25%). This may reflect low levels of berry producing plants in the habitats in the vicinity of the Gregg/Luscar mine area.

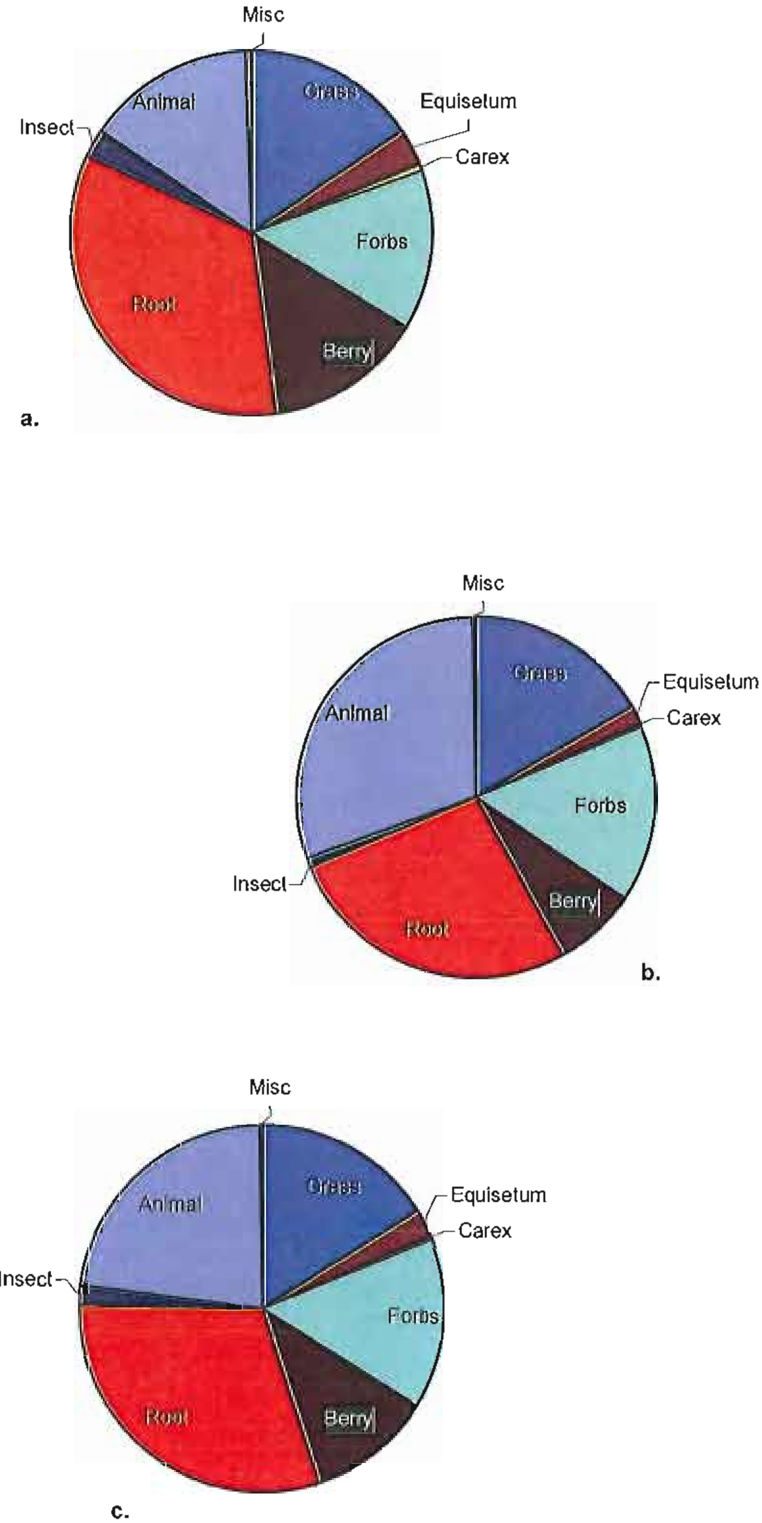


Figure 3-9. Proportionate contribution of major food classes to the total multi-annual diet volume of (a) female (b) male and (c) all bears combined, in the Gregg/Luscar area as determined by fecal analysis, 2001-2003.

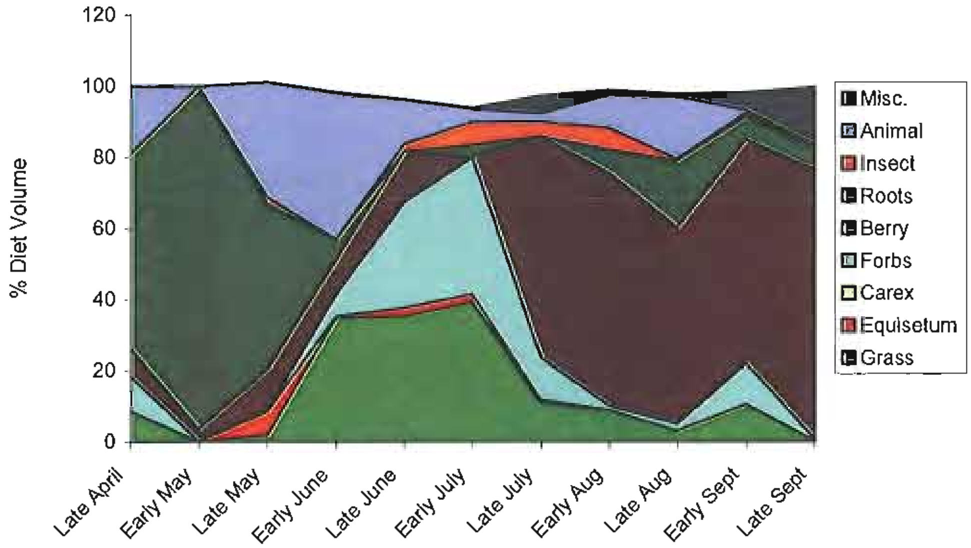


Figure 3-10. Proportionate contribution of major food classes to bi-weekly diet volume of female grizzly bears across the BPU, 2001-2003.

Table 3-16. Seasonal comparison of major food items (percent diet volume) contained within female (F) grizzly bear scats collected between 2001 and 2003 (Munro et al. in prep).

Season	# Scats	Grass	Equisetum	Carex	Forbs	Berry	Roots	Insect	Animal	Misc.
	F	F	F	F	F	F	F	F	F	F
Spring	64	11	2	0	4	8	51	0	23	0
Summer	77	24	1	0	20	36	2	5	7	2
Fall	18	5	0	0	5	65	11	1	6	7
Annual Avg.	159	14	1	0	10	34	22	2	13	3

Table 3-17. Bi-weekly comparison of major food items (percent diet volume) contained within female (F) grizzly bear scats collected between 2001 and 2003 (Munro et al. in prep).

Season	# Scats	Grass	Equisetum	Carex	Forbs	Berry	Roots	Insect	Animal	Misc.
	F	F	F	F	F	F	F	F	F	F
Late April	19	9	0	0	10	8	55	0	19	0
Early May	10	0	0	0	0	3	96	0	0	0
Late May	15	2	7	0	0	12	47	2	32	0
Early June	20	35	0	0	6	10	6	0	41	0
Late June	11	35	2	0	30	14	0	2	12	0
Early July	30	39	2	0	38	0	3	7	4	0
Late July	8	11	1	0	12	62	0	4	2	5
Early Aug	28	9	0	0	1	65	7	6	9	1
Late Aug	8	3	0	0	2	55	19	0	17	1
Early Sept	8	11	0	0	11	63	6	1	1	5
Late Sept	2	0	0	0	1	76	6	1	0	16

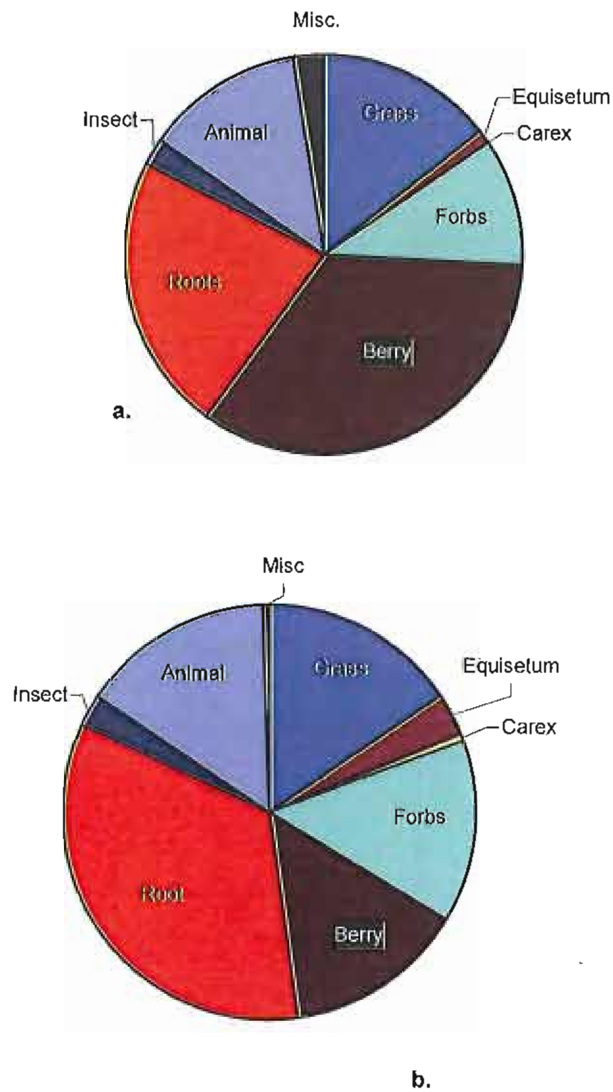


Figure 3-11. Proportionate contribution of major food classes to the total multi-annual diet volume of female bears within (a) BPU and (b) Gregg/Luscar study areas, as determined by fecal analysis, 2001-2003.

3.5 Movement corridors across the Gregg/Luscar mine lease area

We used the classified graph theory model (Schwab 2003) to identify corridors of low, moderate and high probability of female grizzly bear movement across the Gregg/Luscar Mine lease area (Figure 3-12). This model describes potential movement corridors based on a least-cost path analysis between patches of high quality habitats. Habitat quality was represented in the model as an average across all seasons and identified as being highly selected by adult female grizzly bears. The least-cost path represents the path that takes the least amount of time, distance or effort for a grizzly bear to travel from one area of quality habitat to another.

We calculated 58km of movement corridors across the permit area. The higher probability movement corridors (thick lines) within the permit area, link east west between the Gregg R. and Luscar Crk/McLeod River corridors (Figure 3-12). Other movement corridors through the lease area are north south paths near Gregg River, linking habitats in the mountains near the boundary of Jasper National park with habitats to the east of the mine lease area. Minimizing human disturbance along these potential travel routes will facilitate the movement of bears on a daily and seasonal basis within their home ranges and across landscapes. Using this graph theory model in making appropriate land use decisions can be of great benefit to bears.

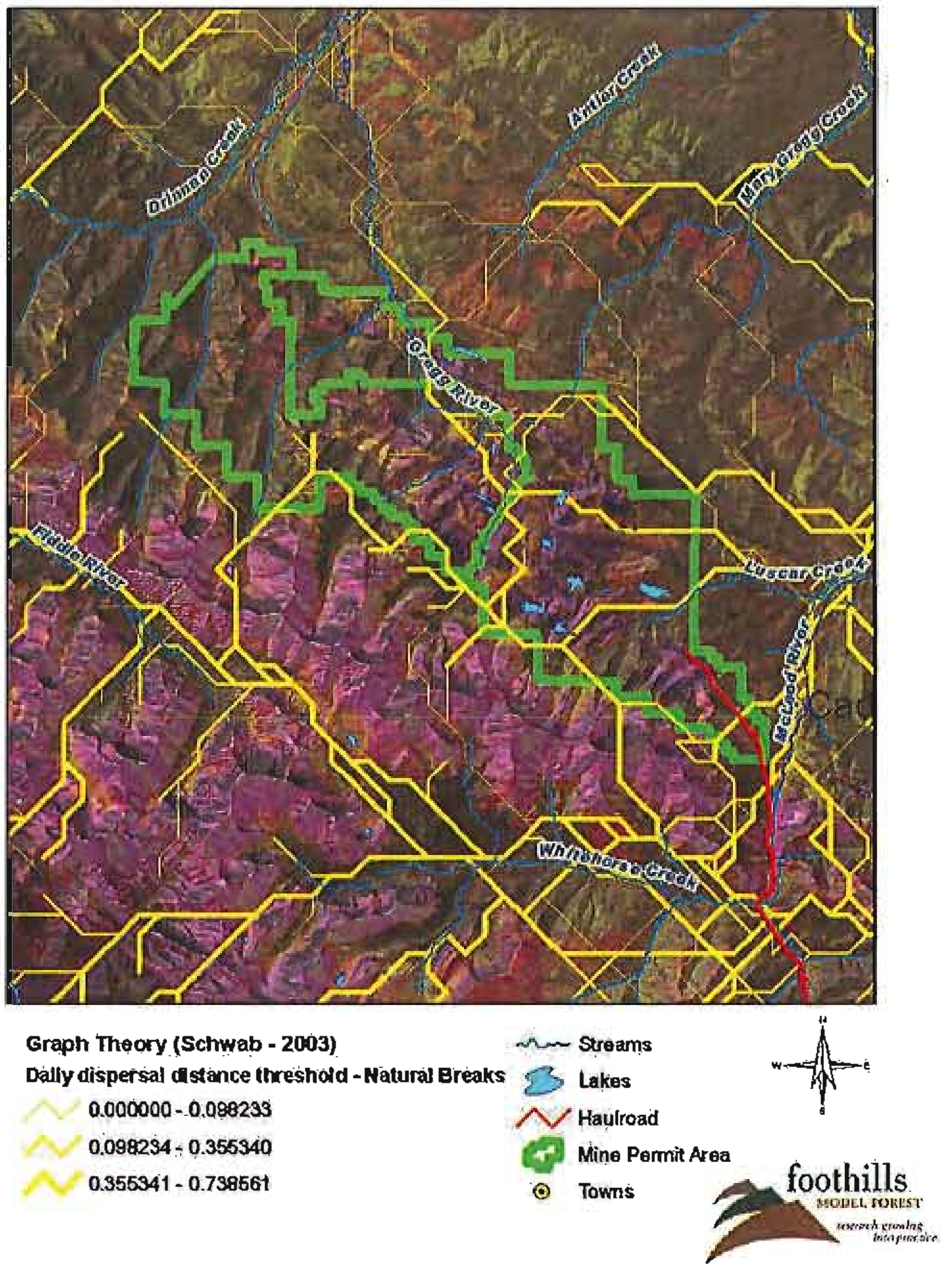


Figure 3-12. Graph Theory model indicating paths of low, moderate and high probability of grizzly bear movement corridors across the Gregg/Luscar Mine lease area.

3.6 Conclusion

In this chapter we have provided a summary of grizzly bear use within and around the Gregg/Luscar Mine, an active mining area between 1999 and 2004. Some of the leading conclusions of our analyses show that grizzly bears using the Gregg/Luscar Mine area are similar in their seasonal and annual home range sizes relative to bears using habitats around the Cheviot area. Bears were most often documented using the Gregg/Luscar lease area in spring compared to summer and fall, and although they were occasionally found within specific sites of active and inactive mining, they were most often documented using either the mine lease lands (62% of all locations) outside of the core area of mining activity or within undisturbed patches of land (15% of locations) amongst the active and inactive mine sites. Bears were also documented within reclaimed mine sites (12.5% of locations).

Grizzly bears using the Gregg/Luscar area were susceptible to many of the same mortality factors as bears across the broader landscape within the defined bear population unit. Most known bear mortalities were human caused and occurred within 100 meters of a road and 45% of all documented mortalities across the study area were a result of illegal hunting/poaching. Minimizing or restricting human access, especially by way of roads, in areas of good bear habitats is critical to reducing these mortality risks to bears. We presented a mortality risk model for the Gregg/Luscar area, and although it provides a basis for characterizing areas of high to low probability of mortality risk based on population level mortality and landscape data, we emphasize that these risk values may be reduced locally by means of sound management practices. Local management initiatives such as public education, signage, closures, quotas or permits minimizing human access including motorized vehicle restrictions, all contribute to reducing risk of mortality to bears.

Our analysis of bear's crossing over highway 40 within the Gregg/Luscar Mine lease area substantiates that individuals did cross the road while it was used by mining traffic. We could only confidently distinguish day vs. night crossings for 54% of the total crossings made by bears within the lease area, 86% of which were documented as daytime crossings. The GPS location data, collected at minimum every 4 hours, was not frequent enough to allow us to identify specific crossing locations.

We summarized denning characteristics from known den sites in the Gregg/Luscar area. Bears frequenting the Gregg/Luscar mine area denned in sites very typical of other bear dens across the BPU. Mine bears and other bears across the BPU selected den sites of nearly identical slope angle and within very similar elevations. Males and females across both areas selected mostly east and north aspects on which to den. There were 4 den sites within the Gregg/Luscar lease area boundary, on mine lease lands that were beyond the core of mining activity.

A summary of grizzly bear diet, using fecal analysis data from bears using the Gregg/Luscar Mine lease area, indicated that animal protein was the most predominant food for males on a multi-annual average. For female grizzlies during the same period, roots were the most predominant food consumed. We compared these analyses to the diet of female bears across the BPU and found that animal protein for these females was a less significant part of the diet than females in the Gregg/Luscar area, whereas berries were the most significant.

The previous chapter of this report addressed bear use within and around the Cheviot Mine lease area, prior to any mining activity. There are challenges in drawing direct comparisons between these two study areas, specific to the analysis of bear response to areas of active mining versus areas where mining is scheduled to begin. The two study areas are, and historically have been, quite different in their topography, vegetation and human use. The intent of this project was to summarize our knowledge of grizzly bear use in the Cheviot area prior to mining development, and to summarize how bears used the active Gregg/Luscar Mine area over the past 6 years. We summarize and provide models and tools that are currently available to incorporate into the planning and operations of the Cheviot Mine for the long-term benefit to bears. Similarly, as mining activity in the Gregg/Luscar area ceases and reclamation proceeds, these models could guide the re-establishment of important habitat conditions and movement corridors for bears, while minimizing mortality risk.

We recommend that the spatial mine activity data for the Gregg/Luscar Mine, as provided by CRO for this project, be used to update the RSF habitat model within the permit area boundary. This would provide a better predictive model of seasonal grizzly bear use within the Gregg/Luscar area.

With this summary of specific grizzly bear use of the Cheviot and Gregg/Luscar regions, combined with predictive habitat, mortality and movement corridor models, regional resource managers and local industry sectors should be well equipped to make informed decisions towards optimal grizzly bear conservation.

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4.0 DNA-BASED MONITORING DESIGN FOR GRIZZLY BEAR POPULATIONS NEAR THE CHEVIOT MINE AREA.

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4.1 Introduction

This report presents the design for a DNA-based monitoring plan for potential impacts of the recent Cheviot Mine haul road and accompanying open pit coal mine on local grizzly bear populations. A haul road has recently been constructed near the Cheviot mine site. The large volume of traffic and mine activity has potential to impact local grizzly bear population distribution and demography in the vicinity of the mine site and haul road.

The primary objective of monitoring efforts will be the detection of change in bear distribution and demography relative to the Cheviot mine haul road and surrounding area. This will be accomplished through modeling of trend in bear distribution and demography in the Cheviot mine site and surrounding area. This work will be integrated with DNA sampling efforts in 2004 in the larger regional grizzly bear population unit between Highways 16 and 11, and the planned re-sampling of this management unit in the future.

4.2 Methods

The primary methodology for monitoring will be sampling of DNA hair snag sites and associated genotyping of bear hair from sites (Woods et al. 1999). The occurrence and number of bears identified at bait sites will be used to assess bear distribution around mine site areas. In addition, if sample sizes permit, the resulting data will be used to monitor the demography of bears within the sampling area. Each of these topics is now covered separately.

4.21 <u>Monitoring of bear occurrence</u>

In 2004, a large-scale DNA grizzly bear inventory occurred in the grizzly bear management unit between Highways 16 and 11, which included the Cheviot mine and surrounding area (Figure 1). This effort provides a baseline dataset for bear abundance and distribution in the Cheviot area. The basic design of the Cheviot monitoring project will use bait sites that were sampled during this project. By doing this, data for an initial sampling session will be already collected. In addition, this should allow for results from the Cheviot project to be integrated with future provincial sampling in the area.

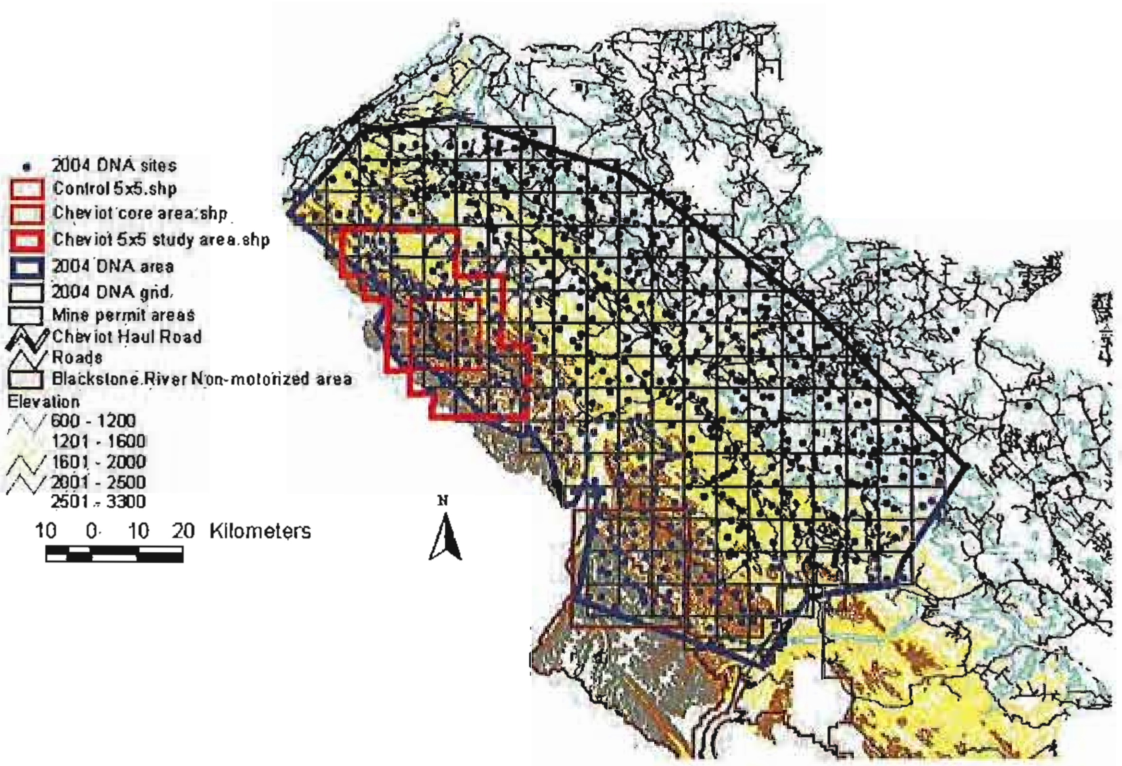

Figure 4-1. The Alberta 2004 Grizzly Bear DNA census area with the proposed Cheviot study area

Various factors such as habitat type, time of year, and age/sex class of bears can influence bear distribution. The main challenge of monitoring will be attempting to separate these factors from the potential influence of the Cheviot mine. We propose the following approach. First, an occupancy model (MacKenzie et al. 2003; MacKenzie et al. 2002; MacKenzie et al. 2004) will be developed from the 2004 DNA data sampling effort. This model will estimate probabilities of occurrence for grizzly bears at each of the bait sites that were sampled during the 2004 sampling effort. Inputs for this model with be IDT habitat classes and RSF scores from previous GPS collar-based RSF models (Nielsen et al. 2002). This will provide a baseline model of occurrence for bears in the Cheviot mine area. The area around the Cheviot mine will then be sampled in yearly or bi-yearly intervals. The occurrence data from these efforts will then be integrated into the model developed from the 2004 data with the objective of determining if the probabilities of occurrence for bait sites around the Cheviot mine site has changed in comparison to other areas that are further from the site. Occupancy models are currently implemented in program MARK (White and Burnham 1999).

4.22 Monitoring of bear demography

A secondary objective of sampling efforts will be the modeling of bear demography in the Cheviot mine site area. The basic approach involves tracking the fates of genotyped bears sampled at bait sites in the Cheviot area over time. For example, approximately 19 bears were identified in the proposed Cheviot area during the 2004 DNA surveys. If the area is sampled in subsequent year some of these bears may be recaptured in bait sites, and some previously identified bears might also be captured. The resulting data set can be modeled using open mark recapture models. These models estimate rates of bear additions (births and immigration), apparent survival (emigration and death), population trend (λ), and recapture rate (Boulanger et al. 2004a; Pradel 1996). In addition, environmental covariates can be used to explore factors affecting population demography. For example, Boulanger et al. (2004a) used this methodology to estimate trend for grizzly bears in coastal British Columbia, and associate bear demography with escapement levels of salmon.

The main constraint for this approach is sample size and subsequent power. The sample size of bears in the Cheviot study area is relatively low and therefore recapture rates of bears will have to be higher to have adequate power to detect changes in population size and demography. In 2004, approximately 19 bears were genotyped in the proposed Cheviot study area. We can assume that the actual number of bears is higher in the area given that not all bears are captured in DNA efforts. This would put the number closer to 25 which is the minimal number of bears needed in a study area for demographic modeling (John Boulanger, unpublished data). For this reason, we suggest a sampling design with relatively intensive bait site coverage. This approach also will provide finer scale inference for monitoring of bear distribution.

4.23 Proposed study area and study design

We propose a study area that encompasses the Cheviot, Greg River, and Cardinal River Coals mine areas. The boundaries of this study area are roughly based upon grid cells for the 2004 inventory project. To make the best use of the 2004 data we suggest that the same sites that were sampled in 2004 be sampled for the Cheviot mine area unless sites are too close so that independence of captures cannot be assumed (as discussed later). We suggest that a 5x5 km grid cell size be used for sampling the primary study area. One bait site will be sampled per session in each cell. For the core study area, 2 sites (that are greater than 1.69 km apart) will be sampled to allow higher resolution for the actual Cheviot area. This study area would contain 41 5x5 cells. Nine cells would be in the core area that would contain 2 bait sites. This would result in 50 bait sites being sampled each session (Figure 4-2).

Two 10-14 day sampling sessions will be conducted on a yearly basis for three years after which monitoring will occur on a bi or tri-yearly basis. This design will allow quick collection of preliminary data needed to obtain estimates for open mark-recapture models We suggest that the initial data is analyzed after 3-4 years to assess approximate trends in distribution demography and sample sizes of bears. At this time, the optimal subsequent monitoring interval can be more easily determined. Sampling would occur in the early spring when most DNA mark-recapture projects occur (Boulanger et al. 2002).

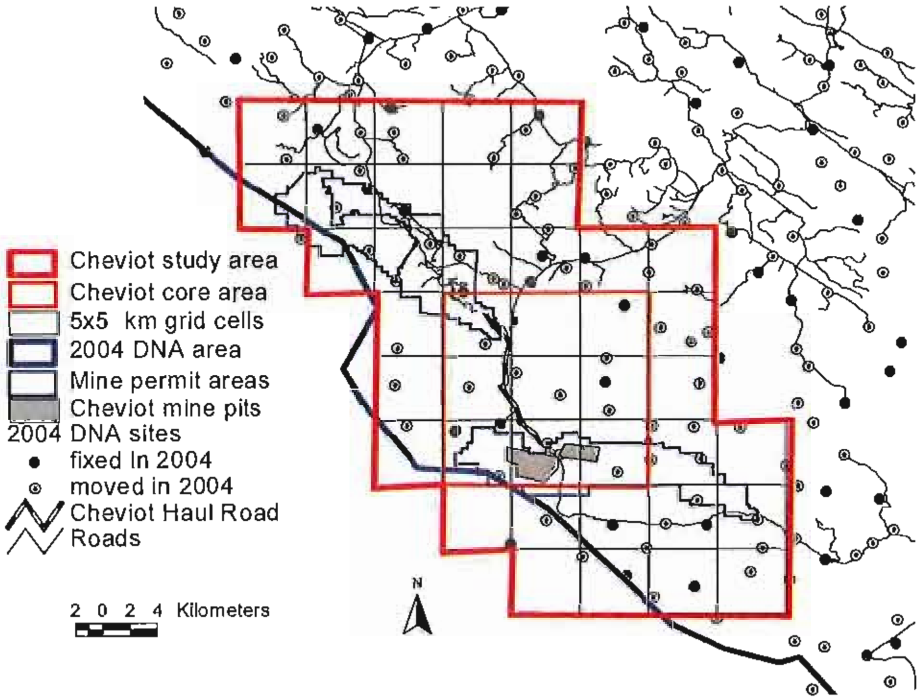

Figure 4-2. Proposed Cheviot study area with 5x5 km cells

4.24 <u>The need for control areas</u>

One inherent issue with this study is that inference about spatial change in bear distribution and demography around the mine areas will be limited to the immediate Cheviot study area. Therefore, it will be difficult to determine if trends in the Cheviot area are part of a larger trend in the population unit. For example, it will be difficult to determine if a decreasing population of bears in the area is due to factors specific to Cheviot, or an overall decrease in the population unit. One direct way to account for this would be to sample a control area. One area that is less influenced by road access issues is the Blackstone non-roaded area. We propose that a smaller grid of 25 5x5 km grid cells (with 1 bait site) is also sampled (Figure 3). This will provide a contrast with the Cheviot area in terms of habitat use. In addition, study-area specific covariates could be used to further infer difference in demography between the Cheviot and Blackstone areas. Finally, joint modeling of demography from the Cheviot and Blackstone area will increase sample size of marked bears therefore increasing the power and precision of monitoring results (Boulanger et al. 2004a).

Alternatively, a partial control will be available in 2009 when this population unit is re-sampled as part of a provincial monitoring program. This data will provide a snapshot of spatial distribution for other parts of this population unit, which will be particularly useful for habitat modeling. However, it will not be possible to integrate this data into demographic mark-recapture models that require concurrent sampling between the Cheviot and other areas for every year that the Cheviot area is sampled.

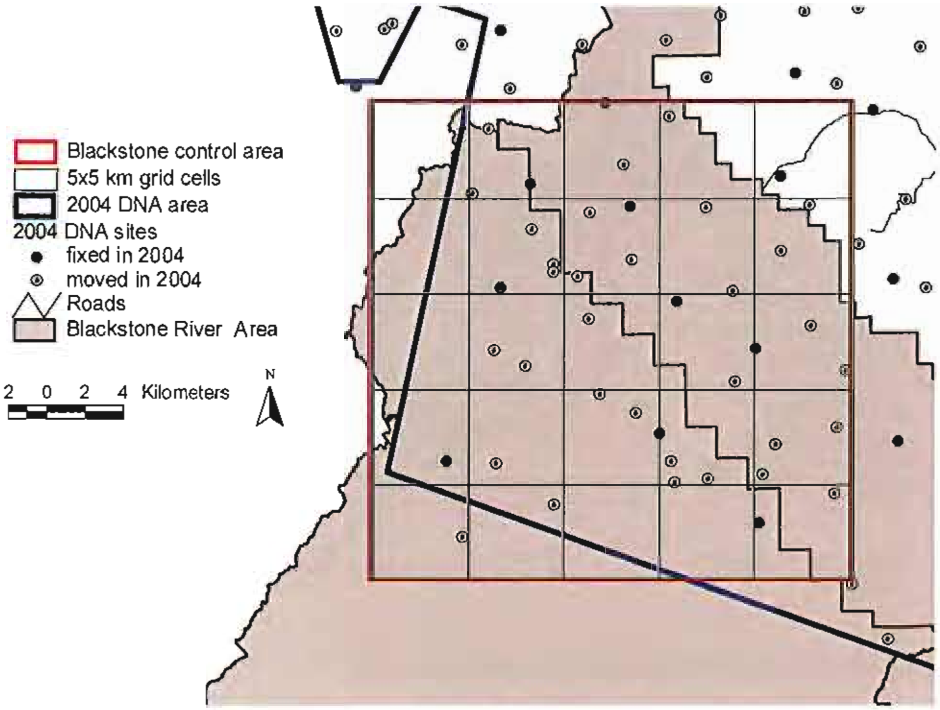

Figure 4-3. Proposed control area in the Blackstone non-motorized area

4.25 <u>Site selection</u>

A primary objective for site selection will be the use of bait sites used in the 2004 inventory. However, many of these sites are very close together and therefore independence of bear captures cannot be assumed which would bias habitat selection analyses. We used a buffer distance of 1.69 kilometers as the distance at which bait sites are independent. This is based upon the work of Boulanger et al. (2004b) who estimated that 95% of bear captures occurred for GPS bears that came within 1.69 kilometers of bait sites. Therefore this could be considered the maximum attraction radius of sites. We buffered the 2004 bait sites to determine which sites were independent given this rule (Figures 4 and 5). We suggest that a single independent bait site is picked from the 2004 data for each 5x5 km cell using this rule. Priority should be given to sites that were fixed for 4 sampling sessions in 2004 given that these sites received the most sampling effort. It can be seen that independent sites can be chosen in most cells including the core cells that would receive 2 sites each. A site that is near the border of a cell can be considered in any cell in which its 1.69 km buffer overlaps. In some cases new sites may need to be added to cells, however, we suggest the use of 2004 sites for the majority of cells.

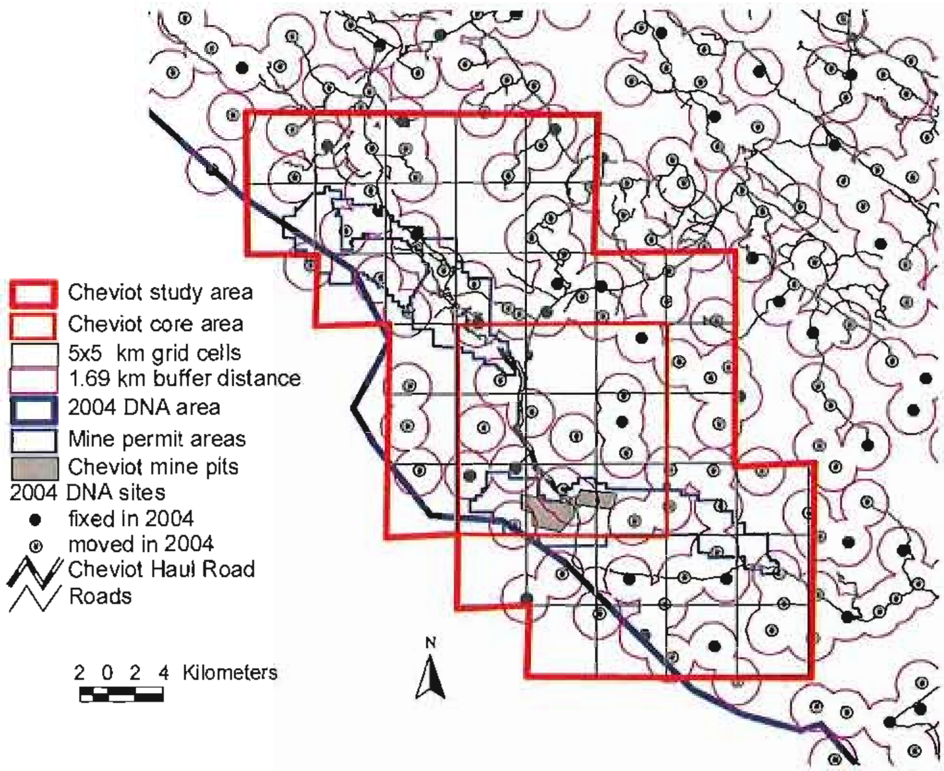

Figure 4-4. Cheviot area study area with 2004 bait sites that are buffered by 1.69 km.

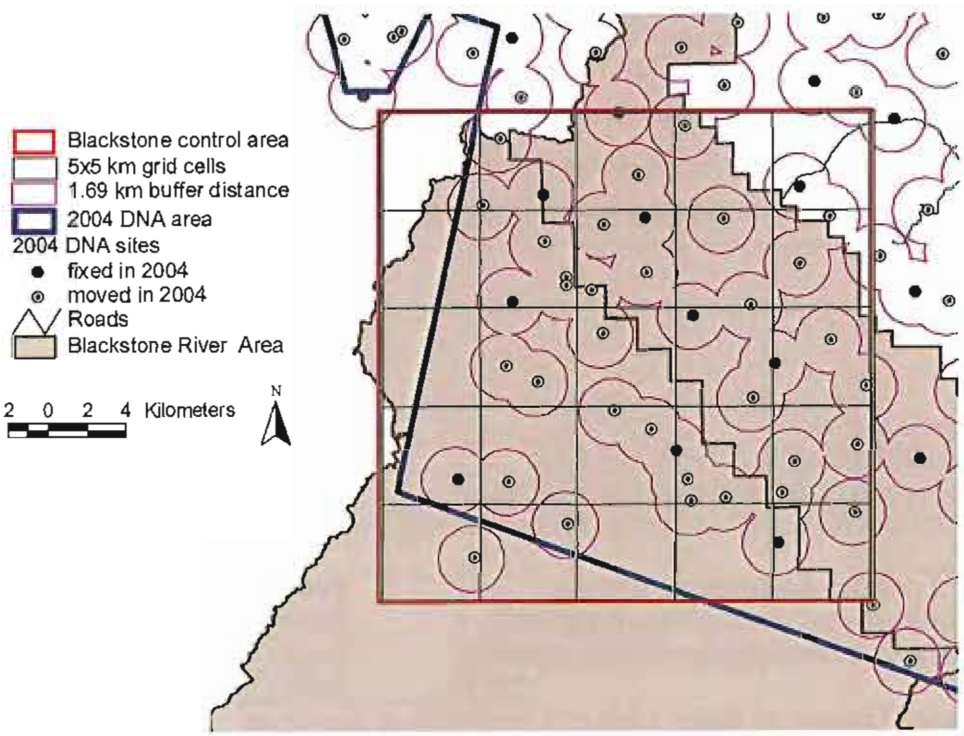

Figure 4-5: Blackstone control area with 2004 bait sites that are buffered by 1.69 km.

4.26 The need for expert personnel

We emphasize that the methods suggested for this project all demand expert personnel to assure success of the monitoring project. A DNA project can be conceptualized as a multi-step process (i.e. study design-fieldwork-genetic analysis-mark-recapture analysis). Suboptimal implementation of any step can seriously compromise the results regardless of how well other steps were implemented. For this reason we recommend the use of expert bear biologists with prior DNA sampling experience, geneticists with experience with DNA hair samples (i.e. Wildlife Genetics International, Nelson, BC), and biometricians experienced with recent mark-recapture modeling techniques.

4.3 Proposed Schedule

We propose the following sampling schedule. We suggest that the preliminary demographic data is analyzed after 2007. This will give a rough idea of estimate precision. Using this data the sampling program could be optimized to meet target levels of precision and power. After 2016, the monitoring would continue on a three-year schedule, or optimal schedule determined by the analysis of mark-recapture data.

Table 4-1: Proposed sampling schedule

Year	Action
2006	➢ 2 season sampling for study area and control area
2007	➢ 2 season sampling for study area and control area
	➢ Assessment of preliminary demographic data using open mark-recapture models. Potential adjustment of schedule
2010	➢ 2 season sampling for study area and control area
2013	➢ 2 season sampling for study area and control area
2016	➢ 2 season sampling for study area and control area

4.4 Budget*

Bait	$ 2,000.00
Supplies and Materials	$ 4,500.00
Vehicle Rental (1 month 2 vehicles and fuel)	$ 4,000.00
Helicopter Support ($1000/hour with fuel) 30 hours	$30,000.00
DNA Lab Analysis (based on current density estimates)	$20,000.00
Personnel	
3 teams of 2 persons (6x$200/dayx40days)	$48,000.00
Statistical Analysis and Report (15 days@$450)	$ 6,750.00
Project Leader and Management (10 days@$450)	$ 4,500.00
TOTAL	**$119,750.00**

***annual budget based on study area and control area sampling**

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APPENDIX A

Minimum numbers of bear crossings of the Grave Flats road within the Cheviot permit area between known dates and time of day.

Year	Bear ID	Min. # of crossings	From (Date Time)	From Period	To (Date Time)	To Period	In/Out Permit Area
1999							
	003	3	6/9/99 19:02	day	6/10/99 7:02	day	out
		1	6/1/99 7:02	day	6/1/99 15:17	day	out
	004	1	6/13/99 16:31	day	6/13/99 20:31	day	out
		1	6/16/99 20:31	day	6/17/99 0:31	night	in
		1	7/8/99 20:32	day	7/9/99 0:30	night	out
		1	7/29/99 16:31	day	7/29/99 20:31	Day	out
		1	10/18/99 8:30	day	10/18/99 20:31	night	out
		1	10/18/99 20:31	night	10/19/99 8:32	Day	out
	016	1	6/29/99 15:31	day	6/29/99 23:31	night	out
		1	6/28/99 19:32	day	6/29/99 23:32	night	out
	006	1	6/9/99 20:03	day	6/10/99 0:11	night	in
	008	1	9/2/99 9:02	day	9/3/99 9:03	day	out
		1	6/28/99 21:02	day	6/29/99 5:01	day	out
		1	8/19/99 17:02	day	8/19/99 21:02	night	out
		1	8/20/99 5:01	night	8/20/99 13:02	day	out
		1	7/7/99 17:02	day	7/7/99 21:01	day	in
		1	8/7/99 5:01	night	8/7/99 9:02	day	in
		1	5/20/99 5:01	day	5/20/99 9:01	day	out
		1	5/19/99 9:02	day	5/19/99 13:01	day	out
		1	6/13/99 1:01	night	6/13/99 5:01	day	out
		1	7/5/99 5:02	day	7/5/99 9:01	day	out
		1	9/3/99 21:02	night	9/4/99 17:03	day	out
2000							
	004	1	6/14/00 2:01	night	6/14/00 10:02	day	out
		1	6/21/00 18:01	day	6/21/00 22:01	night	out
		1	5/28/00 22:02	night	5/29/00 2:02	night	out
	006	1	5/19/00 6:00	day	5/19/00 22:01	night	out
		1	5/24/00 18:01	day	5/24/00 22:01	night	out
	029	1	8/1/00 3:17	night	8/1/00 11:28	day	out
		1	6/2/00 3:19	night	6/2/00 7:04	day	out
		1	6/2/00 7:04	day	6/2/00 23:03	night	out
		1	7/30/00 19:07	day	8/1/00 3:17	night	out
2001							
	003	1	6/26/01 16:00	day	6/27/01 0:06	night	out
		1	6/9/01 4:01	night	6/9/01 8:01	day	In

Year	Bear ID	Min. # of crossings	From (Date Time)	From Period	To (Date Time)	To Period	In/Out Permit Area
		1	8/1/01 4:01	night	8/1/01 20:02	day	out
		1	6/10/01 16:00	day	6/11/01 0:05	Night	out
	003	1	5/23/01 4:00	night	5/23/01 8:00	day	out
		1	8/2/01 12:02	day	8/2/01 16:01	day	in
		1	6/26/01 8:00	day	6/26/01 12:00	day	in
		1	5/23/01 16:00	day	5/23/01 20:00	day	in
	004	2	7/30/01 22:04	night	7/31/01 10:19	day	out
	016	1	8/10/01 5:01	night	8/10/01 13:01	day	out
2002							
	008	1	7/12/02 17:16	day	7/13/02 5:15	day	in
		1	9/18/02 17:15	day	9/18/02 21:15	night	out
		1	9/9/02 13:15	day	9/9/02 17:15	day	out
		1	9/17/02 13:16	day	9/18/02 1:16	night	out
		1	8/21/02 17:15	day	8/22/02 1:16	night	out
		1	8/27/02 5:15	night	8/27/02 9:15	day	out
		1	9/6/02 5:17	night	9/6/02 5:16	night	out
		1	7/5/02 9:15	day	7/6/02 1:16	night	out
2003							
	028	2	7/26/02 10:16	day	7/26/02 22:16	night	out
	043	1	10/1/03 6:15	night	10/1/03 9:15	day	in
		1	9/28/03 15:16	day	9/29/03 6:15	night	in
		1	10/14/03 11:15	day	10/14/03 15:15	day	in
		1	10/3/03 6:15	night	10/3/03 9:15	day	out
		1	10/23/03 15:16	day	10/24/03 6:15	night	out
		1	10/22/03 20:16	night	10/23/03 6:16	night	out
		1	7/16/03 6:15	day	7/16/03 11:15	day	out
		1	8/23/03 20:16	night	8/24/03 6:15	day	out
		1	9/17/03 15:16	day	9/18/03 6:16	night	out
	044	1	5/31/03 6:18	day	6/1/03 2:05	night	in
		1	9/28/03 14:19	day	9/28/03 18:04	day	in
		1	9/19/03 10:34	day	9/19/03 14:19	day	in
		1	10/1/03 6:04	night	10/1/03 14:34	day	in
		1	8/5/03 18:04	day	8/6/03 2:04	night	in
		2	6/2/03 18:40	day	6/3/03 10:35	day	in
		1	6/1/03 2:05	night	6/2/03 18:40	day	in
		1	10/13/03 6:36	night	10/13/03 10:03	day	out
		1	9/24/03 6:24	night	9/24/03 22:06	night	out
		1	10/3/03 6:03	night	10/3/03 10:04	day	out
		1	9/18/03 6:03	night	9/18/03 18:05	day	out
	055	1	9/10/03 6:15	night	9/10/03 10:16	day	out
		2	9/11/03 6:16	night	9/11/03 18:16	day	out
		1	8/24/03 2:16	night	8/24/03 6:17	day	out

APPENDIX B

Minimum numbers of bear crossings of Highway 40, inside of the Gregg/Luscar Mine permit area, between known dates and time of day.

Year	Bear ID	Min. # of crossings	From Date	From Time	From period	To Date	To Time	To Period
1999	008	1	14-Jul	21:02	day	16-Jul	1:02	night
	017	1	4-Jun	20:02	day	5-Jun	0:03	night
	020	1	1-Jul	18:02	day	2-Jul	10:02	day
	029	2	4-Jun	23:01	night	5-Jun	3:01	night
		1	5-Jun	7:01	day	5-Jun	11:01	day
		1	5-Jun	19:01	day	5-Jun	23:01	night
		1	5-Jun	23:01	night	6-Jun	3:02	night
		1	6-Jun	7:01	day	6-Jun	11:01	day
		1	6-Jun	11:01	day	6-Jun	15:01	day
		1	6-Jun	19:02	day	6-Jun	23:01	night
		1	7-Jun	3:01	night	7-Jun	7:02	day
		1	10-Jun	15:01	day	10-Jun	23:01	night
		1	30-Jun	19:01	day	30-Jun	23:01	night
		1	16-Jul	19:01	day	17-Jul	3:01	night
2000	014	1	5-Jun	23:03	night	6-Jun	11:34	day
	017	1	27-May	22:03	night	28-May	6:19	day
	020	1	2-Jun	21:01	day	3-Jun	2:00	night
	023	1	25-Jun	22:02	night	26-Jun	6:04	day
		1	26-Jun	22:04	night	27-Jun	10:19	day
		1	3-Aug	22:02	night	4-Aug	6:17	day
	029	1	3-Jun	19:04	day	3-Jun	23:04	night
		1	4-Jun	3:03	night	4-Jun	15:19	day
		1	11-Jun	3:19	night	11-Jun	11:03	day
		4	30-Jul	19:07	day	1-Aug	3:17	night
2001	023	1	5-Jul	3:00	night	5-Jul	5:01	day
		1	10-Jul	23:01	night	11-Jul	1:00	night
	029	1	25-May	22:01	night	26-May	0:05	night
		1	6-Jun	18:01	day	6-Jun	20:01	day
		1	17-Jun	8:01	day	17-Jun	12:01	day
		1	2-Jul	18:00	day	2-Jul	20:00	day
	038	1	18-Jun	6:01	day	19-Jun	14:02	day
	040	1	19-May	17:06	day	19-May	21:04	night
		1	19-May	21:04	night	20-May	1:03	night
		1	22-May	21:19	night	23-May	9:04	day
		1	27-May	5:19	day	27-May	17:04	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From period	To Date	To Time	To Period
		1	27-May	17:04	day	28-May	9:05	day
		1	28-May	21:04	night	29-May	9:35	day
		1	30-May	1:33	night	30-May	17:37	day
		1	3-Jun	9:19	day	3-Jun	13:04	day
		1	8-Jun	5:04	day	8-Jun	17:37	day
		1	14-Jun	21:35	night	16-Jun	1:07	night
		1	19-Jun	21:04	day	20-Jun	5:34	day
		1	24-Jun	9:35	day	27-Jun	1:42	night
		1	2-Jul	5:19	day	2-Jul	13:20	day
		1	4-Jul	17:04	day	6-Jul	21:22	night
		1	6-Jul	21:22	night	7-Jul	21:05	day
		1	7-Jul	21:05	day	10-Jul	1:10	night
		1	13-Jul	13:14	day	14-Jul	9:35	day
		1	15-Jul	9:21	day	16-Jul	5:05	day
		1	24-Jul	9:37	day	29-Jul	17:44	day
		1	29-Jul	17:44	day	31-Jul	13:37	day
		1	31-Aug	6:03	day	2-Sep	9:20	day
		1	2-Sep	9:20	day	5-Sep	9:43	day
	100	1	12-Jun	22:01	night	13-Jun	14:01	day
		2	24-Jun	14:01	day	25-Jun	2:01	night
		1	14-Jul	10:01	day	14-Jul	18:02	day
		1	14-Jul	18:02	day	14-Jul	22:02	night
2002	008	1	20-Jun	5:16	day	20-Jun	9:16	day
	023	1	6-Jun	13:16	day	7-Jun	9:16	day
		1	4-Jul	18:16	day	5-Jul	4:16	night
		1	11-Jul	4:15	night	11-Jul	23:16	night
		1	13-Jul	9:15	day	13-Jul	23:16	night
	037	1	6-Sep	15:17	day	7-Sep	6:16	day
		1	14-Sep	6:16	night	14-Sep	20:17	night
		1	16-Sep	15:17	day	17-Sep	6:17	night
		1	17-Sep	6:17	night	17-Sep	20:17	night
		1	19-Sep	6:16	night	19-Sep	15:17	day
		1	26-Sep	1:16	night	27-Sep	1:16	night
		1	12-Oct	15:16	day	13-Oct	1:16	night
		2	17-Oct	20:17	night	19-Oct	1:16	night
		2	20-Oct	6:16	night	20-Oct	11:17	day
		1	20-Oct	20:16	night	21-Oct	11:17	day
	040	1	13-May	11:16	day	13-May	23:16	night
		1	16-May	11:15	day	16-May	15:16	day
		1	5-Jun	3:16	night	5-Jun	7:16	day
		1	11-Jun	15:16	day	11-Jun	23:17	night
		1	11-Jun	23:17	night	12-Jun	11:16	day
		1	17-Jun	11:16	day	18-Jun	7:16	day
		1	3-Jul	19:16	day	4-Jul	7:15	day
		1	7-Jul	11:16	day	7-Jul	23:16	night
		1	8-Jul	23:16	night	9-Jul	7:16	day
		1	14-Jul	11:16	day	14-Jul	19:16	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From period	To Date	To Time	To Period
		1	17-Jul	19:16	day	18-Jul	3:17	night
		2	18-Jul	3:17	night	18-Jul	11:16	day
		1	10-Aug	7:15	day	10-Aug	11:17	day
		1	20-Oct	7:15	night	20-Oct	15:16	day
		1	30-Oct	11:15	day	30-Oct	15:16	day
	100	1	18-Jul	16:34	day	18-Jul	20:34	day
		1	18-Jul	20:34	day	19-Jul	0:03	night
		1	29-Jul	4:04	night	29-Jul	8:34	day
		1	14-Nov	20:08	night	15-Nov	8:34	day
2003	023	1	5-Jun	4:16	night	5-Jun	9:16	day
		1	9-Jun	4:16	night	10-Jun	18:16	day
		1	23-Jun	23:16	night	24-Jun	13:16	day
		1	1-Jul	18:16	day	2-Jul	4:15	night
		1	3-Jul	23:16	night	4-Jul	4:16	night
		1	7-Jul	4:16	night	7-Jul	9:16	day
		1	9-Jul	23:16	night	10-Jul	4:16	night
		1	16-Jul	4:16	night	16-Jul	13:16	day
		1	22-Jul	23:16	night	23-Jul	4:16	night
	040	1	21-May	11:16	day	21-May	15:16	day
		1	26-May	11:16	day	26-May	15:16	day
		1	31-May	7:16	day	31-May	11:17	day
		1	3-Jun	7:16	day	3-Jun	11:16	day
		1	4-Jun	7:16	day	4-Jun	15:17	day
		1	6-Jun	19:17	day	6-Jun	23:16	night
		1	19-Jun	19:17	day	20-Jun	7:17	day
		1	20-Jun	19:16	day	21-Jun	7:16	day
		1	27-Jun	7:16	day	27-Jun	15:17	day
		1	27-Jun	15:17	day	27-Jun	19:15	day
		1	27-Jun	19:15	day	28-Jun	7:16	day
		1	28-Jun	23:16	night	29-Jun	7:16	day
		1	3-Jul	7:16	day	3-Jul	19:16	day
		1	4-Jul	7:16	day	4-Jul	11:16	day
		1	4-Jul	19:16	day	5-Jul	11:16	day
		1	6-Jul	7:16	day	7-Jul	7:15	day
		1	7-Jul	7:15	day	7-Jul	15:16	day
		1	8-Jul	3:16	night	8-Jul	11:16	day
		1	11-Jul	19:16	day	11-Jul	23:16	night
		1	11-Jul	23:16	night	12-Jul	7:17	day
		1	12-Jul	19:16	day	12-Jul	23:15	night
		1	13-Jul	23:16	night	14-Jul	7:16	day
		1	14-Jul	11:16	day	14-Jul	19:16	day
		1	16-Jul	7:16	day	16-Jul	11:16	day
		1	16-Jul	11:16	day	16-Jul	19:17	day
		1	18-Jul	3:17	night	18-Jul	7:16	day
		1	18-Jul	7:16	day	18-Jul	11:15	day
		1	20-Jul	19:15	day	21-Jul	19:16	day
		1	22-Jul	11:16	day	22-Jul	23:16	night
		1	27-Jul	15:16	day	27-Jul	19:17	day
		1	31-Jul	3:16	night	31-Jul	15:17	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From period	To Date	To Time	To Period
		1	31-Jul	15:17	day	1-Aug	15:16	day
		1	4-Aug	3:17	night	4-Aug	7:17	day
		1	5-Aug	3:17	night	5-Aug	7:16	day
		1	5-Aug	7:16	day	5-Aug	11:15	day
		2	5-Aug	19:15	day	6-Aug	3:17	night
		1	6-Aug	3:17	night	6-Aug	7:16	day
		1	6-Aug	7:16	day	6-Aug	19:16	day
		1	7-Aug	7:16	day	7-Aug	19:16	day
		1	7-Aug	19:16	day	8-Aug	3:16	night
		1	24-Aug	3:15	night	24-Aug	11:15	day
		1	24-Aug	11:15	day	24-Aug	15:16	day
		1	1-Sep	15:16	day	1-Sep	19:16	day
		1	1-Sep	19:16	day	2-Sep	7:15	day
		1	3-Sep	11:16	day	3-Sep	19:16	day
		1	11-Sep	15:16	day	11-Sep	19:15	day
		1	11-Sep	23:17	night	12-Sep	7:15	day
		1	25-Sep	15:17	day	25-Sep	19:16	night
		2	26-Sep	19:16	night	27-Sep	7:16	day
		1	27-Sep	15:16	day	27-Sep	19:16	night
		1	27-Sep	19:16	night	28-Sep	7:16	day
		1	28-Sep	7:16	day	28-Sep	15:18	day
		1	10-Oct	7:17	day	10-Oct	11:16	day
		1	10-Oct	11:16	day	10-Oct	15:16	day
		1	11-Oct	7:17	day	11-Oct	11:16	day
		1	19-Oct	15:15	day	20-Oct	7:16	night
		1	21-Oct	19:16	night	21-Oct	23:16	night
		1	22-Oct	7:16	night	22-Oct	11:17	day
		1	22-Oct	15:16	day	22-Oct	19:16	night
		1	23-Oct	15:16	day	24-Oct	11:16	day
		1	24-Oct	11:16	day	24-Oct	15:16	day
		1	24-Oct	15:16	day	25-Oct	3:16	night
		1	25-Oct	7:16	night	25-Oct	15:16	day
	100	1	12-May	20:16	day	13-May	15:16	day
		1	8-Jun	6:16	day	9-Jun	6:16	day
		1	9-Jun	20:16	day	12-Jun	11:16	day
2004	100	1	6-May	1:16	night	6-May	20:16	day

APPENDIX C

Minimum numbers of bear crossings of Highway 40, outside of the Gregg/Luscar Mine permit area, between known dates and time of day.

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
1999	008	1	5-Jun	1:01	night	5-Jun	9:02	day
		1	6-Jun	21:01	day	7-Jun	1:01	night
		1	14-Jun	21:02	day	15-Jun	1:02	night
		1	15-Jun	9:02	day	15-Jun	21:01	day
		1	29-Jun	13:01	day	29-Jun	17:02	day
		1	30-Jun	5:02	day	30-Jun	13:01	day
		1	5-Aug	17:02	day	5-Aug	21:02	night
	017	1	30-May	13:02	day	30-May	17:32	day
		1	2-Jun	13:03	day	2-Jun	21:31	night
	020	1	14-Jun	18:02	day	14-Jun	22:01	night
		1	16-Jun	18:02	day	16-Jun	22:02	night
		1	16-Jun	22:02	night	17-Jun	10:02	day
		1	17-Jun	14:02	day	17-Jun	18:02	day
		1	17-Jun	18:02	day	18-Jun	10:02	day
		1	25-Jun	14:01	day	25-Jun	22:01	night
		1	26-Jun	2:02	night	26-Jun	10:02	day
		1	10-Jul	18:02	day	11-Jul	10:02	day
		1	11-Jul	10:02	day	11-Jul	14:02	day
		1	14-Jul	14:02	day	14-Jul	18:02	day
		1	15-Jul	14:01	day	15-Jul	18:02	day
		1	16-Jul	18:01	day	16-Jul	22:01	night
		1	16-Jul	22:01	night	17-Jul	6:01	day
		1	17-Jul	6:01	day	17-Jul	10:01	day
		1	18-Jul	18:02	day	18-Jul	22:01	night
		1	18-Jul	22:01	night	19-Jul	2:01	night
		1	22-Jul	22:02	night	23-Jul	6:01	day
		1	24-Jul	14:01	day	24-Jul	18:02	day
		1	24-Jul	18:02	day	24-Jul	22:01	night
		1	24-Jul	22:01	night	25-Jul	2:01	night
		1	26-Jul	10:02	day	26-Jul	22:01	night
		3	29-Jul	6:01	day	29-Jul	14:01	day
		1	7-Aug	10:02	day	7-Aug	18:01	day
		1	18-Aug	18:01	day	19-Aug	2:01	night
		1	19-Aug	10:02	day	19-Aug	14:02	day
		1	21-Aug	18:01	day	21-Aug	22:01	night
		1	7-Sep	14:01	day	7-Sep	18:02	day
		1	11-Sep	14:01	day	11-Sep	18:01	day
		1	11-Sep	18:01	day	11-Sep	22:01	night
		1	20-Sep	18:02	day	20-Sep	22:01	night
		1	25-Sep	18:02	day	25-Sep	22:01	night
		1	25-Sep	22:01	night	26-Sep	6:02	night
		1	26-Sep	6:02	night	26-Sep	10:01	day
		2	27-Sep	18:01	day	27-Sep	22:02	night
		1	2-Oct	18:01	day	2-Oct	22:01	night
		1	2-Oct	22:01	night	3-Oct	10:01	day
		1	3-Oct	10:01	day	3-Oct	14:02	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
		1	4-Oct	18:02	day	4-Oct	22:01	night
		1	5-Oct	2:02	night	5-Oct	10:01	day
		1	5-Oct	18:01	day	5-Oct	22:01	night
		1	6-Oct	6:02	night	6-Oct	10:01	day
		1	7-Oct	6:02	night	7-Oct	10:01	day
		1	7-Oct	14:01	day	7-Oct	18:02	day
		1	7-Oct	18:02	day	7-Oct	22:01	night
		2	7-Oct	22:01	night	8-Oct	2:01	night
		1	8-Oct	6:01	night	8-Oct	10:01	day
		1	18-Oct	6:01	night	18-Oct	10:02	day
		1	20-Oct	6:02	night	20-Oct	14:02	day
		1	20-Oct	22:01	night	21-Oct	2:01	night
		1	21-Oct	2:01	night	21-Oct	6:01	night
		1	5-Nov	22:02	night	6-Nov	10:01	day
	029	1	23-May	19:01	day	23-May	23:01	night
		1	29-May	23:01	night	30-May	3:01	night
		1	7-Jun	19:01	day	7-Jun	23:01	night
		1	11-Jun	3:01	night	11-Jun	7:01	day
		1	11-Jun	11:01	day	11-Jun	15:01	day
		1	11-Jun	15:01	day	11-Jun	19:02	day
		1	11-Jun	23:02	night	12-Jun	3:01	night
		1	12-Jun	3:01	night	12-Jun	14:00	day
		2	13-Jun	19:01	day	13-Jun	23:01	night
		1	14-Jun	15:01	day	14-Jun	19:01	day
		1	15-Jun	3:01	night	15-Jun	7:01	day
		1	17-Jun	15:01	day	17-Jun	19:01	day
		1	18-Jun	7:02	day	18-Jun	11:01	day
		1	18-Jun	19:01	day	19-Jun	3:01	night
		1	28-Jun	15:02	day	29-Jun	3:01	night
		1	1-Jul	3:01	night	1-Jul	11:01	day
		1	5-Jul	14:00	day	5-Jul	11:01	day
		1	8-Jul	11:02	day	8-Jul	23:01	night
		1	17-Jul	15:01	day	17-Jul	19:01	day
		1	24-Jul	19:01	day	24-Jul	23:01	night
		1	25-Jul	19:01	day	25-Jul	23:02	night
		1	27-Jul	23:01	night	28-Jul	3:02	night
		1	28-Jul	3:02	night	28-Jul	7:01	day
		1	29-Jul	7:01	day	29-Jul	11:01	day
		1	30-Jul	23:01	night	31-Jul	3:02	night
		1	31-Jul	3:02	night	31-Jul	7:01	day
		1	4-Aug	3:01	night	4-Aug	7:01	day
		1	5-Aug	3:01	night	5-Aug	7:01	day
		1	12-Aug	19:01	day	12-Aug	23:02	night
		1	15-Aug	19:02	day	15-Aug	23:01	night
2000	014	1	28-May	19:18	day	28-May	23:03	night
		1	4-Jun	15:19	day	4-Jun	23:03	night
		2	10-Jun	15:33	day	11-Jun	3:04	night
		1	15-Jun	23:03	night	16-Jun	3:03	night
	017	1	28-May	18:33	day	28-May	22:03	night

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
	020	1	26-Apr	17:01	day	26-Apr	21:01	night
		1	3-Jun	5:01	day	3-Jun	9:01	day
		1	4-Jun	10:00	day	4-Jun	9:02	day
		1	9-Jun	17:01	day	9-Jun	21:01	day
		1	11-Jun	5:01	day	11-Jun	9:01	day
		1	14-Jun	9:01	day	14-Jun	17:01	day
		1	15-Jun	5:01	day	15-Jun	9:01	day
		1	26-Jun	17:01	day	26-Jun	21:01	day
		1	28-Jun	1:01	night	20-Oct	14:02	day
		1	22-Oct	6:01	night	22-Oct	10:01	day
		1	22-Oct	18:01	night	22-Oct	22:02	night
		1	23-Oct	6:00	night	23-Oct	10:01	day
		1	30-Oct	18:00	night	30-Oct	22:01	night
	023	1	9-May	18:33	day	9-May	22:04	night
		1	16-May	2:18	night	16-May	10:03	day
		1	21-May	22:03	night	22-May	2:03	night
		1	23-May	10:19	day	23-May	18:03	day
		1	4-Jun	2:03	night	4-Jun	10:03	day
		1	5-Jun	18:04	day	5-Jun	22:03	night
		1	5-Jun	22:03	night	6-Jun	10:04	day
		1	9-Jun	10:03	day	10-Jun	18:35	day
		1	10-Jun	18:35	day	11-Jun	10:04	day
		1	15-Jun	14:03	day	15-Jun	22:34	night
		1	16-Jun	10:19	day	16-Jun	22:03	night
		1	20-Jun	14:32	day	20-Jun	22:02	night
		1	27-Jun	22:04	night	28-Jun	18:34	day
		1	7-Jul	14:02	day	7-Jul	22:17	night
		1	10-Jul	6:17	day	10-Jul	18:19	day
		1	12-Jul	18:02	day	12-Jul	22:17	night
		1	28-Jul	22:17	night	29-Jul	6:19	day
		1	6-Aug	18:02	day	6-Aug	22:02	night
		1	8-Aug	6:04	day	8-Aug	10:32	day
		1	20-Sep	22:02	night	21-Sep	6:34	night
		1	21-Sep	22:02	night	22-Sep	2:02	night
		1	2-Oct	22:02	night	3-Oct	2:02	night
		1	6-Oct	6:34	night	7-Oct	2:19	night
		1	7-Oct	2:19	night	7-Oct	6:04	night
		1	11-Oct	14:32	day	11-Oct	22:02	night
		1	11-Oct	22:02	night	12-Oct	6:34	night
	029	1	22-May	11:04	day	23-May	7:34	day
		1	8-Jun	19:04	day	8-Jun	23:04	night
		1	9-Jun	3:19	night	9-Jun	19:19	day
		1	14-Jun	19:19	day	14-Jun	23:04	night
		1	25-Jun	15:18	day	25-Jun	23:03	night
		1	11-Jul	0:18	night	11-Jul	12:04	day
		1	13-Jul	0:49	night	13-Jul	2:23	night
		2	14-Jul	0:31	night	14-Jul	4:18	night
		1	22-Jul	0:04	night	22-Jul	1:31	night
		1	22-Jul	1:31	night	22-Jul	16:34	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
2001	017	1	17-May	3:03	night	17-May	19:20	day
		1	19-May	15:19	day	19-May	23:34	night
		1	22-May	19:04	day	22-May	23:03	night
		1	23-May	19:19	day	23-May	23:35	night
		1	6-Jun	3:05	night	7-Jun	11:20	day
	020	1	10-May	10:01	day	10-May	14:01	day
		1	10-May	18:01	day	10-May	22:01	night
		1	22-Oct	14:02	day	22-Oct	18:00	night
		1	22-Oct	18:00	night	22-Oct	22:01	night
		1	23-Oct	2:02	night	23-Oct	10:00	day
		1	23-Oct	18:01	night	23-Oct	22:01	night
		1	24-Oct	2:01	night	24-Oct	10:00	day
		1	24-Oct	18:00	night	24-Oct	22:01	night
		1	25-Oct	6:01	night	25-Oct	10:00	day
		1	25-Oct	18:00	night	25-Oct	22:01	night
		1	26-Oct	6:01	night	26-Oct	10:02	day
		1	26-Oct	18:01	night	26-Oct	22:01	night
		1	27-Oct	18:02	night	30-Oct	14:02	day
		1	30-Oct	14:02	day	30-Oct	18:02	night
		1	30-Oct	22:01	night	31-Oct	18:01	night
	023	1	21-Jul	15:01	day	21-Jul	19:00	day
		1	22-Jul	21:01	night	22-Jul	23:00	night
		1	27-Jul	5:00	day	27-Jul	7:00	day
		1	8-Aug	15:01	day	8-Aug	17:01	day
		1	19-Aug	9:00	day	19-Aug	13:01	day
		1	20-Aug	7:00	day	20-Aug	9:01	day
		1	20-Aug	19:01	day	20-Aug	21:00	night
		1	5-Oct	1:06	night	5-Oct	21:01	night
		1	5-Oct	21:01	night	12-Oct	1:02	night
		1	17-Oct	5:02	night	20-Oct	17:02	day
		1	25-Oct	9:02	day	9-Nov	17:05	night
	029	1	8-May	20:01	day	8-May	22:00	night
		1	15-May	22:02	night	16-May	0:05	night
		1	20-May	4:02	night	20-May	10:01	day
		1	23-May	22:01	night	24-May	2:01	night
		1	24-May	2:01	night	24-May	4:01	night
		1	25-May	2:02	night	25-May	4:01	night
		1	26-May	20:02	day	26-May	22:01	night
		1	27-May	2:01	night	27-May	8:01	day
		2	31-May	18:01	day	1-Jun	4:01	night
		1	3-Jun	2:01	night	3-Jun	6:01	day
		1	4-Jun	6:01	day	4-Jun	10:01	day
		4	18-Jun	0:06	night	18-Jun	6:01	day
		1	19-Jun	18:00	day	19-Jun	20:00	day
		1	20-Jun	16:01	day	20-Jun	22:02	night
		1	3-Jul	0:05	night	3-Jul	2:01	night
		1	3-Jul	2:01	night	3-Jul	6:01	day
		1	4-Jul	6:00	day	4-Jul	8:00	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
		1	8-Jul	0:07	night	8-Jul	2:00	night
		1	8-Jul	2:00	night	8-Jul	4:00	night
		1	11-Jul	1:32	night	11-Jul	19:55	day
		1	15-Jul	20:01	day	15-Jul	22:00	night
		1	18-Jul	4:01	night	18-Jul	10:01	day
		1	23-Jul	20:00	day	23-Jul	22:00	night
		1	4-Oct	12:02	day	4-Oct	14:01	day
		1	5-Oct	12:01	day	5-Oct	14:00	day
		1	17-Oct	16:00	day	17-Oct	22:01	night
	036	1	11-Sep	19:02	day	12-Sep	11:02	day
	038	1	23-May	22:01	night	24-May	2:02	night
		1	18-Jun	2:02	night	18-Jun	6:01	day
	100	1	19-May	10:01	day	19-May	22:01	night
		1	26-May	2:01	night	26-May	14:02	day
		1	6-Jun	18:02	day	6-Jun	22:01	night
		1	10-Jun	18:02	day	10-Jun	22:01	night
		1	13-Jun	18:02	day	14-Jun	2:01	night
		1	14-Jun	18:02	day	14-Jun	22:02	night
		1	14-Jun	22:02	night	15-Jun	14:01	day
		1	20-Jun	18:02	day	20-Jun	22:01	night
		1	20-Jun	22:01	night	21-Jun	2:02	night
		1	21-Jun	2:02	night	21-Jun	10:01	day
		1	21-Jun	18:01	day	21-Jun	22:02	night
		1	22-Jun	6:01	day	22-Jun	10:02	day
		1	23-Jun	2:01	night	23-Jun	14:01	day
		1	24-Jun	2:01	night	24-Jun	6:01	day
		1	27-Jun	18:02	day	28-Jun	6:02	day
		1	4-Jul	2:02	night	4-Jul	6:02	day
		1	4-Jul	6:02	day	4-Jul	10:02	day
		1	6-Aug	14:01	day	6-Aug	22:02	night
		1	21-Sep	6:02	night	21-Sep	10:01	day
		1	25-Sep	18:02	day	25-Sep	22:02	night
		1	28-Sep	18:02	day	28-Sep	22:01	night
		1	4-Oct	22:02	night	5-Oct	2:01	night
		1	5-Oct	14:02	day	5-Oct	22:02	night
		1	10-Nov	14:02	day	10-Nov	22:01	night
		1	10-Nov	22:01	night	11-Nov	2:01	night
2002	008	1	3-Jun	17:16	day	4-Jun	1:17	night
		1	8-Jun	17:16	day	9-Jun	1:16	night
		1	10-Jun	1:16	night	10-Jun	5:16	day
		1	11-Jun	21:17	day	12-Jun	5:16	day
		1	13-Jun	17:16	day	13-Jun	21:16	day
		1	14-Jun	13:16	day	15-Jun	9:16	day
		2	22-Jun	5:17	day	22-Jun	9:16	day
		1	27-Jun	17:16	day	27-Jun	21:16	day
		1	4-Jul	13:15	day	5-Jul	1:16	night
		1	14-Jul	9:16	day	14-Jul	13:16	day
		1	14-Jul	21:16	night	15-Jul	9:16	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
	017	1	14-May	11:16	day	14-May	13:16	day
		2	14-May	13:16	day	14-May	15:16	day
		1	16-Jun	19:16	day	17-Jun	9:17	day
		1	4-Jul	19:15	day	4-Jul	23:16	night
		1	24-Jul	21:15	night	24-Jul	23:15	night
		1	1-Aug	23:16	night	2-Aug	7:16	day
		1	12-Aug	15:17	day	14-Oct	23:21	night
		1	16-Oct	3:16	night	16-Oct	23:16	night
		1	2-Nov	23:16	night	3-Nov	3:16	night
	020	1	12-May	18:02	day	13-May	6:01	day
		1	14-May	18:02	day	15-May	10:01	day
		1	15-May	10:01	day	16-May	10:01	day
		1	18-Jun	10:02	day	19-Jun	2:02	night
		1	19-Jun	10:01	day	19-Jun	18:02	day
		1	19-Jun	18:02	day	19-Jun	22:00	night
		1	19-Jun	22:00	night	20-Jun	2:01	night
		1	20-Jun	6:01	day	20-Jun	18:02	day
		1	23-Jul	22:01	night	24-Jul	6:01	day
		1	24-Jul	18:01	day	24-Jul	22:02	night
		1	24-Jul	22:02	night	25-Jul	2:02	night
		2	25-Jul	2:02	night	25-Jul	6:01	day
		1	25-Jul	6:01	day	25-Jul	10:01	day
	023	1	2-Jun	18:16	day	4-Jun	13:16	day
		1	13-Jun	13:16	day	13-Jun	18:16	day
		1	19-Jun	13:16	day	20-Jun	9:16	day
		2	21-Jun	18:16	day	21-Jun	23:16	night
		3	29-Jun	4:16	night	29-Jun	13:16	day
		1	6-Jul	18:16	day	6-Jul	23:15	night
		1	8-Jul	18:16	day	9-Jul	9:16	day
		1	18-Jul	23:16	night	19-Jul	9:16	day
		1	25-Jul	4:16	night	26-Jul	4:16	night
		1	2-Aug	4:15	night	2-Aug	18:16	day
		3	2-Aug	18:16	day	3-Aug	9:16	day
		1	7-Aug	9:15	day	8-Aug	9:16	day
		1	25-Sep	23:16	night	26-Sep	23:17	night
		1	8-Oct	9:16	day	9-Oct	18:16	night
		1	12-Oct	9:16	day	12-Oct	23:16	night
		1	12-Oct	23:16	night	13-Oct	13:16	day
		1	17-Oct	13:16	day	17-Oct	23:16	night
		1	18-Oct	4:15	night	18-Oct	13:16	day
		1	18-Oct	18:16	night	18-Oct	23:15	night
	037	1	6-Jun	15:16	day	6-Jun	20:17	day
		1	11-Jun	11:16	day	11-Jun	20:17	day
		1	13-Jun	20:17	day	14-Jun	1:16	night
		1	14-Jun	1:16	night	14-Jun	6:16	day
		1	19-Jun	20:16	day	20-Jun	15:17	day
		1	13-Jul	20:17	day	14-Jul	1:16	night
		1	24-Jul	20:16	day	25-Jul	6:16	day
		1	31-Jul	20:16	day	1-Aug	11:16	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
		1	2-Aug	20:16	day	3-Aug	6:17	day
		1	13-Sep	15:16	day	13-Sep	20:16	night
		1	15-Sep	15:16	day	16-Sep	6:16	night
		1	16-Sep	6:16	night	16-Sep	15:17	day
		5	22-Sep	15:16	day	23-Sep	20:17	night
		1	23-Sep	20:17	night	24-Sep	1:16	night
		2	25-Sep	20:17	night	26-Sep	1:16	night
		1	4-Oct	11:17	day	5-Oct	1:16	night
		1	5-Oct	1:16	night	6-Oct	1:16	night
		1	10-Oct	1:16	night	10-Oct	11:16	day
		1	10-Oct	15:17	day	10-Oct	20:16	night
		1	21-Oct	11:17	day	21-Oct	20:16	night
		1	23-Oct	1:17	night	23-Oct	15:17	day
		1	2-Nov	20:16	night	3-Nov	1:16	night
		2	3-Nov	1:16	night	3-Nov	11:17	day
		1	3-Nov	15:17	day	3-Nov	20:16	night
		1	3-Nov	20:16	night	4-Nov	1:17	night
	040	1	22-May	23:16	night	23-May	3:17	night
		1	23-May	3:17	night	23-May	7:16	day
		1	24-May	23:16	night	25-May	7:16	day
		1	25-May	7:16	day	25-May	15:16	day
		1	25-May	15:16	day	25-May	19:16	day
		1	25-May	19:16	day	25-May	23:16	night
		1	25-May	23:16	night	26-May	7:16	day
		1	26-May	15:16	day	26-May	19:16	day
		1	26-May	23:16	night	27-May	3:17	night
		1	27-May	3:17	night	27-May	7:16	day
		1	28-May	3:16	night	28-May	11:16	day
		1	10-Jun	15:16	day	10-Jun	23:16	night
		1	13-Jun	11:16	day	13-Jun	23:16	night
		1	15-Jun	11:16	day	16-Jun	7:16	day
		1	17-Jun	3:17	night	17-Jun	7:16	day
		1	22-Jun	7:15	day	23-Jun	3:16	night
		1	4-Jul	23:16	night	5-Jul	7:16	day
		1	10-Jul	7:16	day	10-Jul	11:17	day
		1	24-Jul	19:16	day	24-Jul	23:16	night
		1	24-Jul	23:16	night	25-Jul	7:15	day
		1	25-Jul	7:15	day	25-Jul	15:17	day
		1	25-Jul	15:17	day	25-Jul	19:16	day
		1	25-Jul	19:16	day	26-Jul	3:16	night
		1	29-Jul	11:16	day	30-Jul	7:16	day
		2	30-Jul	7:16	day	30-Jul	23:17	night
		1	2-Aug	19:16	day	3-Aug	7:15	day
		2	3-Aug	7:15	day	3-Aug	11:15	day
		1	3-Aug	11:15	day	3-Aug	15:17	day
		1	3-Aug	15:17	day	4-Aug	3:17	night
		1	10-Aug	19:16	day	11-Aug	3:16	night
		1	2-Sep	23:16	night	3-Sep	3:15	night
		1	9-Sep	15:16	day	10-Sep	3:16	night
		1	11-Sep	11:16	day	11-Sep	23:16	night
		1	12-Sep	7:16	day	12-Sep	15:17	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
		1	15-Sep	7:16	day	15-Sep	11:17	day
		1	15-Sep	11:17	day	15-Sep	15:17	day
		1	17-Sep	23:16	night	18-Sep	7:17	day
		1	18-Sep	15:16	day	18-Sep	23:16	night
		2	19-Sep	15:17	day	19-Sep	19:16	night
		1	19-Sep	19:16	night	20-Sep	3:16	night
		1	3-Oct	7:16	day	3-Oct	15:15	day
		1	4-Oct	7:15	day	4-Oct	11:16	day
		1	4-Oct	11:16	day	4-Oct	15:16	day
		1	11-Oct	19:16	night	12-Oct	15:17	day
		1	12-Oct	15:17	day	13-Oct	3:15	night
		1	14-Oct	7:16	day	14-Oct	11:16	day
		1	14-Oct	15:16	day	15-Oct	15:16	day
		1	21-Oct	7:16	night	21-Oct	15:16	day
		1	22-Oct	7:17	night	22-Oct	15:16	day
	100	1	29-Jul	8:34	day	29-Jul	20:04	day
		1	1-Nov	8:34	day	1-Nov	16:34	day
		1	1-Nov	16:34	day	1-Nov	20:04	night
2003	023	1	23-Jul	13:16	day	24-Jul	4:15	night
		1	21-Aug	18:16	day	22-Aug	9:16	day
		1	22-Aug	9:16	day	22-Aug	18:16	day
		1	16-Sep	9:15	day	17-Sep	13:16	day
		1	17-Sep	13:16	day	17-Sep	18:16	day
		1	1-Oct	23:16	night	2-Oct	9:17	day
		1	2-Oct	9:17	day	2-Oct	23:16	night
		1	5-Oct	23:15	night	6-Oct	13:16	day
		2	10-Oct	18:16	night	10-Oct	23:15	night
		1	10-Oct	23:15	night	11-Oct	4:16	night
		1	11-Oct	18:16	night	11-Oct	23:15	night
		1	11-Oct	23:15	night	12-Oct	4:16	night
		1	12-Oct	4:16	night	12-Oct	18:16	night
		2	12-Oct	18:16	night	12-Oct	23:16	night
		3	12-Oct	23:16	night	13-Oct	4:15	night
	040	1	29-Jul	7:16	day	30-Jul	11:16	day
		2	25-Aug	19:16	day	26-Aug	7:17	day
		2	27-Aug	15:16	day	28-Aug	3:16	night
		1	2-Sep	7:15	day	2-Sep	11:15	day
		1	16-Sep	7:16	day	16-Sep	15:16	day
		1	16-Sep	15:16	day	16-Sep	19:16	night
		1	19-Sep	7:15	day	19-Sep	15:16	day
		1	19-Sep	15:16	day	19-Sep	19:16	night
		1	19-Sep	19:16	night	20-Sep	11:17	day
		2	21-Sep	7:15	day	21-Sep	15:16	day
		1	22-Sep	23:16	night	23-Sep	15:16	day
		1	2-Oct	15:15	day	3-Oct	15:16	day
		3	3-Oct	23:16	night	4-Oct	15:16	day
		1	5-Oct	11:16	day	5-Oct	19:16	night
		1	6-Oct	11:16	day	6-Oct	15:16	day
		1	12-Oct	11:17	day	12-Oct	15:17	day

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
		1	16-Oct	19:15	night	17-Oct	7:17	night
		1	17-Oct	7:17	night	17-Oct	15:16	day
	100	1	14-May	15:16	day	14-May	20:16	day
		1	14-May	20:16	day	15-May	6:16	day
		1	17-May	20:16	day	18-May	1:16	night
		1	18-May	15:16	day	20-May	11:17	day
		1	28-May	1:16	night	28-May	20:16	day
		1	31-May	15:16	day	1-Jun	6:16	day
		2	13-Jun	1:16	night	13-Jun	20:16	day
		1	15-Jun	11:16	day	15-Jun	20:16	day
		1	15-Jun	20:16	day	16-Jun	1:16	night
		1	19-Jun	6:16	day	19-Jun	11:16	day
		1	19-Jun	20:16	day	20-Jun	6:15	day
		1	20-Jun	6:15	day	20-Jun	20:16	day
		1	21-Jun	6:15	day	22-Jun	11:16	day
		3	25-Jun	11:16	day	26-Jun	15:16	day
		1	27-Jun	6:16	day	27-Jun	11:16	day
		1	29-Jun	6:16	day	29-Jun	11:16	day
		1	16-Jul	20:16	day	17-Jul	11:16	day
		1	17-Jul	15:15	day	17-Jul	20:15	day
		1	18-Jul	11:16	day	19-Jul	1:16	night
		1	19-Jul	15:16	day	21-Jul	20:16	day
		1	31-Jul	1:16	night	31-Jul	6:16	day
		1	31-Jul	6:16	day	31-Jul	15:16	day
		1	31-Jul	15:16	day	31-Jul	20:16	day
		1	1-Aug	20:15	day	2-Aug	1:16	night
		1	9-Aug	20:16	day	10-Aug	6:16	day
		1	12-Aug	6:16	day	12-Aug	15:16	day
		1	13-Aug	15:16	day	13-Aug	20:16	day
		1	15-Aug	20:16	day	16-Aug	6:16	day
		1	20-Aug	20:16	night	21-Aug	20:16	night
		1	22-Aug	6:16	day	22-Aug	20:16	night
		1	22-Aug	20:16	night	23-Aug	20:16	night
		1	25-Aug	6:16	day	25-Aug	11:16	day
		1	1-Sep	6:15	day	2-Sep	1:16	night
		1	3-Sep	20:16	night	4-Sep	6:16	day
		1	10-Sep	11:16	day	10-Sep	20:16	night
		1	10-Sep	20:16	night	11-Sep	6:15	night
		1	11-Sep	6:15	night	11-Sep	15:16	day
		1	12-Sep	15:16	day	12-Sep	20:16	night
		1	13-Sep	15:16	day	13-Sep	20:17	night
		1	1-Oct	15:16	day	1-Oct	20:16	night
		1	2-Oct	6:15	night	2-Oct	11:16	day
		1	3-Oct	1:15	night	3-Oct	6:15	night
		1	4-Oct	6:16	night	4-Oct	11:16	day
		1	7-Oct	15:16	day	7-Oct	20:16	night
		1	7-Oct	20:16	night	8-Oct	6:16	night
		1	13-Oct	1:16	night	13-Oct	20:16	night
		1	13-Oct	20:16	night	14-Oct	1:15	night
		1	14-Oct	1:15	night	14-Oct	6:16	night
		1	14-Oct	6:16	night	14-Oct	20:16	night

Year	Bear ID	Min. # of crossings	From Date	From Time	From Period	To Date	To Time	To Period
		1	22-Oct	20:16	night	23-Oct	1:15	night
		3	23-Oct	15:15	day	23-Oct	20:16	night
2004	100	1	13-Apr	15:16	day	13-Apr	20:16	night
		1	17-Apr	15:16	day	17-Apr	20:16	night
		1	7-May	11:16	day	7-May	15:16	day