Testing Landscape Modeling Approaches for Environmental Impact Assessment of Mining Land Use on Grizzly Bears (*Ursus arctos horribilis*) in the Foothills Region of West Central Alberta

By

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We accept this thesis as conforming
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Abstract

The grizzly bear habitat effectiveness model (HEM) was used in west-central Alberta for Cumulative Environmental Assessments (1996 and 1999) of the Cheviot open pit coal mine project. This thesis tested HEM predictions regarding the Cheviot mine with empirical data. The HEM outputs were disproved for grizzly bear response to mining land use. Further, when tested at the mining land use scale, current Resource Selection Function (RSF) modelling is not predictive of grizzly bear occurrence. Grizzly bear movement paths prior to and during mine disturbance determined that mining land use does not present significant landscape or regional barriers to grizzly bears. This study examined regional and mining land use opportunities and risks pertaining to grizzly bears. I provide a critical review of the Cheviot CEA process and the implications of commitments made by governments and conclude with recommendations for mining land use and regional planning for grizzly bear protection.

Keywords: Grizzly bear, *Ursus arctos horribilis*, Habitat effectiveness model, Resource selection function, Models, Cheviot mine, Mining, Land Use, FMFGRP, Environmental impact assessment, Cumulative environmental assessment, Alberta

"The role of model testing is not to prove the truth of a model, which is impossible because models are never a perfect description of reality. Rather, testing should help identify the weakest aspects of models so they can be improved". (McCarthy, M.A., Possingham, H.P., Day, J.R., and Tyre, A.J., 2001).

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Maturana states that "*the journey is the destiny*". This journey has been one at times seemingly very private and introvert. At other junctures, I have felt hands around me; supporting, encouraging, and coaching. To many individuals I am very grateful. My wife, Francine: recently and gracefully earning your own Masters; I owe you thanks for showing me how it can be done and inspiring me. Hannah, Mathieu, and Luke: you are the greatest kids that a Dad could have. I have learned how much I long to be with you and will never take you for granted. Mom and Dad: always with your words of love and optimism; you are truly appreciated.

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Table of Contents

List of Figures

List of Tables

List of Acronyms

AEUB: Alberta Energy & Utilities Board

AENV: Alberta Environment

AEP: Alberta Environmental Protection

BMA: Bear management area

CRC: Cardinal River Coals Limited

CEA: Cumulative effects assessment

CEM: Cumulative effects model

Cheviot Project: Cheviot open pit coal mine project

DC: Disturbance coefficient

EIA: Environmental Impact Assessment

FMFGRP: Foothills Model Forest Grizzly Research Program

GIS: Geographic information system

GPS: Geographic positioning system

HEM: Habitat effectiveness model

JNP: Jasper National Park

NESERC: Northern East Slopes Environmental Resources Committee

RSF: Resource selection function

ZOI: Zone of influence

Chapter One: Introduction

The Grizzly Bear as a Valued Ecosystem Component

Understanding factors that influence and predict grizzly bear distribution and abundance is fundamental to their conservation (Apps, McLellan, Woods, & Proctor, 2004). Like many large mammalian carnivores, grizzly bears have been considered to be sensitive to human-induced landscape change due to their low population density, low fecundity, limited ability to disperse across open or developed habitat, and other traits that may lower their ecological resilience (Weaver, Paquet, & Ruggiero, 1996). This makes this animal a potential focal species for use in regional wildlife conservation planning. As such the grizzly bear has been used throughout North America as an umbrella species for the management of multiple land use impacts on regional landscapes (Carroll, Paquet, Noss, & Strittholt, 1998). Conditions necessary for the long-term persistence of grizzly bears have potential to form the framework within which other elements of regional-scale conservation planning may be efficiently addressed and human land uses and activities effectively evaluated (Carroll, Noss, & Paquet, n.d.).

Case Study: Grizzly Bear and the Cheviot Open Pit Coal Mine

Cheviot Project Regulatory Background

The Cheviot open pit coal mine project [Cheviot project] is located on the front range of the Rocky Mountains, within the Coal Branch Forest Land Use Zone approximately 60 km south of the town of Hinton, in west-central Alberta. It was originally proposed as a 20 year, metallurgical coal mining development by project proponent, Cardinal River Coals Limited (CRC). The regulatory process was initiated in 1994 with the preparation of draft terms of reference for an environmental impact assessment (EIA) by the proponent. Following public input, the EIA terms of reference were finalized in 1995 by Alberta Environmental Protection (AEP) with federal agency agreement. EIA is required under the Alberta Environmental Protection and Enhancement Act (EPEA) and applicable federal legislation for all major industrial projects in Alberta, and is prepared by major industrial project proponents to assist the government and public in understanding the environmental consequences of a proposed project (AEP, 1995). Project-specific effects are a major focus of EIA. Decision makers responsible for issuing project approvals must be convinced that the direct environmental effects of projects and the resulting impacts on valued ecosystem components (VEC) have been adequately addressed (Kennett, 2002).

The EIA requirements for the Cheviot project included an assessment of cumulative environmental effects (CEA), consistent with the federal Canadian Environmental Assessment Act [CEAA] and EPEA. CEA criteria required the proponent to gather and evaluate not only the proposed Cheviot project's impacts, but also to consider cumulatively the past, existing, and "imminent" activities in the defined CEA 3,040 km^2 study area which radiated approximately 25 km around the proposed Cheviot project area.

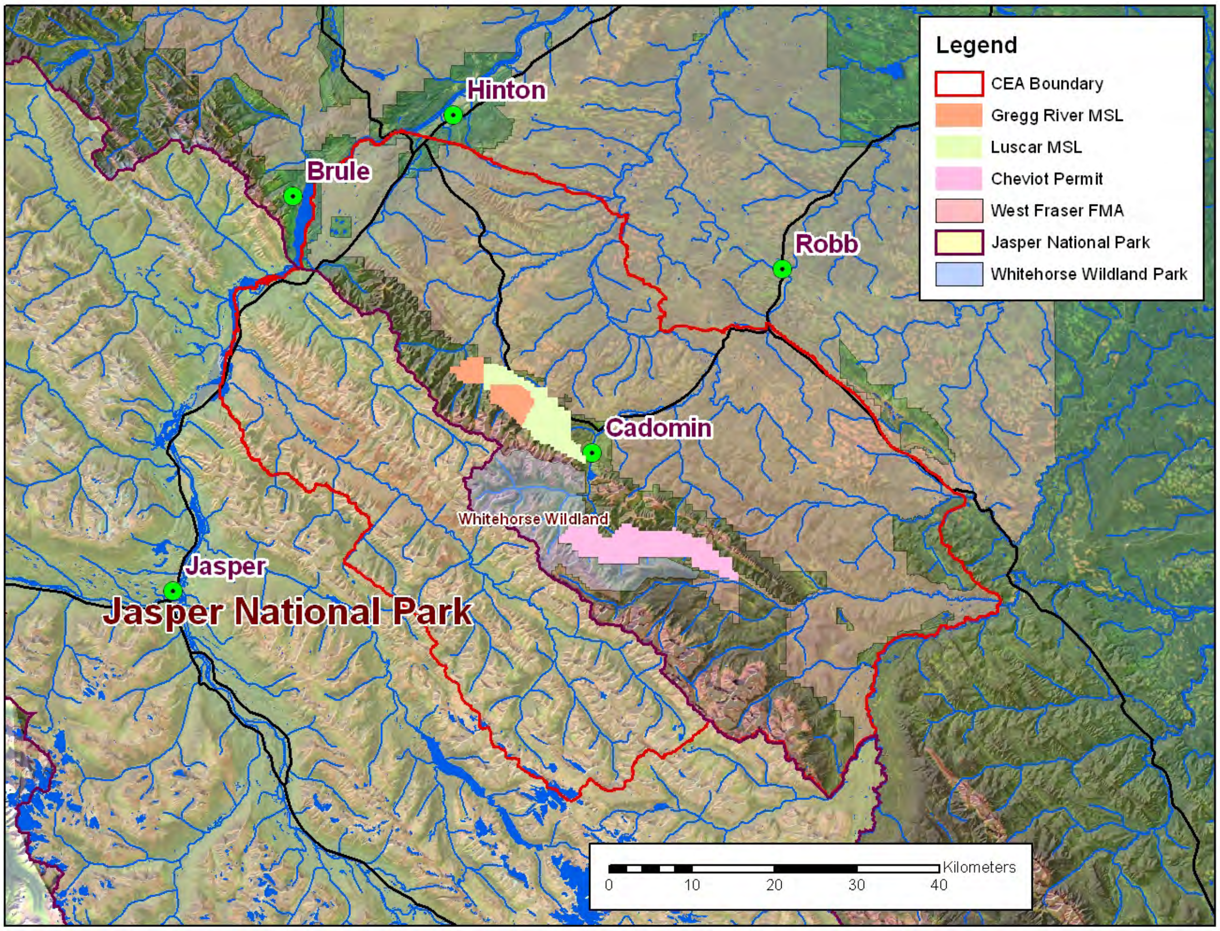

Figure 1. Cheviot CEA Study Area

Following extensive public consultation, the project application was filed in 1996 (Cardinal River Coals Ltd., 1996; Logan & Ferster, 2002). Environmental issues raised by the Cheviot project included the loss and fragmentation of aquatic and terrestrial habitat and the disruption of wildlife movement corridors. Further, given the range and intensity of other land uses in the surrounding region, cumulative environmental effects emerged as a major focus of public, regulatory and judicial attention (Kennett, 2002). The EIA addressed project and cumulative effects for 99 VECs. The grizzly bear was identified as the flagship VEC for assessing the regional, cumulative effects of the proposed Cheviot project in conjunction with other existing and planned land uses.

At the time of the EIA in 1996, provincial and federal regulators, environmental advocacy groups, and the project proponent all consistently agreed that this species was particularly well suited as a focal species for CEA. This was due to the existence of what was deemed an established, quantitative methodology for CEA for grizzly bear, which had been developed and employed in the United Stated (Christenson, 1986; United States Department of Agriculture (USDA), 1990; Weaver, Escano, Mattson, Puchlerz, & Despain, 1986). Further, as a wide ranging carnivore species, the grizzly bear would serve as an indicator and umbrella species for measuring and managing impacts on other large carnivores (BIOS Environmental Research and Planning Associates Ltd. [BIOS], 1996; Logan & Ferster, 2002; Paquet & Hackman, 1995; Stenhouse & Munro, 2000). It was proposed that, "if the grizzly survives in the region, then most other carnivores, most of which have significant range overlap with the grizzly, would also likely survive" (BIOS, 1996).

The history of the regulatory and judicial review of the Cheviot project is both lengthy and complex. It has served as a case study concerning CEA (Hegmann et al., 1999) and cumulative environmental management (Jeffrey & Duinker, 2002; Kennett, 2002; Logan & Ferster, 2002). In summation, since the original EIA, the Cheviot project has been the subject of two Alberta Energy & Utilities Board – Canadian Environmental Assessment Agency (AEUB-CEAA) joint review panel hearings, two judicial reviews, including a Supreme Court of Canada challenge, and several judicial challenges before the Alberta Environmental Appeals Board (AEAB) (AEAB 2003, 2004a, 2004b, 2004c, 2005a; 2005b, 2007).

The Cheviot project development plan was modified in its 2003 EPEA applications. This included construction of a twenty kilometer haul road to deliver raw coal back to the Luscar mine site's existing coal processing plant, rail system, and other required infrastructure. This modification eliminated the project's requirement for a high speed public road, rail, and higher voltage transmission line within the McLeod River corridor to the Cheviot project area. It further reduced the requirement to construct a coal processing plant and associated infrastructure in the Cheviot project area. Nearly a decade since the original EIA, following lengthy regulatory and judicial processes, a pause by the proponent due to global coal market conditions, and consolidation of ownership, all project permitting was affirmed and the Cheviot project began development in late 2004. The Cheviot project is currently operated by Elk Valley Coal (EVC)'s Cardinal River Operations. EVC is owned by Teck Cominco and Fording Canadian Coal Trust.

Study Area

The Cheviot project is located within the front range of the Rocky Mountains of west-central Alberta. Historically, coal mining in the Cheviot project area began in 1911, when the small town (~1000 people) of Mountain Park was established. Mining activities continued until the industry and town succumbed to the coal depression following World War II, forcing the closure of operations by 1950 (MacCallum, 2005).

The Cheviot coal mine permit area is approximately 7,150 hectares (ha) (71.5 km^2) with topographic elevation ranging from 1,640 m to 2,500 masl. 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 (Figure 2). Sub-alpine and alpine ecological regions characterize the Cheviot mine permit area, and vegetation varies from forests of Lodgepole pine (*Pinus contorta*) to mixed willow (*Salix spp.*), grasslands, alpine vegetation and rock (MacCallum, 2005). At its most westerly point, the mine permit area is approximately 3km from Jasper National Park (JNP), including one mountain range located within the provincial Whitehorse Wildland Park. At its nearest proximity, the Cheviot mine development plan will remain approximately 4.7 km from the JNP boundary.

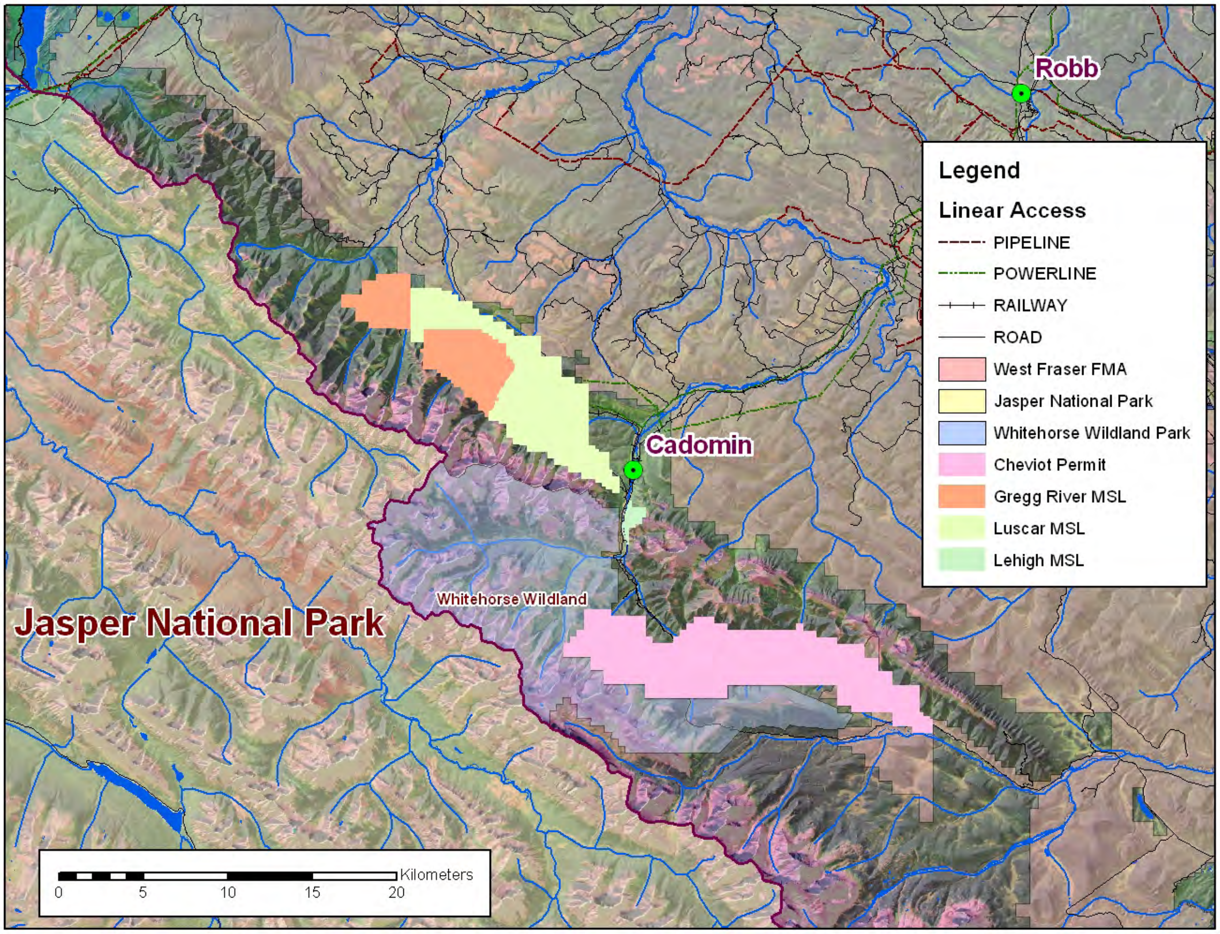

Figure 2. Cheviot Project Area, Luscar & Gregg River Mines

The Gregg River and Luscar mines are located approximately 20 km to the north of Cheviot and 40 km south of the town of Hinton. At their most westerly point, these are approximately 3.7 km from JNP. These two mines are immediately adjacent to each other (Figure 2) and are separated by the Gregg River. The total Luscar MSL area is 4,425 ha and the Gregg River MSL 2,675 ha, for a combined 7,100 ha under disposition of the mines. Both mines are located in the sub-alpine ecological region with elevations ranging between 1,540 m and 2,080 masl. Undisturbed areas within the adjacent mine lease boundaries currently comprise approximately

3,700 ha. These are vegetated predominantly by coniferous forests, with small amounts of shrub riparian habitat and sub-alpine grasslands (MacCallum, 2005).

Mine Land Use and Reclamation

In 2000, the AEUB-CEAA joint review panel issued approval for the Cheviot project. This provided approval of the conceptual project plan within the defined Cheviot permit area over the life of the project. Within the approved permit area, the planned Cheviot project consists of seven phased pit developments over the 20 year life of the project. Each phase of development requires specific project plan submissions, detailing all activities and areas planned for development to exploit the coal reserve and reclamation. Upon attaining all provincial and federal approvals to extract each of these specific coal reserves (or project phases), a surface disposition is obtained to carry out these activities. This is referred to as the mineral surface lease [MSL]. The MSL is a surface disposition granted to the proponent by the Crown to conduct land development activities on a specific land base to extract the coal reserves.

From October 2004 until present, the Cheviot project operates within an MSL to develop the Cheviot creek pit. The current Cheviot project mineral surface lease is located within a 1,100ha area in the westerly portion of the greater 7,150 ha Cheviot permit area. Outside of the existing MSL, but within the Cheviot permit area, there exists no surface disposition and no continuous mine related activity. The exception to this is for periodic exploration drilling programs to refine planned mine development. Otherwise, public access continues to be managed within the Cheviot permit area under provincial jurisdiction, which permits other land use activities, including motorized recreation use.

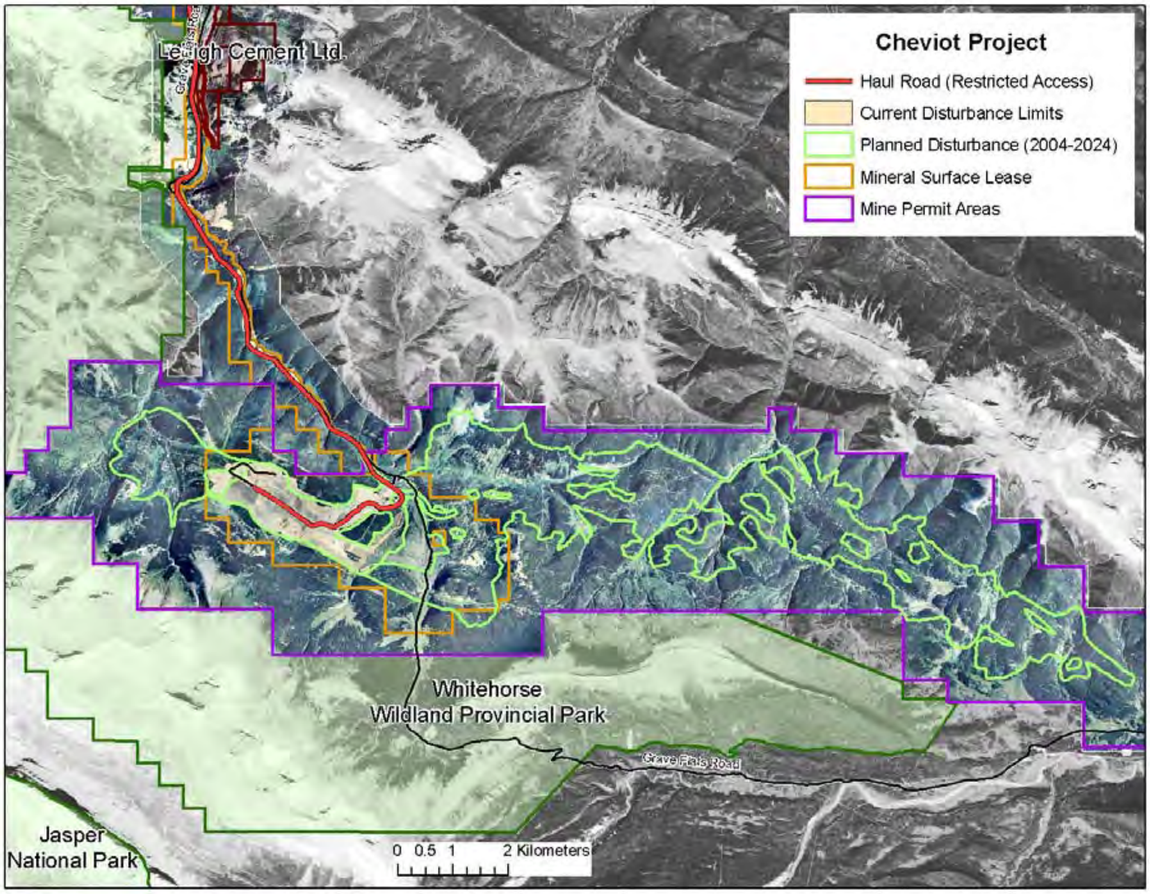

Figure 3. Cheviot Mining Land Use

Only a portion of the lands within an MSL is disturbed over the course of mining. Within the 7,150 ha Cheviot permit area, mining will disturb a planned total of approximately 2,800 ha. These disturbed lands will occur as the project phases are developed over its 20 year projected mining life. While development progresses, previously disturbed lands will be progressively reclaimed as part of the mine life cycle.

For the purpose of this study, definitions of lands found within mining land use include:

- *Undisturbed lands* include those within the MSL which will not be disturbed through the life of the mine. As well, it includes all those lands which may be (but have not yet been) disturbed by future mining land use during the life of the mine project.
- *Disturbed lands* are those defined by the disturbance footprint. These include the active coal exploitation pit, the adjacent waste rock disposal area, coversoil stockpile locations and additional infrastructure such that may occur including haul road, transmission line right of way, clean water diversions and runoff water management structures. *Disturbed lands* include portions of *reclaimed lands* until such time as they are effectively reclaimed and certified as such.
- *Reclaimed lands* are areas that have been disturbed by mine related activity. Reclamation consists of resloping and landform design, coversoil placement, and revegetation. Historically, revegetation has consisted of establishing forage cover, and has since evolved to include tree planting and techniques to encourage and enhance native species reestablishment and biodiversity. All revegetation programs, upon initial completion, result in early vegetation seral succession.

Reclamation requirements as identified in the project application and subsequent regulatory approval conditions must be adhered to, to the satisfaction of the provincial authority, prior to reclamation certification. Upon attaining this milestone of the mine life cycle, the lands are deemed acceptable to be returned to the Province of Alberta.

Completion of mining in each development phase of an overall project will see progressive reclamation, whereby the life cycle of that pit development will only be complete following reclamation. This will be accomplished through the phased progress of the Cheviot project, whereby outstanding disturbance areas will be progressively reclaimed. Completed pits and associated out of pit disturbances will be reclaimed following the optimization of integrated material handling between successive phases, such that backfilling of completed pits will be accomplished with waste rock from new adjacent active pit development. The result would be similar to that of the Gregg River mine. The Gregg River mine began mining in 1981 and completed coal extraction in 2000, at which time extensive reclamation programs were carried out. By 2004, reclamation was 95% complete (MacCallum, 2005) on the 1,350 ha of disturbance. This would, however differ from the Luscar mine, within which mining was initiated in 1969 and mining largely completed by 2004. Although approximately 1,100 ha of disturbed land have been reclaimed throughout the life of the mine, there currently remains some 900 ha of disturbed lands with reclamation activities still outstanding. Further, a portion of the Luscar mine will remain as *disturbed land* through the mine life of the Cheviot project to support coal handling, processing, and rail loading for the Cheviot project.

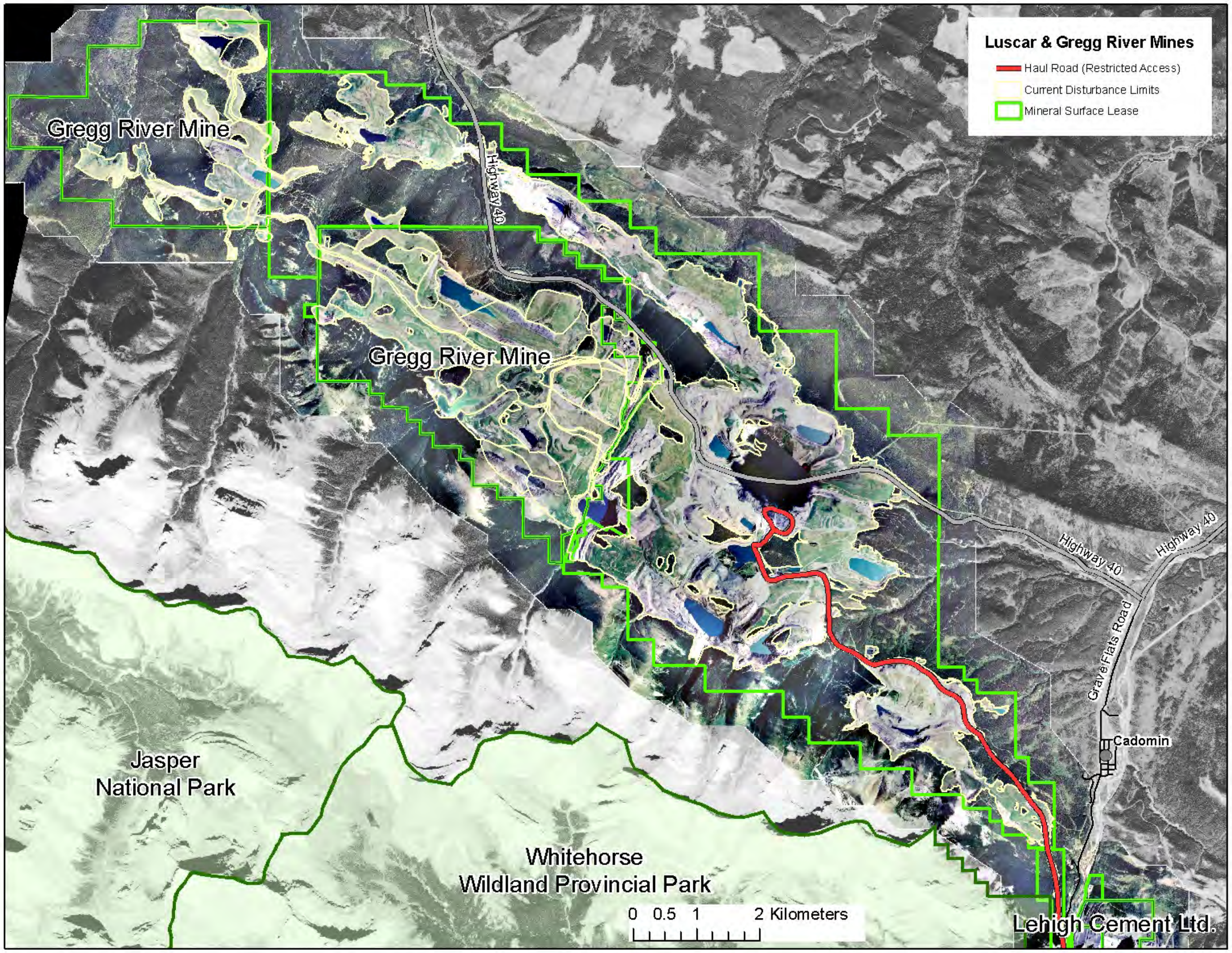

Figure 4. Luscar & Gregg River Mining Land Use

The lands adjacent to these existing mine operations, including within the Cheviot mine permit area outside of the existing MSL, are subject to multiple industrial and recreational land uses. These include forestry, oil and gas development, coal mining, hunting, hiking, off-highway vehicle (OHV) and equestrian use. Within each of these mines' respective MSLs, public access is only permitted by designated access trails which permits public access by designated means only, such as OHV or other, but does not permit hunting. These MSLs are anthropogenic boundaries which define the approved mining areas. They also create opportunities for unique public access management while the MSLs remain under active disposition. Because of this resultant access management, in combination with undisturbed, disturbed, and reclaimed lands, and the mining activities found within, all lands occurring within MSL are considered *mining land use*.

Foothills Model Forest Grizzly Bear Research Program

The lack of suitable regional grizzly bear data was identified in the Cheviot CEA (AEUB-CEAA, 1997). As a result of CEA conclusions regarding projected impacts to grizzly bears *with or without* the Cheviot project, the proponent proposed a Carnivore Compensation Program. This program proposed that a regional, multi-stakeholder approach to studying, managing, and monitoring human land use effects on carnivores in the region be developed (Cardinal River Coals Ltd., 1996). As a condition of project approval, the proponent was to "act as a catalyst in generating multi-stakeholder support for the implementation of the carnivore compensation plan" (AEUB-CEAA, 1997). The outcome of this initiative, along with other Cheviot joint review panel recommendations resulted in: provincial and federal governments devising cooperative agreements for grizzly bear conservation (Parks Canada, 1997); development of a regional strategic framework (Northern East Slopes Environmental Resource Committee, 2000), and; development of a comprehensive grizzly bear research program. This research program was initiated through the Foothills Model Forest as the Grizzly Bear Research Project [FMFGRP]. The FMFGRP has since expanded to become provincial in scope. It has resulted in several published academic and research studies. These are cited in annual FMFGRP reports for public review (Foothills Model Forest, 2008).

The Foothills Model Forest [FMF] is a not-for-profit corporation conducting research into sustainable forest management. Established in 1992, the FMF is one of a network of 11 model forests across Canada. Located in west central Alberta, the FMF encompasses 2.75 million hectares of alpine and boreal forest on the eastern slopes of the Canadian Rockies, and includes Jasper National Park, Wilmore Wilderness Park, Whitehorse Wildland Park, West Fraser’s Hinton Division’s Forest Management Area, and other crown lands (Cranston, 2006). The FMFGRP is one of the primary research initiatives at the FMF. Now in its eighth year, the long term goal of this $11 million study, funded jointly by industry and government, is to provide new knowledge and planning tools to assist managers with the conservation of grizzly bears in Alberta (Stenhouse & Graham, 2006).

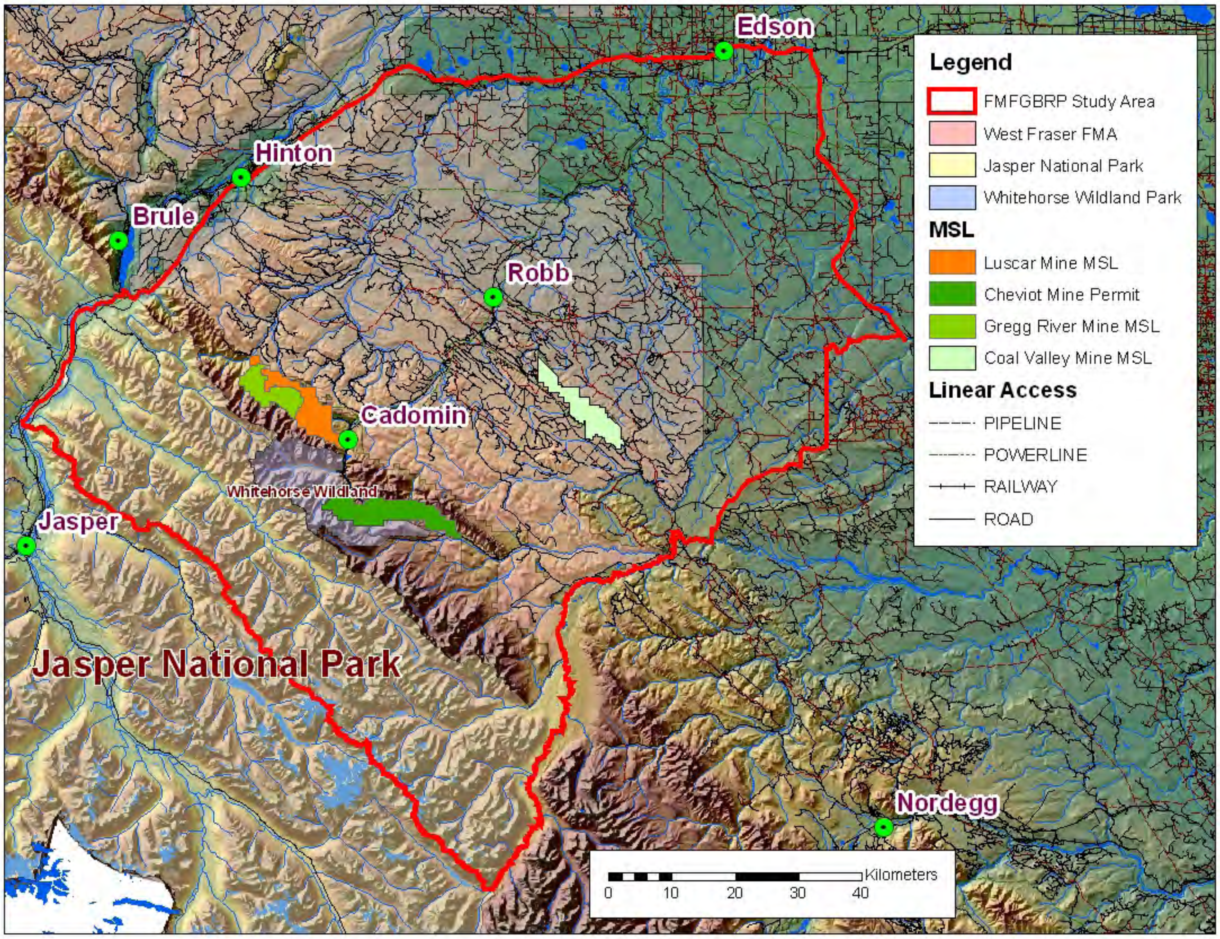

Figure 5. FMFGRP Study Area (1999-2004)

Interrelationships Between Resource Development, Human Access, and Grizzly Bears

Research shows that behavioral response to roads by grizzly bears is variable (Roever, 2007). Several benchmark field studies in the mid-1980s began to explore the relationships between roads, human settlement, and grizzly bears. Although conclusions differed among studies, each of these early investigations documented situations under which grizzly bears responded negatively to road traffic. Differing conclusions among these studies have been attributed to both different methods used and probable differences in nature and intensity of human land use and associated bear behavior among study areas (Mace, 2004). In northwestern Montana, Waller and Servheen (2005) found that grizzly bears strongly avoided areas within 500 m of highways and that most highway crossings occurred at night when highway traffic volume was lowest. Other researchers concluded that most grizzly bears used habitats within 100m of roads less than expected. Avoidance of roads was independent of traffic volume, suggesting that even a few vehicles can displace bears. (McLellan, & Shackleton, 1988). Still, research in the Swan Mountains, Montana, suggested that most grizzly bears exhibited either neutral or positive selection for buffers surrounding closed roads and roads receiving less than 10 vehicles per day but avoided buffers surrounding roads having greater than 10 vehicles per day (Mace, Waller, Manley, Lyon, & Zuuring, 1996).

Further, several studies have attempted to predict probability of grizzly bear occurrence and habitat effectiveness, which is the potential usefulness of a habitat given the negative impacts of human activity, such as those adjacent to roadways. Several outcomes have been concluded. In the protected areas of Banff National Park and surrounding areas, researchers examined grizzly bears' spatial response to roads, road-crossing behaviour, crossing-location attributes, and habitat and temporal patterns of cross-road movements. They found that grizzly bears used areas close to roads more than expected, particularly roads with low traffic volume (Chrusczcz, Clevenger, Gunson, & Gibeau, 2003).

In the eastern foothills of the Rocky Mountains, within the FMFGRP study area, it has been observed that grizzly bears are closely associated with roads. Grizzly bears are selecting roads for roadside vegetation, their association with riparian habitat and cutblocks, or their spatial orientation on the regional landscape (Roever, 2007). Neilsen (2005) found that contrary to previous studies, in west-central Alberta, grizzly bears selected clearcuts for critical food resources. These provide an attractive alternative to natural openings and young seral forests that are less prominent within the foothills. There are, however strong correlations between landscape disturbance and road development.

The grizzly bear populations in the FMFGRP appear unique in that they occupy both mountainous and foothill (boreal) environments. They exhibit notable differences in diet when compared to other populations, whereby the diet of grizzly bears in the foothills have nearly 2.5 times the amount of animal matter than that in the diets of grizzly bears in the mountains. It is suspected that this results from the differences in ungulate availability (Munro, Nielsen, Price, Stenhouse, & Boyce, 2006). Grizzly bears also feed on agronomic and pioneering forbs and legumes such as *Melilotus sp.* (clovers), *Lathyrus venosus* (wild peavine), *Taraxacum ceratophorum* (dandelion), and *Medicago sp. (*alfalfa). These species are associated with recently disturbed sites such as clear-cuts, roadsides, abandoned gas and oil well pads, and reclaimed landscapes of open pit coal mines. As a result, researchers have surmised that the use of such disturbance-evolved forbs may be indicative of the large amount of resource development activity within the FMFGRP study area.

Although forestry and oil and gas development is concentrated northeast of the Cheviot project area, there exists an annual average 5 to 10% increase among all recreation uses in the Coal Branch Forest Land Use Zone (Equus Consulting Group Inc., 1999). However, despite high levels of human activity, especially in the foothills, grizzly bears are most active during diurnal and crepuscular periods, with bedding occurring most frequently at night (Munro et al., 2006). This contradicts studies that have shown grizzly bears to be more nocturnal in areas where human activity is high. This also suggests that the level of human activity in the foothills and mountains of west-central Alberta is not high enough to disrupt the typical daylight activity pattern of grizzly bears (Munro et al., 2006).

Some permanent habitat loss has occurred in grizzly bear habitats east of the Rocky Mountains in Alberta due to settlement and agricultural development, however a major influence on grizzly bears results from habitat alteration, primarily due to forest harvest, oil and gas development, and utilities development (Kansas, 2002a). Open pit mining land use, operating typically in a phased (temporal and spatial) development also results in temporary habitat loss specifically during active pit mining, followed by an altered, early seral succession habitat. These habitat alterations can either result in negative, positive or neutral affects for grizzly bears. Not all anthropogenic activities are detrimental to grizzly bears. Some have been shown to be beneficial (Roever, 2007). For example, there exists evidence that temporary modifications such as forestry clear cuts can be positive for grizzly bear from a habitat perspective (Kansas, 2002a; Neilsen, 2005). However, though cutblocks and other anthropogenic disturbance appear to increase bear foods, their association with open roads may be creating an attractive sink (Delibes, Gaona, & Ferreras, 2001; McLellan et al., 1999; Neilson, Boyce, & Stenhouse, 2004) due to human-caused mortality.

Relatively little field study has been conducted specifically evaluating the response of grizzly bears to open pit coal mining and land reclamation. Yet scientists and decision makers alike have relied extensively on landscape modeling outputs to predict the effects of the Cheviot project on grizzly bears, to guide impact significance ratings (BIOS, 1996; Cardinal River Coals Ltd., 1996a; Herrero, 2000; Natural Resources Canada, 2000), and to influence policy or management processes. Thereby modeled predictions have resulted in significant regulatory, stakeholder, and ecological management implications.

Thesis Hypothesis and Objectives

Research Problem

Industrial projects rely upon EIA to identify and assess the significance of impacts under specific, proposed development scenarios. As identified in the Cheviot project, often these environmental assessments rely on models which may be supported by only limited field study (BIOS, 1996) or by expert opinion. The implications of using either inductive or empirical models to make management decisions regarding grizzly bears must be considered. Alone, neither might be appropriate assessment tools to adequately express habitat use, mortality risk, nor regional grizzly bear population persistence.

Thesis Objectives

This thesis will test the Cheviot CEA model assumptions and outputs for mining land use by examining empirical data collected from grizzly bears using the Luscar/Gregg River mine sites. These were both active mining land use areas during the 1996 and 1999 Cheviot CEA assessments. Data was collected by the FMFGRP program (1999-2004), and a 2006 and 2007 grizzly bear radio-telemetry program to determine grizzly bear use within, and adjacent to, areas of mining land use. These findings will then be discussed in relation to the use of inductive models to evaluate predicted impacts of the Cheviot project.

By testing the Cheviot project assessment conclusions, this research will:

- determine the ability of the tools employed in CEA to predict effects in this case study;
- test subsequently developed regional modeling tools to empirical results at the project scale;
- determine the importance of empirical (and modeled) approaches to EIA in general;
- provide context for these findings to a regional grizzly bear management perspective, and;

- discuss potential opportunities and risks to persistence of grizzly bears in Alberta's Yellowhead Ecosystem.

Finally, it is critical to discuss integration of this research for both mine land use planning, regional management and policy decisions for grizzly bear conservation given our current state of knowledge.

Research Hypothesis

This thesis is specifically designed to review CEA model inputs selected for the Cheviot project and evaluate the predictive capability of the grizzly bear CEM model used to determine habitat effectiveness of mining land uses by comparing its predicted grizzly bear use against empirical grizzly bear use from field data.

H_o: There is a significant difference in grizzly bear use on, and adjacent to, mining land use areas than predicted using HEM.

H_a: There is no significant difference in grizzly bear use on, and adjacent to, mining land use areas than predicted using HEM.

Research Questions

The thesis objectives will be met by addressing the following research questions:

Chapter 2.

- What did we think prior to collecting FMFGRP empirical data about grizzly bear occurrence and movement around mines based on CEA modeling?
- What (modeling) predictions are made in the Cheviot CEA and what conclusions were drawn?

Chapter 3.

- Are there risks to the application of inductive modeling tools for EIA designed for regional scale, threshold-based land use planning? What might be the management decision making implications?

Chapter 4.

- What have we learned from GPS collar data regarding grizzly bear occurrence and movement within and adjacent to active mining land use areas?

Chapter 5.

- How might mining land use be applied to the current state of science for grizzly bear conservation from a regional context?
- What opportunities exist for current and post mining landscapes to serve as long term grizzly bear safe harbour areas?

Chapter Two: Testing of the Cheviot 1996 Grizzly Bear CEA Model: Habitat Effectiveness for Mining Land Use

In 1996, the Cheviot Project application used cumulative effects modeling to analyze and predict the proposed mine's impacts on grizzly bears (BIOS, 1996). The cumulative effects model's (CEM) primary outputs included a description of current and predicted habitat quality and habitat effectiveness. Habitat quality is a measure of how inherently suitable an area is for a species, whereas habitat effectiveness is a measure of an area's potential usefulness to a species given the predicted negative impacts of human activity and development (BIOS, 1996). It assesses the quantitative and qualitative effects of human actions on grizzly bears and their habitat. The habitat effective model (HEM) routine relates habitat quality with human activities to estimate overall grizzly bear habitat effectiveness (Gibeau, Herrero, Kansas, Benn, 1996; Purves & Doering, 1998). Use of the grizzly bear HEM is said to offer a predictive tool for more detailed planning of current and proposed developments in areas containing grizzly bear habitats (Hood & Parket, 2001).

Habitat effectiveness is the major component of early grizzly bear cumulative effects models (CEM). United States-based CEMs have been adopted by Canadian researchers since the early 1990s. They have been applied in environmental impact assessment (EIA) on several industrial or resource development projects in Alberta and have been regularly used in the last 15 years to predict impacts and guide land management and decision-making (Kansas, 2002b).

This Chapter will review previous assumptions regarding grizzly bear movement and use in and adjacent to mining land use, define how these assumptions were applied in modeling, and define how these provided HEM modeling predictions. It then introduces subsequent empirical grizzly bear data collected in and adjacent to active mining land use and evaluates model predictions based upon analysis of empirical data. Finally, it will discuss the subsequent CEA conclusions for the Cheviot project, and the implications of model use in EIA.

HEM and its use in Cheviot CEA for Grizzly Bears

CEM for grizzly bears are designed to quantify both individual industrial projects and collective effects of other land uses and activities in time and space. They provide resource managers with an analytical tool for evaluating alternative decisions relative to grizzly bear conservation goals and objectives (Weaver, 2000). Standardized CEM was pioneered in the early 1980s in the contiguous United States (USDA, 1990) in an effort to assess cumulative land use effects on grizzly bears (Christensen, 1986). These were originally developed for use in the Northern Continental Divide (East) ecosystem (Apps, 1993; URSUS Ecosystem Management Ltd. (URSUS), 1999). Since that time, it has been used as a planning and management tool (BIOS, 1996; Kansas, 2003; Logan & Ferster, 2002; Stenhouse, Dugas, Boulanger, Hobson, & Purves, 2003).

The original Cheviot project specific and cumulative effects assessment regarding grizzly bears utilized an inductive CEM over the 3,040 km^2 Cumulative Effects Analysis (CEA) study area. This boundary was established by forming a polygon whose perimeter extended approximately 25 km outward from the proposed Cheviot project area, then adjusted to conform to watershed divides and watercourses. At the time, the size of the study area was defined in part by the maximum published diameter of a grizzly bear’s home range in the region (URSUS, 1999). To analyze existing habitat conditions and developments, the grizzly bear CEA study area was divided into Bear Management Units (BMUs), which were further divided into Bear Management Sub-Units (BMSU). These were approximately the size of female grizzly bear annual home ranges.

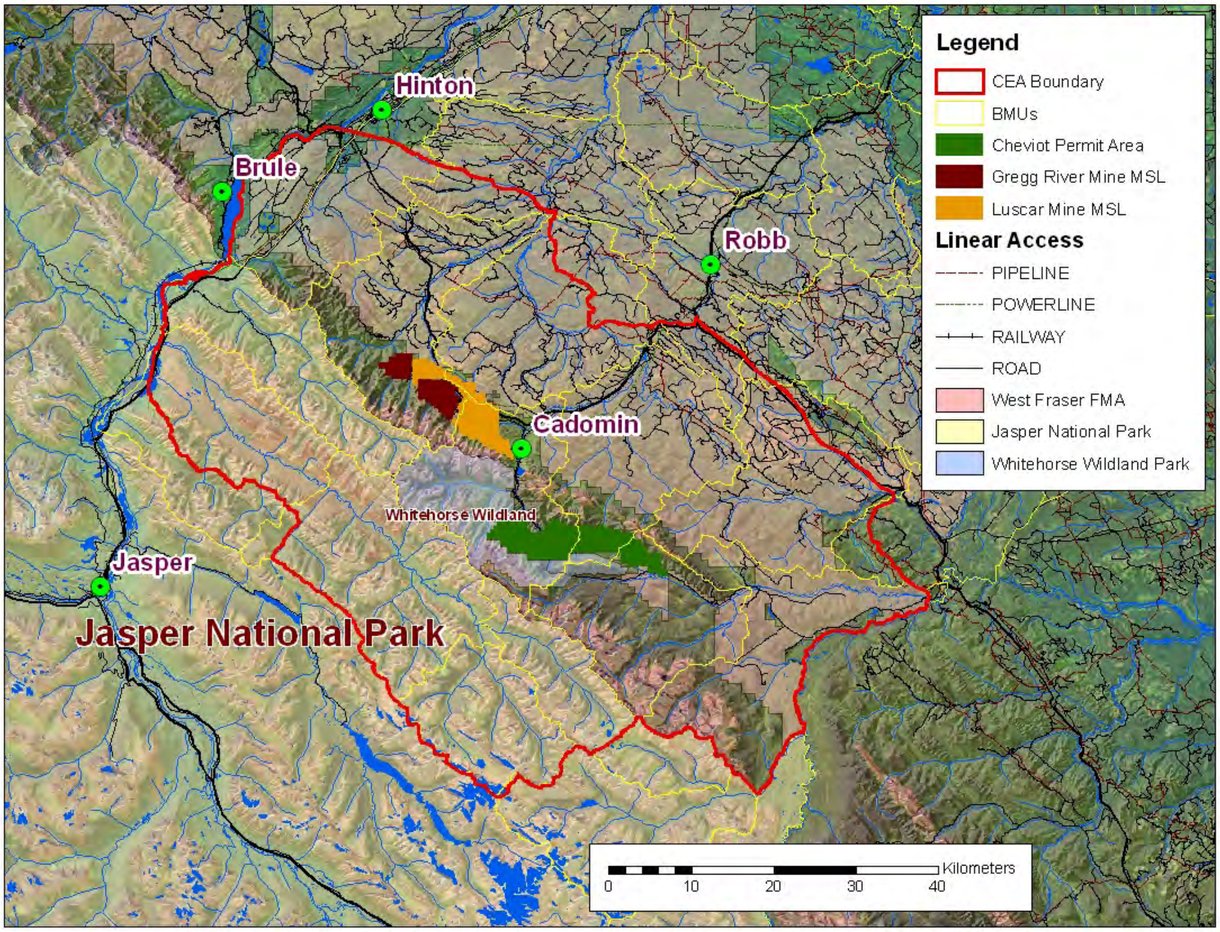

Figure 6. Cheviot CEA Study Area with BMU

CEM quantitatively estimates individual (specific) and collective (cumulative) effects of various land uses and activities in space and through time (BIOS, 1996; USDA, 1990). The various existing and planned anthropogenic activities were assigned disturbance coefficients. These disturbance coefficients were developed in the United States version of the grizzly bear CEM because there was no empirical data on human influences in the Canadian Rocky Mountains (Gibeau, 1998). Disturbance coefficients are a measure of the effective reduction in inherent grizzly bear habitat supply. A 100% habitat effectiveness value means that grizzly bears are not deterred from using that available habitat due to human factors. The CEM is composed of the following three routines:

1. Habitat routine: a given landscape/habitat area or unit has an inherent value for grizzly bears.

2. Disturbance routine: quantitatively considers human use factors that subtracts from this inherent habitat value (USFWS, 1993). Disturbance layers were buffered using zones of influence based in the values in Table 1.

3. Mortality routine: This routine of the CEA model was not used because of inherent difficulties with the model (Weaver, Escano, Mattson, & Puchlerz, 1986). Instead, for CEA purposes, areas of high habitat effectiveness were assigned a low mortality risk. Inversely, areas of determined low habitat effectiveness were assigned a high mortality risk.

Modeled Disturbance Routine for Mining Land Use

Specific to this study's analysis, the proposed Cheviot mine was treated as a "special case" for definition of both a disturbance coefficient and zone of influence for the disturbance routine. A disturbance coefficient is an assignment that identifies reduced habitat effectiveness to an area as a result of human disturbance from what it would otherwise be. This disturbance coefficient is specific to the human activity type. The zone of influence is the spatial assignment of that disturbance coefficient. The zone of influence defines the adjacent area whose habitat effectiveness would be adversely impacted or degraded as a result of human disturbance or activity.

Table 1. CEA Model (1996) Disturbance Coefficients and Zones of Influence for Land Use Activities in the Grizzly Bear

Activity Type	Activity Code	Use Duration	Use Level	Disturbance Coefficient (Cover)	Disturbance Coefficient (Non-Cover)	*Zone of Influence (m)
Motorized	Linear	-	High	0.25	0.05	1000
		-	Low	0.67	0.25	1000
	Point, Polygon	Diurnal	High	0.12	0.05	1000
		Diurnal	Low	0.31	0.1	1000
		24 hr	-	0.06	0	1000
	Dispersed	-	High	0.2	0.1	N/A
		-	Low	0.9	0.8	N/A
Non-Motorized	Linear	-	High	0.75	0.25	1000
		-	Low	1	0.4	500
	Poly, Point	Diurnal	-	0.75	0.2	500
		24 hr	-	0.03	0.05	500
	Dispersed	-	High	0.3	0.1	N/A
		-	Low	0.1	1	N/A

* assumed 1000m = 0.50 mile
(adapted from BIOS, 1996, p.22)

All current and planned mining land uses, based on expert opinion and available knowledge of the day, were assigned a *motorized, polygon, 24 hour activity classification code.* This assignment included a 1 km (0.5 mile) zone of influence around their respective disturbance footprints within which little or no grizzly bear use was expected (Table 1). This defined a *mask* over the entire 20 year planned mine disturbance area plus a 1 km buffer all around this. It defined the area as being under continuous (24 hour) motorized activity. For the Cheviot project, features within the McLeod River corridor originally planned as a high voltage transmission line, high speed public road, and rail line were assigned a *motorized, linear, high classification*, which defines a 1 km zone of influence on either side, adjacent to this approximate 10 km access to the

Cheviot project where the corresponding disturbance coefficient is 0.25. These rules imply that grizzly bear use of the adjacent 2 km zone of influence (1km on either side) would be impacted such that resultant likelihood of grizzly bear use would decrease by 75%. Where mine area and linear disturbance buffers overlapped, the disturbance coefficients were multiplied, resulting in very low probability of grizzly bear occurrence.

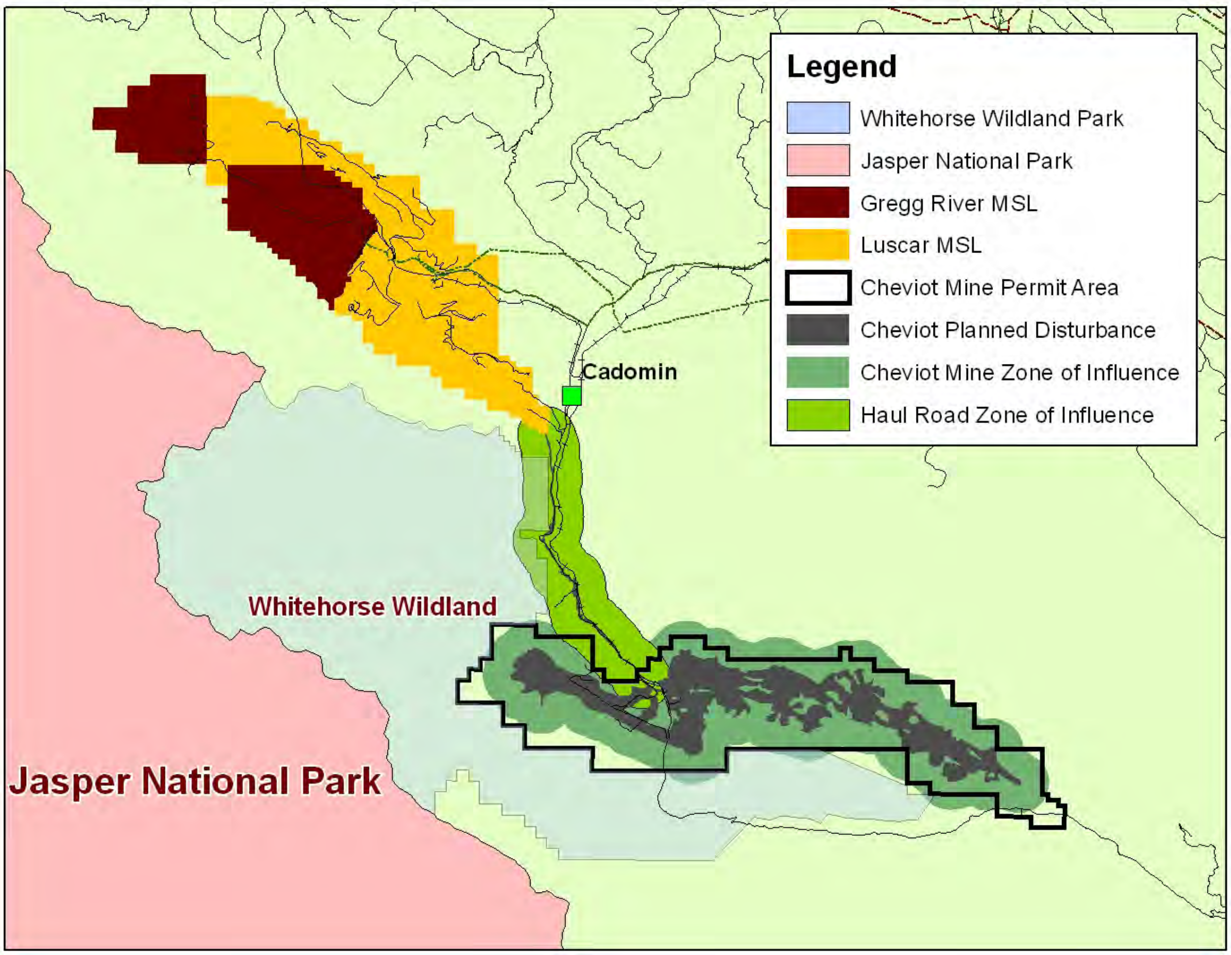

Figure 7. Cheviot Project Planned Disturbance and CEM Zone of Influence

It was, therefore concluded, based upon CEA modeling, that impacts to grizzly bear habitat effectiveness would result in essentially no grizzly bear use of mining areas, nor within adjacent undisturbed areas within 1 km of the entire proposed mining disturbance footprint during the entire life cycle of the Cheviot project. The habitat effectiveness model was rerun again to support an updated grizzly bear cumulative impact assessment for the 2000 AEUB-CEAA joint review panel hearings (AEUB-CEAA, 2000; Herrero, S., 2000; URSUS, 1999). Again for this modeling run, the human use features were classified and their assigned zones of influence were based on standards developed by the USDA (1990) for CEM and were the same as those used by BIOS (1996). This 1999 re-assessment however differed through use of a more rigorous human use inventory process, rather than subjective opinion of authors concerning the use of the area and informal discussions with land users. As a result, it used slightly different human use ratings to reflect minor differences in expert opinion as well as improvements in knowledge of human use in the area (URSUS, 1999). While this review was conducted for cumulative effects features, zone of influence and disturbance coefficients associated with mining land use were not revised. URSUS (1999) concluded that changes increased the degree of certainty associated with understanding and evaluation of cumulative impacts, however it also cautioned that these models nonetheless still would require validation through empirical testing.

While these modeling assumptions were used to *predict* impacts for the proposed Cheviot project, they were also applied to Luscar and Gregg River mines. Both of these mines were *existing* operations located twenty kilometers north of the Cheviot Project and within the cumulative effects study area (Alberta Environmental Protection, 1995). These provide the opportunity for testing of these model assumptions and predictions of grizzly bear habitat effectiveness using empirical data collected after the CEA model predictions were made.

Foothills Model Forest Grizzly Research Program: Five Years of Field Study

Between 1999 and 2004, the FMF conducted an intensive field study of grizzly bears within the 10,000 ha FMFGRP study area (Figure 6) that included the Cheviot CEA study area. Field data was obtained through the use of extensive GPS collaring and DNA census efforts. FMF personnel captured 78 grizzly bears and radio-collared and monitored 64 individuals (Stenhouse, Munro, Graham, 2004). Grizzly bears were captured using aerial darting or leg hold snares during the spring capture periods (Stenhouse, Munro, Graham, 2004). Male and female grizzly bears that were suitably large enough were fitted with radio collars equipped with GPS. Alternatively, some small sub-adult grizzly bears were instead fitted with a VHF ear tag transmitter. All grizzly bears were processed to obtain information including a premolar for aging, as well as hair and blood samples for DNA and blood chemistry analysis. Individual weight and standard morphological measurements were also documented (Stenhouse & Munro, 2000). The deployment of these GPS radio collars on grizzly bears allowed researchers to collect detailed movement data, where point data was collected at a maximum 4 hour intervals on a 24-hour basis over a 9-10 month period (Stenhouse & Munro, 2000). Some limitations to GPS collaring occurred, including grizzly bears successfully slipping off their collars because of poor fit, mechanical failure of the collar, or poor quality GPS signal depending on vegetation cover and landscape topography. An average of 4 locations per day was acquired from deployed radio collars. When opportunity allowed, individual grizzly bear re-capturing, and replacing battery-expired GPS collars with new collars, permitted multi-annual location data to be collected (Stenhouse & Munro, 2000).

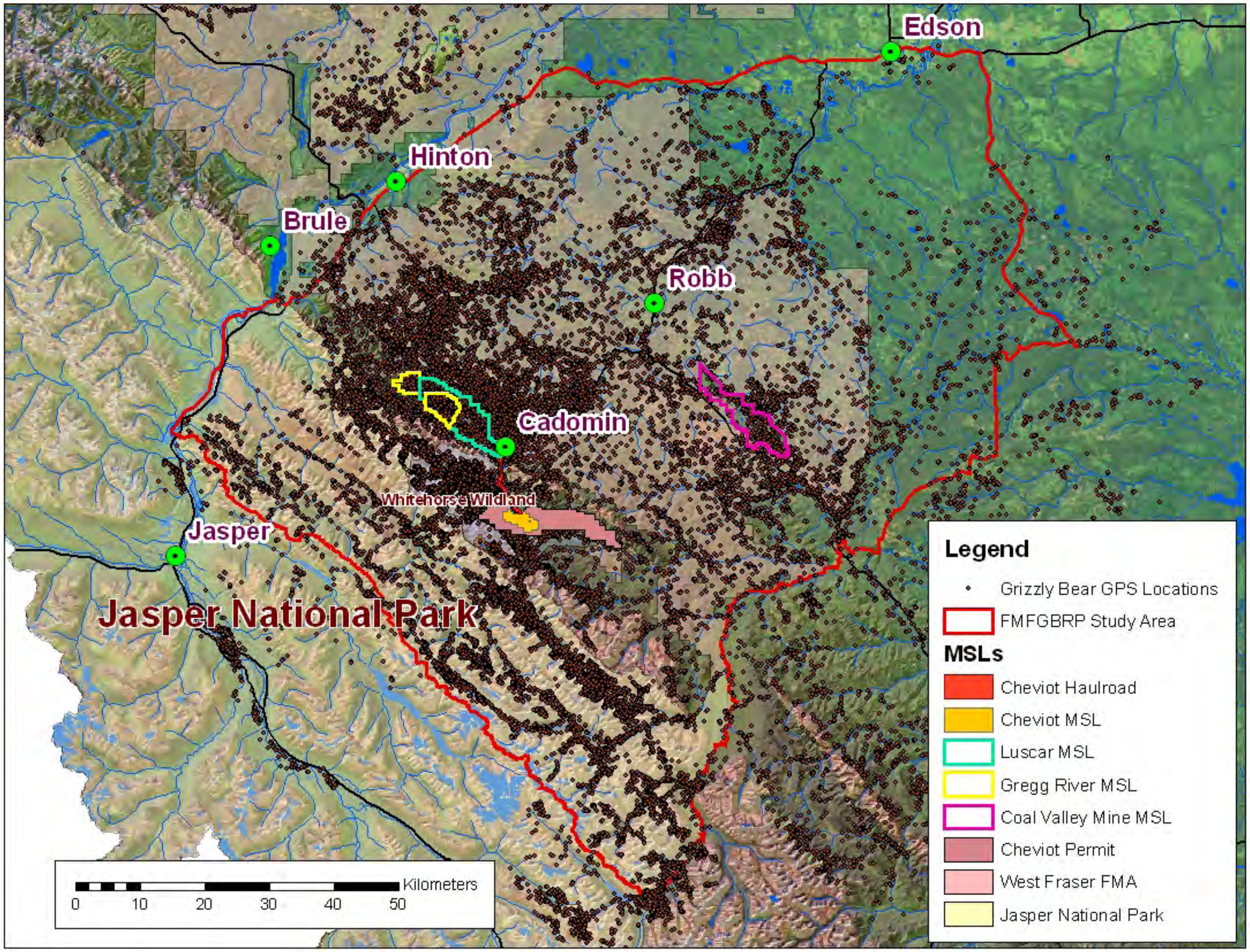

Figure 8. FMFGRP All GPS Points

Location data was stored in the individual GPS collar and retrieved by different methods. Data could either be uploaded monthly by helicopter circling in the vicinity of the grizzly bear or data would be stored within the collar unit's memory until the collar could be recovered and downloaded. Collars were either equipped with a remote drop off system, allowing researchers to remotely trigger the collar to release from the grizzly bear, or the individual was re-captured to have the collar removed. All collars were designed with a canvas "rot-off" to ensure the collar dropped off the grizzly bear at some point in time (Stenhouse & Munro, 2000).

Methodology for Testing HEM Outputs for 1996 Cheviot CEA

Several methods exist to define home range. Home range polygons may be calculated using Minimum Convex Polygon (MCP), which is a simple polygon enclosing the outermost points of a set. While it identifies extent of an animal's range, it does not identify intensity of occurrence. Another method is using a fixed kernel density estimator. The kernel is a contour on a point density surface within which is a specific probability of finding a point (Cranston, 2004). This author has chosen not to apply interpolation or modeling tools to define range. Rather analysis is conducted of empirical, field collected GPS locations of grizzly bears.

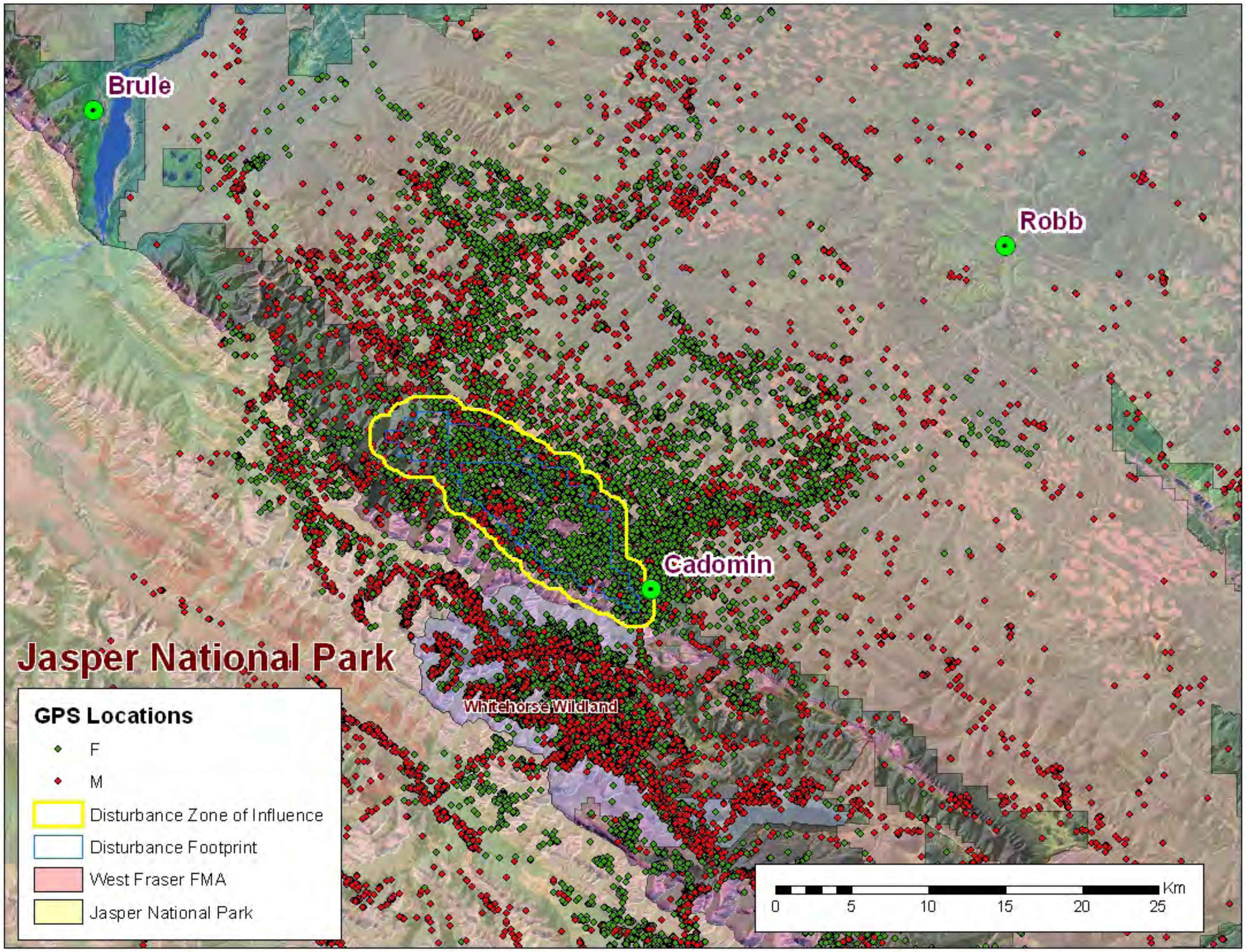

Figure 9. Grizzly Bear GPS Points Occupancy Within Luscar and Gregg River Mines Disturbance Footprint + ZOI

Results

Using HEM in the Cheviot CEA modeling, the response by grizzly bears to mining land use was predicted to be decreased habitat effectiveness, and therefore significant (almost complete) avoidance.

GIS was used to overlay the Luscar and Gregg River mines with all grizzly bear GPS location from the 1999-2004 FMFGRP field program. These were two active mining operations during that period. Fourteen grizzly bears provided a total of 36 individual annual ranges which occurred within the mines' disturbance and zone of influence in the 5 year period (Table 2). It is important to note that these 36 grizzly bear ranges are only from those bears that were successfully collared in the 1999-2004 field program, and serves only as a subset of the regional grizzly bear population. Further, the dataset includes only locations collected when a grizzly was equipped with an active GPS collar. It does not include cubs of the year, nor any other individual grizzly bears that used these areas that were not collared. The dataset is used in this study to understand grizzly bear occurrence. A consistent and continued occurrence of grizzly bears within the mine disturbance and zone of influence is evident. Of the 19,942 total point locations, 23.8% occurred within the Luscar and Gregg disturbance ZOI. The percentage of locations occurring for individual home ranges were from 0.1% to 82.9% (mean 23.2%, n=36). Given the prediction of no grizzly bear use of these mines, haul roads and associated buffers, this analysis has proven the hypothesis that modeling employed for both the 1996 and 1999 grizzly bear CEA was not predictive of actual grizzly bear use or movement within mining land use areas.

Table 2: Individual Grizzly Bear Occurrence Within Luscar and Gregg River Mines Disturbance

Grizzly Bear ID	Year	Total GPS points	GPS points within Luscar & Gregg River Mines Disturbance + ZOI	GPS points within Luscar & Gregg River Mines Disturbance + ZOI (%)
G004	1999	793	1	0.1
G004	2001	542	15	2.8
G008	1999	393	39	9.9
G008	2002	851	53	6.2
G008	2007	1048	121	11.5
G014	2000	283	11	3.9
G017	1999	66	10	15.2
G017	2000	77	3	3.9
G017	2001	150	29	19.3
G017	2002	869	24	2.8
G020	1999	683	138	20.2
G020	2000	453	17	3.8
G020	2001	649	43	6.6
G020	2002	410	10	2.4
G023	2000	623	149	23.9
G023	2001	716	433	60.5
G023	2002	349	81	23.2
G023	2003	399	236	59.1
G024	2000	586	11	1.9
G024	2001	1052	14	1.3
G029	1999	481	190	39.5
G029	2000	442	63	14.3
G029	2001	1525	131	8.6
G037	2002	459	81	17.6
G037	2003	35	29	82.9
G038	2001	438	36	8.2
G040	2001	173	141	81.5
G040	2002	689	332	48.2
G040	2003	665	510	76.7
G040	2006	1919	1511	78.7
G054	2002	124	5	4.0
G055	2003	443	45	10.2
G100	2001	760	109	14.3
G100	2002	128	63	49.2
G100	2003	516	38	7.4
G100	2004	153	25	16.3

Discussion and Conclusion

HEM and its Use for Modeling Grizzly Bear Response to Disturbance

A study by Stenhouse, Dugas, Boulanger, Hobson, & Purves (2003) supports the preceding Luscar/Gregg River mining land use analysis. Those authors tested modeling outputs at a regional scale in the FMFGRP study area. Results suggested that the HEM runs were not predictive of actual bear distribution. Based on comparisons between model outputs and FMFGRP data, Habitat Effectiveness outputs were not significantly correlated to the distribution of bears from DNA data. These outputs were not correlated to level of use by GPS collared bears and were negatively correlated to the distribution of GPS collared bears. The authors concluded that this failure did not necessarily mean that the model lacked validity. The model's ability to predict grizzly bear use of bear management units may be enhanced through improvements to the base mapping or *by reassessing the assumptions used* (Stenhouse, Dugas, Boulanger, Hobson, & Purves, 2003).

Past projects in Alberta have calculated habitat effectiveness outputs using GIS technologies and USDA Forest Service (1990) formulas (Kansas, 2003). Results of these CEM assessments have been used as tools for regional land use planning and single industrial project assessment. While HEMs are being utilized to assess project affects on grizzly bear, changes to, and assumptions applied to inputs can result in noteworthy changes to outputs. There are currently no Canadian-based grizzly bear HEM standards, therefore most CEA practitioners in Alberta have adopted those model coefficients and formulas developed in the United States.

Testing of the sensitivity of CEA output, depending on changes to input variables, has received little attention. (Kansas, 2002). Yet, as a result, if accuracy of the HEM (disturbance coefficients and/or assumptions) exercise is incorrect for given conditions, subsequent local and regional decision-making and management based on these modeled predictions of grizzly bear impacts may be dramatically affected. This has been demonstrated by noteworthy difference between predicted grizzly bear impacts due to mining land use used based on CEM modeling runs for the Cheviot project and actual empirical testing of grizzly bear occurrence.

HEM and its Use in Cheviot CEA for Grizzly Bears

At the time of the Cheviot Project's environmental assessment in 1996, comparatively little was known regarding regional grizzly bear population dynamics and response to human disturbance. Holling (1973) defines resilience as the ability of systems to absorb disturbance and still maintain the same relationships between populations or state variables, and still persist". Researchers suggested that grizzly bears have little resiliency (Weaver, Paquet, & Ruggierp, 1996) and Herrero (2000) suggested that grizzly bears appear highly vulnerable to human-caused sensory disturbance. Because the Cheviot Project impact assessment had to be completed in less than one year, extensive, original field research was not possible (BIOS, 1996). As a result, the HEM model was not empirically validated.

Limited research on HEM has been focused on the ability of the model to accurately predict habitat utilization compared to predicted effectiveness (Stenhouse et al., 2003) or testing the significance of its outputs (Kansas, 2003). Little to no testing of HEM has been conducted of an actual mining life cycle that includes aspects of undisturbed, disturbed, and reclaimed lands within mining land use. This is most notable in consideration of the spatial and temporal components of a phased mine development life cycle within a greater mine permit area, and this mine land use's effects on grizzly bear habitat and its effectiveness. Modeling assumptions for the Cheviot mine were based on 100% of the proposed disturbance area being under 100% active mining activity for 20 years, the duration the project life. The Cheviot project grizzly bear HEM assumption was that upon project start-up, the total 2,800 ha planned disturbance, plus the additional one km zone of influence, for a total area of 12,710 ha (127.1 km^2), would have a HE rating of zero over the planned 20 years of the mine project.

Comparatively, following more than 3 years of active mining, the Cheviot project disturbance footprint is less than 300 hectares, within which reclamation and revegetation has been conducted on 15 hectares. This disturbance footprint is within the current 1,100 ha (11 km^2) Cheviot MSL. Of the 7,150 ha Cheviot permit area, 1,100 ha is currently within MSL, or mining land use. Of this, less than 300 ha of the planned 2,800 ha have been disturbed. This temporal component, omitted in the CEA assessment of mining land use is important. Not only does mining not extend to the planned development footprint immediately, but all lands within the Cheviot permit area not under MSL remain susceptible to multiple land use activities (pressures) under provincial jurisdiction.

Based on the model outputs and expert opinion in the original Cheviot project application, it was concluded that the entire Cheviot mine area would become lost to grizzly bears by the end of the mine's 20 years of operation. Further, it was predicted that "grizzly bear habitat effectiveness, due to the effects of the extensive development [within the modeled mature mining disturbance footprint], was so low that [it] predicted only occasional use of this area by grizzly bears" (BIOS, 1996); and "effective mitigation is improbable, even within a 100 year post-mining framework" (BIOS, 1996).

These HEM outputs were referred to extensively to predict the effects of the Cheviot project on grizzly bears, and to guide impact significance ratings (BIOS, 1996; Cardinal River Coals Ltd, 1996a; Herrero, 2000; Natural Resources Canada, 2000). This thesis research concludes that disturbance coefficients assigned for mining land use for the Cheviot project CEA, as tested empirically in this study, were not valid and model assumptions for mining land use were erroneous.

Chapter Three: Testing New Modeling Tools Developed for Grizzly Bears: RSF Applicability for Mining Land Use

Testing the Resource Selection Function Model

Scientists have developed new predictive and probabilistic modeling tools through the innovation of the FMFGRP and other grizzly bear research programs in North America. Many researchers have used GIS data and satellite remote sensing imagery to classify grizzly bear habitats (Bechtold, Havlick, Stockmann, 1996; Cranston, 2006; Gibeau, 2000; Mace, Waller, Manley, Ake, Wittinger, 1999; McDermid, 2004; Montgomery, 2004; Neilson, Munro, Bainbridge, Stenhouse, Boyce, 2004; Schwab, 2004). Land cover and landscape attributes are classified from GIS and remote sensing sources, then grizzly bear selection for these attributes is modeled to reflect the probability of use of a resource unit (Nielsen, 2005) using Resource Selection Function (RSF). Habitat use can be characterized by RSFs that are proportional to the probability of an area being used by an animal (Boyce & McDonald, 1999). A RSF model has been developed within this grizzly bear population unit to document population level grizzly bear habitat selection (Nielsen, 2004) and this output may then be utilized as an input parameter for the identification of movement corridors across landscapes (Schwab, 2004).

Empirically-based habitat map products have been used to create RSF probability models that are deemed the most current, best available tools and have proven better at predicting relative occurrence of grizzly bears than traditional HEMs (Nielsen, Boyce, Stenhouse, Munroe, 2003). The FMFGRP 1999-2004 GPS location data provided empirical input to the creation of the RSF (2004) in the FMF study area. The grizzly bear RSF is a population level, probability of occurrence surface model. This Chapter tests whether this modeling tool provides an accurate surrogate for predicting grizzly bear use within mining land use areas.

RSF and its Use in Regional Planning for Grizzly Bears

RSF habitat models may be developed in part using Landsat satellite imagery to classify landcover. In the FMFGRP study area, McDermid (2004) created the Integrated Decision Tree (IDT) map by classifying the raw imagery into 13 land cover classes. The IDT map is then combined with grizzly bear points to create the RSF surface (Nielsen, 2004). The RSF raster is a probability surface that reflects the relative attraction of a particular location to a bear. Seasonal grizzly bear habitat RSFs were produced for the FMF based on 30,616 animal use locations from 29 GPS collared female grizzly bears, 16 environmental predictor variables, and 4 mask variables (Nielsen, 2007).

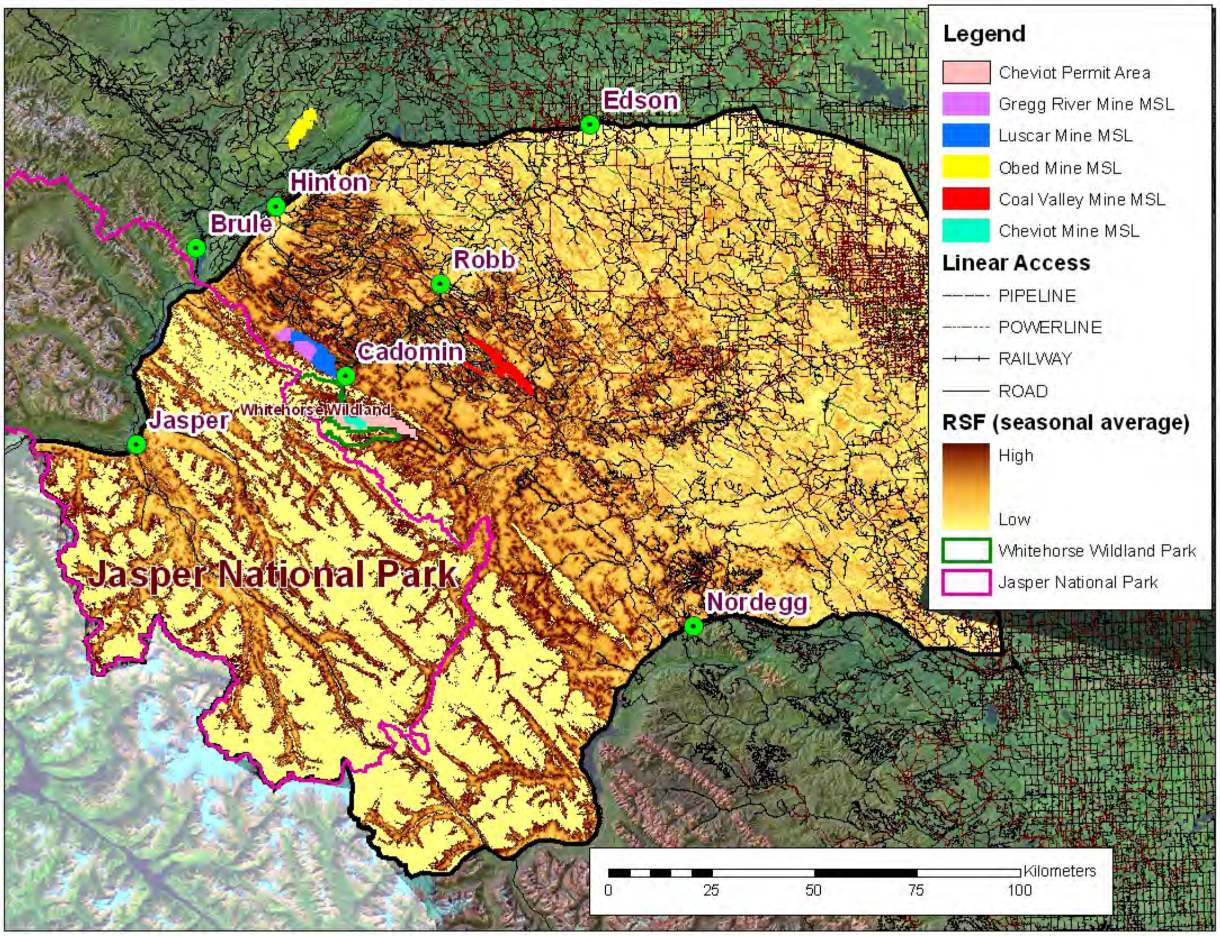

Figure 10. Regional Grizzly Bear RSF (Phase 6 Version)

The RSF subdivides land cover classes according to aspect, elevation, proximity to land use features, etc. 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 points (Cranston, 2006). It is not a habitat map per se, as the term "resource" refers to any natural features used by a bear, whether a berry patch selected for food, a fallen tree used for denning, or a forest canopy cover (Nielsen, 2004). Since resource selection varies widely by age, sex, and season (Nielsen, 2004), RSF maps are generated separately for each sex-age group (adult male, adult female, and sub adult) and season (spring, summer and fall) (Cranston, 2006). RSF output values range from 0 (no probability) to 10 (highest probability).

Methodology for Testing RSF on Mining Land Use

Testing RSF for mining land use was conducted by overlaying the current version of RSF (2007) onto Luscar and Gregg River mines. The Phase 6 RSF version was used for this testing. It is based on 2005 conditions and was released in 2007. The result is the predicted grizzly bear occurrence by RSF class within mining land use areas. This was then overlaid with occurrence of grizzly bear GPS locations for a measure of grizzly bear occurrence per RSF class.

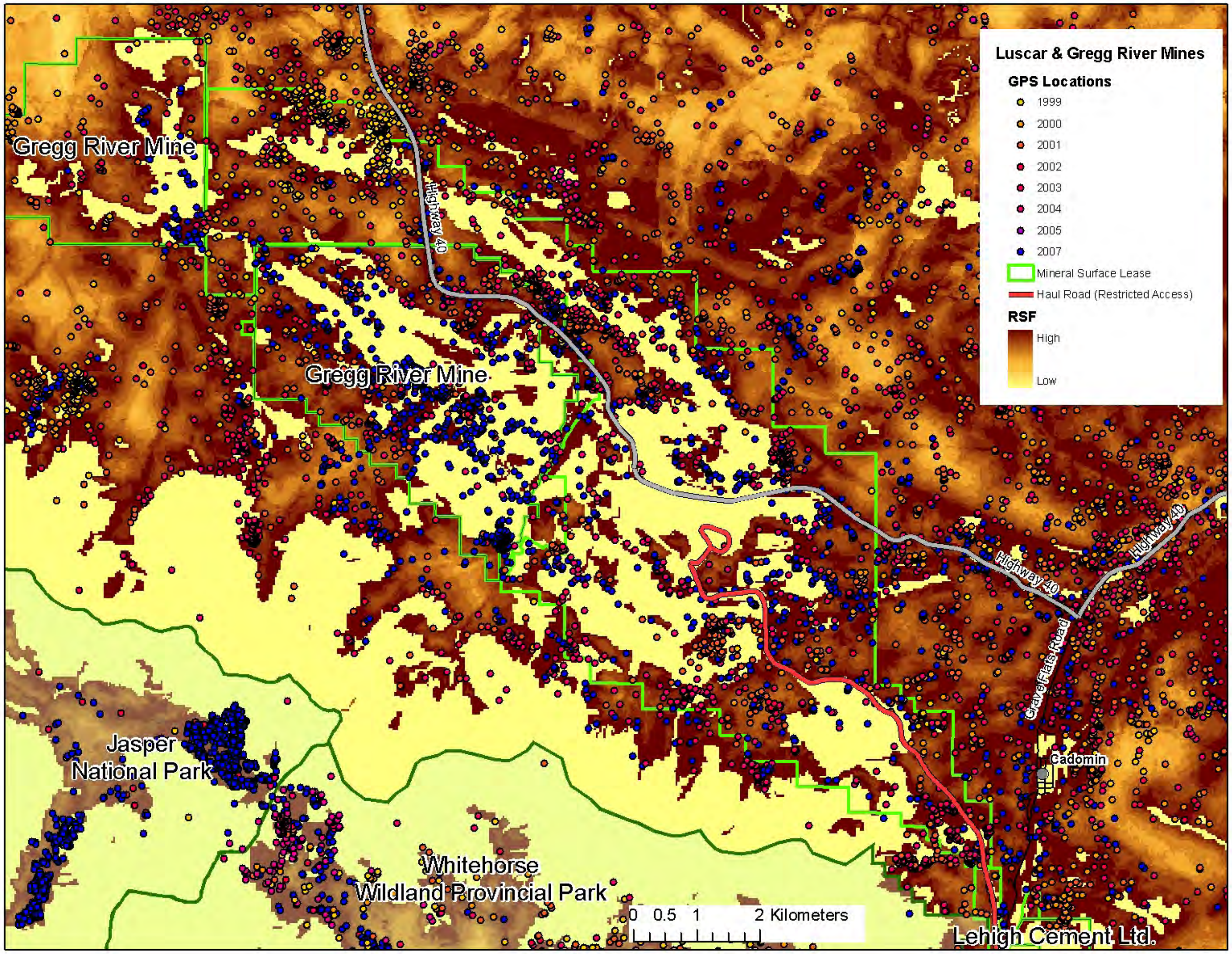

Figure 11. All Grizzly Bear Points within Luscar and Gregg River Mine MSLs with RSF Assigned Values (1-10)

Results: RSF and its Use in Predicting Grizzly Bear Occurrence in Mining Land Use

Table 3. Occurrence of Grizzly Bear Locations within RSF Assigned Values on MSLs

RSF Class	*Area (ha)*	*% of Area*	*GPS locations (#)*	*% Occurrence by RSF Class*	*% Occurrence per unit area*
0	2,935	41.37%	1,140	36.35%	14.9
2	10	0.14%	0	0.00%	0.0
3	26	0.37%	1	0.03%	1.5
4	75	1.06%	5	0.16%	2.6
5	104	1.47%	12	0.38%	4.4
6	208	2.93%	54	1.72%	9.9
7	393	5.54%	141	4.50%	13.7
8	655	9.23%	186	5.93%	10.9
9	944	13.31%	376	11.99%	15.3
10	1,745	24.59%	1,221	38.93%	26.8
Total	7,095	100.00%	3,136	100.00%	100.0

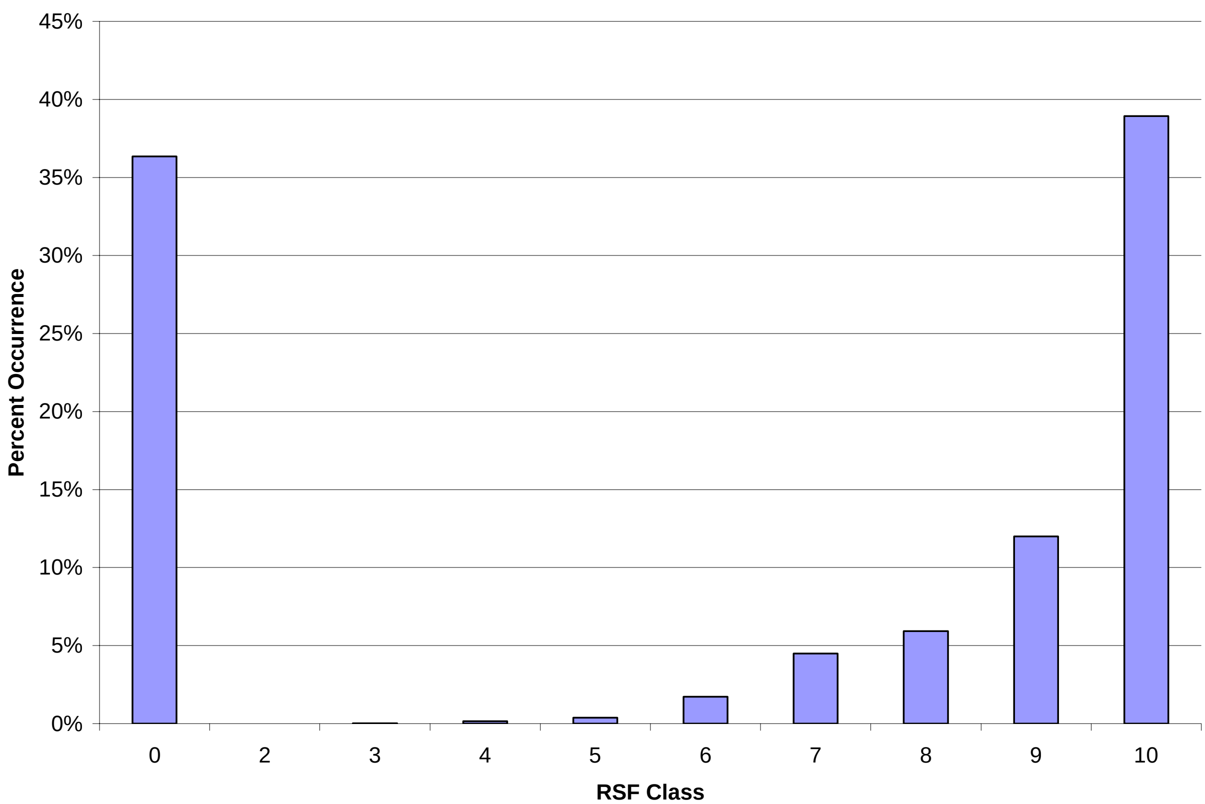

Figure 12. Percent Grizzly Bear Occurrence by RSF Habitat Class within MSL

This RSF model for grizzly bear habitat quality within the boundaries of the Luscar & Gregg River MSLs is significantly limited in its capacity to accurately predict probability of bear occurrence within the mining land use features which include the undisturbed, disturbed and reclaimed lands. Over 1/3 of all grizzly bear locations occurred within RSF class 0. This class is rated as the least probable location that a grizzly bear would use. Its actual level of use however, was similar to that of class 10 (Table 3), which is the highest probability classification. Nominally, the class 0 is assigned to disturbed lands, while higher ranking is provided to undisturbed lands. Figures 11 and 12 suggest that there may be correlation of grizzly bear distribution with other variables. These might include distance to forest cover, ungulate abundance, herbaceous plant production, or other habitat selection feature within mining land use areas. Grizzly bear occurrence on mining land use areas is not incidental but most likely purposeful and methodical. While much of these areas are characterized by RSF with a *no habitat value* mask, they are infact adjacent to portions of undisturbed lands which provide secure forest cover. These open, early succession reclaimed landscapes offer herbaceous forage and abundant ungulate populations in what is otherwise largely a closed forest environment with limited forage resources. Stevens & Duval (2005) found that grizzly bears with home ranges overlapping the Luscar and Gregg River mine land use areas support higher body condition indices than grizzlies with home ranges overlapping the un-mined Cheviot permit area. This is particularly significant for female bears. Grizzly bears with home ranges overlapping the existing Luscar and Gregg River mine land use areas return to previously used home ranges at least as regularly as bears in the un-mined Cheviot area. This implies regular as opposed to sporadic use of the mined lands (Kansas, 2005).

Conclusion and Recommendations

Within mining land use, there is a phased life cycle of development and reclamation. This life cycle, over years or decades, maintains a portion of undisturbed, disturbed, and reclaimed lands accessible to wildlife, under restricted public access. Habitat quality within mining land use areas is misrepresented by the assigned low RSF score within the model, likely resulting from an issue of process in scale with mining land use within the application of this tool for regional mapping or assumptions applied upon interpolation within mining land use areas.

Neilsen (2005) assigned a low RSF score (low probability of bear occurrence) when developing the regional scale model for landcovers with similar vegetative cover, bare ground and greenness values as mining land use (McDermid, 2004). While this may be appropriate at a regional scale resolution, the RSF model fails specifically to provide reasonable predictive relative occurrence of grizzly bears on mine land use landscapes, and rather arbitrarily assigns these areas with a low score. The IDT map developed by McDermid (2004) utilizes 13 land cover classes. No class has been developed specific to mining land use. Contrary to actual empirical data, a 'mask' has been applied to disturbed areas within the mining land use areas to further discount their probability of grizzly bear occurrence. Grizzly bear occurrence may result from reclamation forage, ungulate utilization, or public access management on mining land use areas. Assigning a cover class similar to that done for regenerating clearcuts may be entirely logical for reclaimed mine lands.

In spite of the intensive and long-term nature of the regional grizzly bear research by the FMFGRP, little specific information on grizzly bear response to mine development and reclamation has been conducted. In fact, assumptions made in the construction and applications of RSF and other models, including the mortality risk model and habitat states analysis, constructed on a regional scale, currently consider areas associated with mining and reclamation to be largely unavailable to grizzly bears and of high and even very high mortality risk (Stevens & Duval, 2005). Given their regional significance for grizzly bear use, areas within active MSLs, with their specific public access designation and habitat value, should be reflected accordingly by RSF. End land use planning opportunities and risks are discussed further in Chapter 5. The next Chapter examines two grizzly bears as case studies relating to their occurrence and movement within mining land use areas.

Chapter Four: Case Study of Grizzly Bears and Mining Land Use

Since the 1996 and 1999 Cheviot grizzly bear CEAs, significant knowledge has been gained regarding grizzly bears within the Yellowhead Ecosystem. As well, Chapters 2 and 3 of this thesis have confirmed that grizzly bears routinely use mining land use areas. This Chapter shifts to case studies of two grizzly bears to determine finer scale grizzly bear movement and occurrence within and adjacent to mining land use areas. The first grizzly bear, G008 an adult male, was twenty two years old in 2007. Data was collected on movements and habitat selection through the use of GPS radio collars during two years of pre-disturbance and two years of concurrent active mining land use within the Cheviot project area. The second, G040, was 8 years old in 2006. She is an adult female that provides 4 years of data collected on movements and habitat within and adjacent to existing mining land use of the Luscar and Gregg River mines. Data from these 2 bears is considered within a regional grizzly bear management context.

Grizzly Bear Home Range and Mining Land Use

Home range is a term that has been defined as “that area traversed by the individual in its normal activities of food gathering, mating and caring for young. Occasional sallies outside the area, perhaps exploratory in nature, should not be considered as part of the home range” (Burt, 1943). Rather, it is where an animal goes during its day-to-day activities. The area defined as a home range is dependent on the size of the animal and its requirements for food, water, mates and refuge or den sites (Busch, 2000). Chapters 3 and 4 of this thesis have demonstrated regular grizzly bear occurrence within active mining land use areas. This Chapter explores the impact of mine development on grizzly bears and their subsequent use of these landscapes at a fine scale. Further, this thesis will focus on specific interactions between grizzly bears and mining land uses. This Chapter examines grizzly bears' use of mining land use areas within part of their range.

Researchers may estimate home range polygons using several methods. Minimum Convex Polygon (MCP), generated by the Animal Movement extension of ArcView GIS, is a simple polygon enclosing the outermost GPS points of a set to generate a utilization-distribution. Fixed kernel density estimator is a method of estimation which has been increasingly selected over other methods such as the MCP. MCPs have been found to over-estimate home range size as they include all those unused areas between the outermost locations, and generally increase in area with increasing sample size. Kernel home range estimation is dependent upon percent of fixed kernel and on assigned smoothing factor (Hooge & Eichenlaub, 1997). This study purposefully opted to use only empirical data without home range modeling. As such, grizzly bear movement and use associated with mining land use is determined using GPS locations and the continuous movement paths collected from the collar sensors. For GPS locations collected, grizzly bears are either within the active coal mine MSLs, which are defined as mining land use areas, or they occur outside these areas.

G008 & G040 Research Methodology

Empirical data of grizzly bear movement was collected for this thesis research in 2006 and 2007. In 2006, using helicopter reconnaissance, two grizzly bears were located, tranquilized, and fitted with GPS, camera and sensor equipped collars. This was repeated in 2007 for the successful re-collaring of one of the individual grizzly bears. G040 was translocated in 2006 and thus unavailable for recapture in 2007.

(Sept 7 2007)

Figure 13. Author with Collared Grizzly Bear

This was part of a joint project between this thesis study and a geomatics engineering technology doctoral thesis project, both supported through cooperative partnership with the FMFGRP, Elk Valley Coal, and NSERC/CRD. GPS and sensor data was remote-downloaded monthly using a helicopter. Camera pictures were to be retrieved with collars prior to winter denning in November 2006, although G008's collar was retrieved (and replaced) in spring 2007.

Each collar had sensors programmed to collect 26 GPS locations per day at 30 minute intervals during the early morning and early evening, one hour intervals during the remainder of the daylight hours, and two hour intervals during the night. Additional sensor data recorded continuous movement paths, along with digital pictures taken at approximately 15-minute intervals. GPS and sensor data can be used to determine movement, habitat selection and behavioral patterns. Each bear provided large data sets for analysis of grizzly bear movement and human disturbance.

This study recognizes that data collection may begin at some point following den emergence, and may or may not capture all annual movement of grizzly bears collared. For example, G040 was collared on April 15. Her collar was subsequently removed on July 27 2006, when she was captured by government agency. In 2007, G008 was collared on April 25. His collar failed to collect data following August 2007. Understandably, caution should be applied regarding definition of *home range size* and point distribution based on datasets.

All capture and collaring efforts (1999-2004, 2006-2007) followed procedures outlined by the Canadian Council on Animal Care for the safe handling of bears. Research protocols were further approved by the Animal Care Committee at the Western College of Veterinary Medicine in Saskatoon, Saskatchewan. All capture and handling methods were consistent with the guidelines of the American Society of Mammalogists (Animal Care and Use Committee 1998) (See Appendices 1 & 2).

Table 4: Capture Information for Grizzly Bears G008 and G040

Grizzly Bear ID	Capture Date	General Location	Age (Year)	Capture Method
G008	14-May-99	Drummond Creek	14	heli dart
G008	9-May-02	Whitehorse/Drummond	17	heli dart
G008	19-Apr-06	Headwaters Whitehorse Creek-Fiddle Pass area	21	heli dart
G008	25-Apr-07	Whitehorse Creek	22	heli dart
G040	17-May-01	Highway 40 near Luscar MSL	3	Snare
G040	30-Apr-02	Gregg River MSL	4	heli dart
G040	15-Apr-06	Gregg River MSL	8	heli dart
G040	27-Jul-06	Hamlet of Cadomin	8	Culvert trap

Results of Grizzly Bear Occurrence and Mining Land Use Analysis

Although the sample size of individual grizzly bears presented is small (n=2), they contributed a large amount of occurrence and movement data over 8 years, reducing GPS collar bias (Frair et al., 2004). The two grizzly bears collared in this thesis study have been previously collared over multiple years (Table 4). The FMFGRP (1999-2004) dataset for these grizzly bear occurrences was also utilized to augment the statistical power of the analysis, to conduct analysis including multiple annual datasets, and assess shifts in grizzly bear occurrence over time and with mining land use.

Grizzly Bear G008 Occurrence and Mining Land Use

Grizzly bear G008 occurrence and his association with mining land use between years allowed the assessment of changes in grizzly bear use and movement between years with and without the presence of mine related development activity.

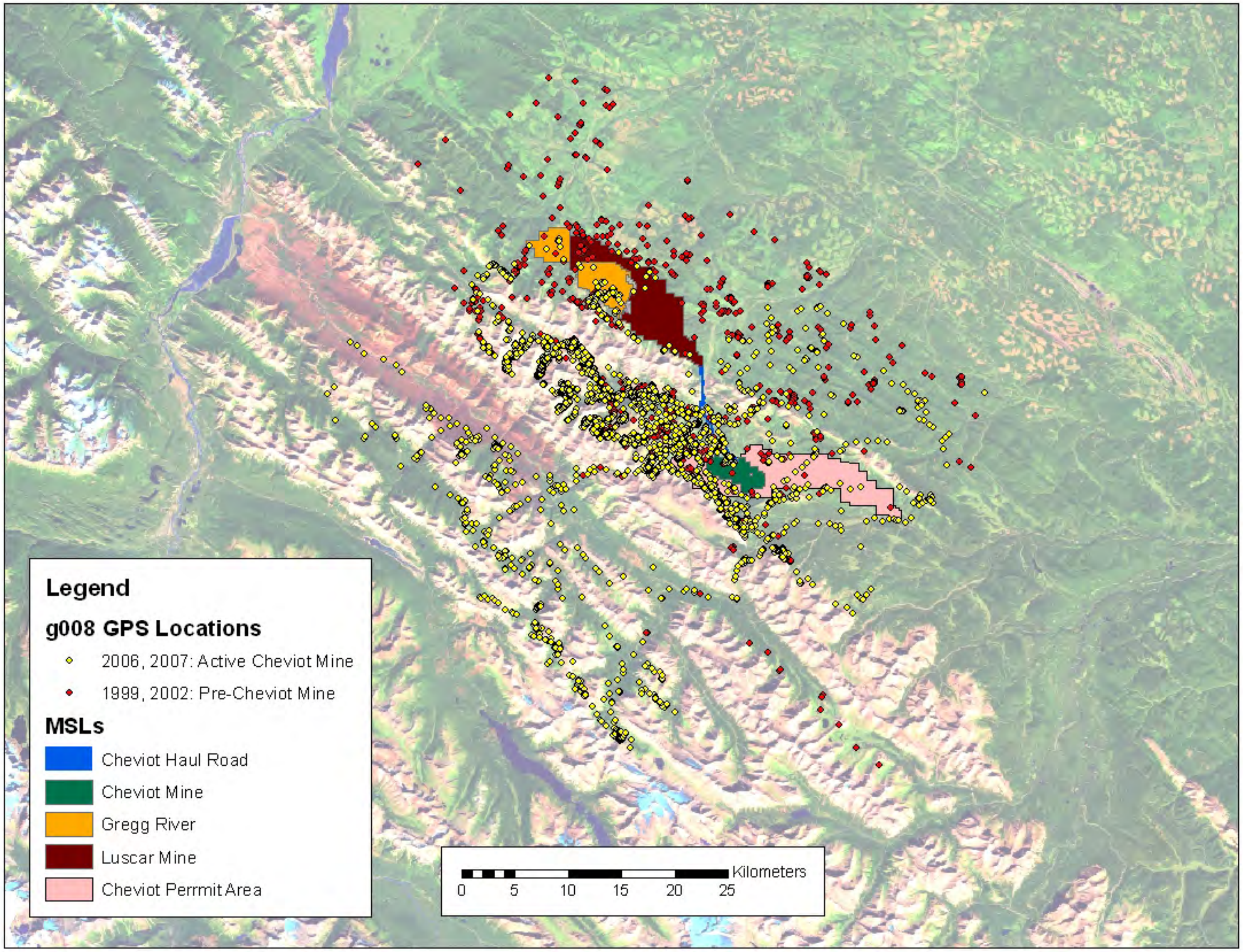

Figure 14. G008 Occurrence *Before* and *With* Cheviot Mining Land Use

Table 5: G008: Percentage of Grizzly Bear Occurrence Within Mining Land Use

Grizzly Bear G008	Total GPS points	GPS points within Cheviot Permit	% GPS Locations within Cheviot Permit	GPS points within Cheviot MSL (Mine & Haul Road)	GPS points within Luscar & Gregg River Mines MSL	GPS points within all active MSL	GPS Locations within Mining Land Use (% within active MSL)
1999	393	29	7.4	4	14	14	**3.6**
2002	851	83	9.8	6	16	16	**1.9**
2006	3,777	223	5.9	47	0	47	**1.2**
2007	1,048	126	12.0	6	77	83	**7.9**

(grey) *before* Cheviot project
(white) *with* Cheviot project

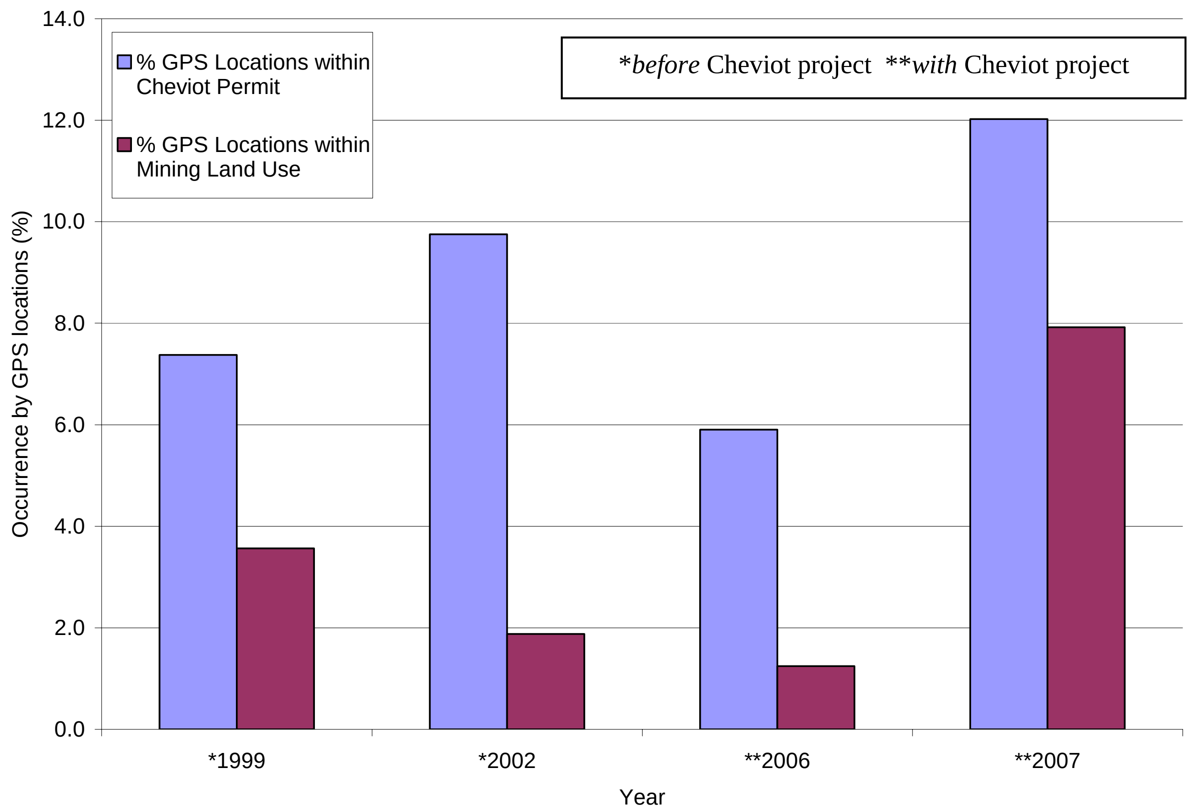

Figure 15. G008: Percentage of Grizzly Bear Occurrence (GPS Points) Within Mining Land Use and Cheviot Permit Area

An occurrence distribution of each year for G008 compared between years *before* (1999 & 2002) and *with* (2006 & 2007) mine related land use in the Cheviot project area.

Grizzly Bear G040 Occurrence and Mining Land Use

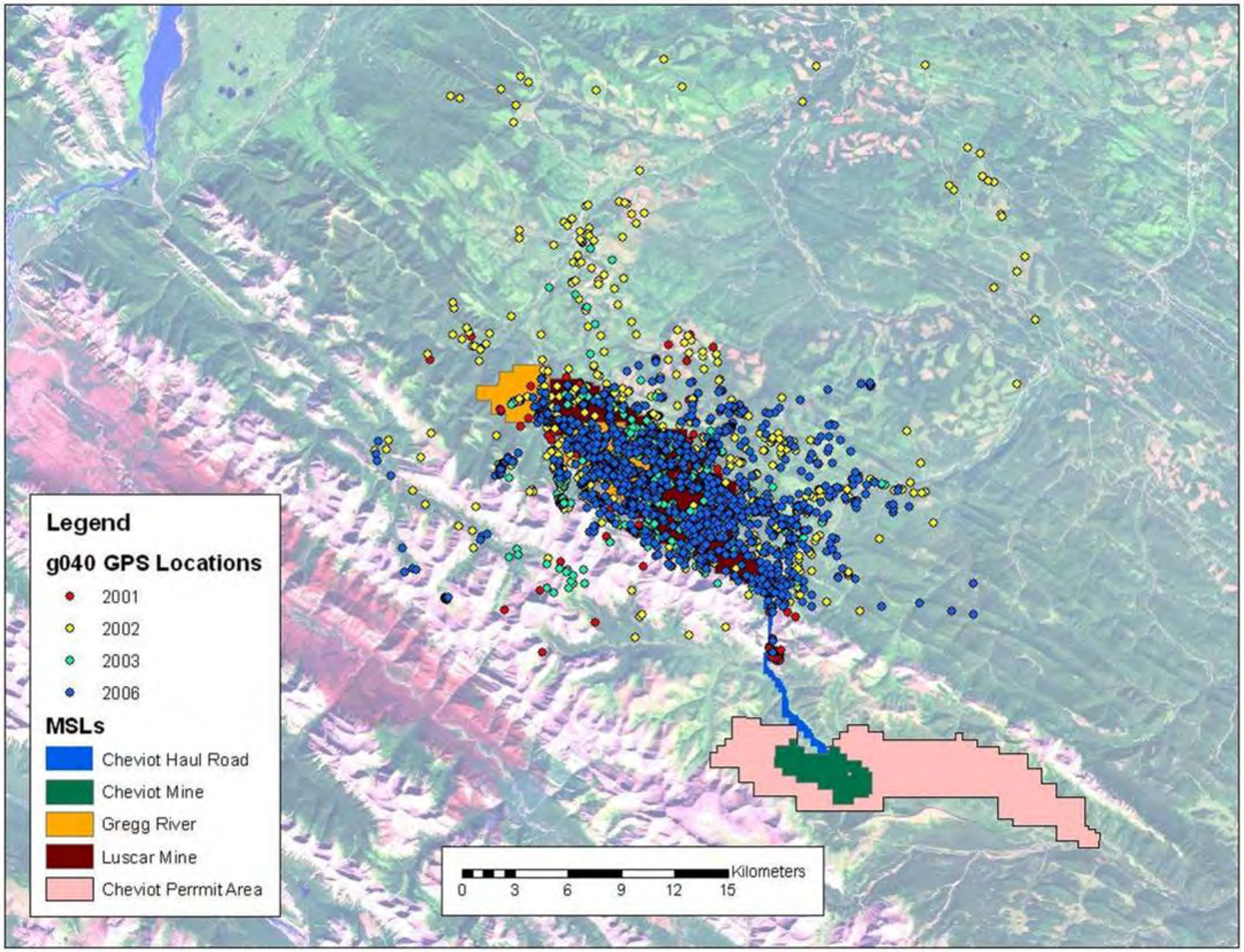

Figure 16. G040: All GPS Points by Year

Grizzly bear G040 occurrence and her association with mining land use between years allowed the assessment of changes in grizzly bear use over time.

Table 6: G040: Percentage of Grizzly Bear Occurrence Within Mining Land Use

Grizzly Bear G040	Total GPS points	GPS points within Cheviot MSL (Mine & Haul Road)	GPS points within Luscar & Gregg River Mines MSL	GPS points within all active MSL	GPS Locations within Mining Land Use (% within active MSL)
2001	173	6	115	121	66.5
2002	689	1	172	173	25.0
2003	665	0	422	422	63.5
2006	1919	4	1261	1265	65.9

before Cheviot project (shaded)
with Cheviot project (unshaded)

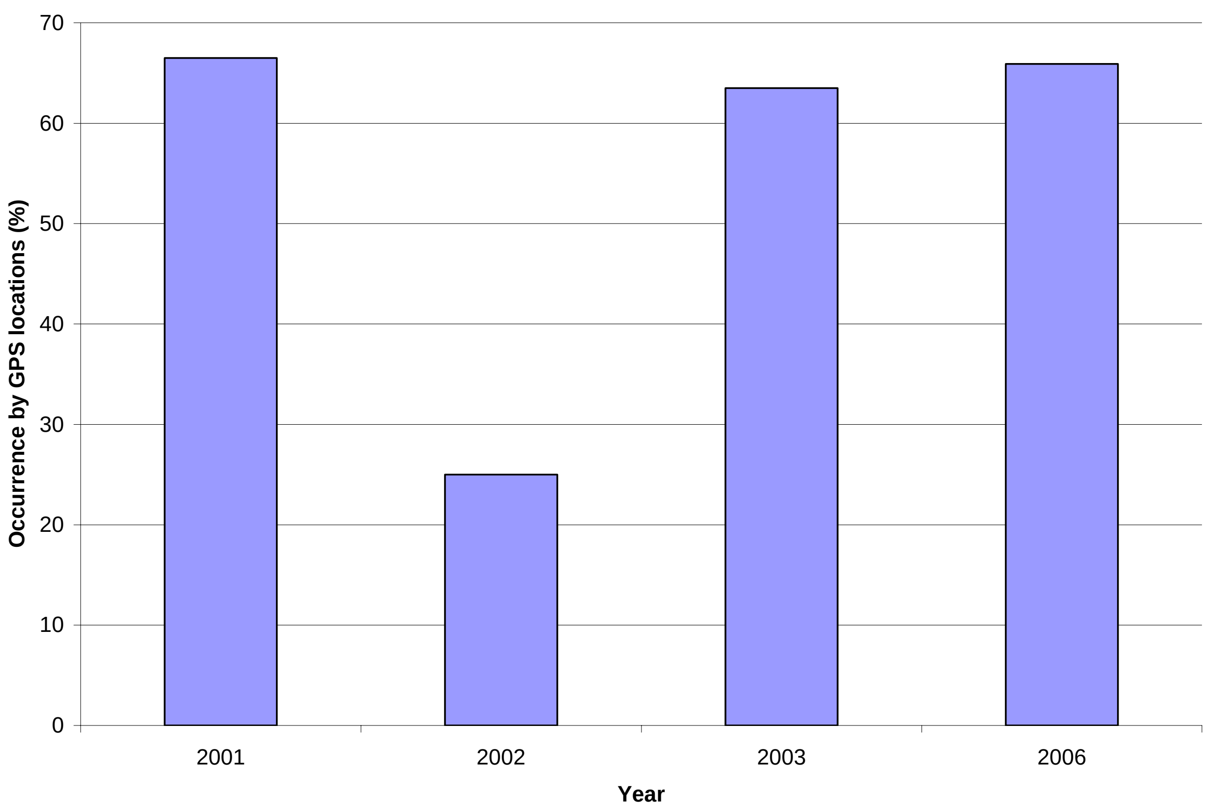

Figure 17. G040: Percentage of Grizzly Bear Occurrence within Mining Land Use by Year

An occurrence distribution of each of 4 years (2001-2003, 2006) for G040 compared her occurrence within active mine land use over this period of time.

Results of Grizzly Bear Movement and Mining Land Use Analysis

Grizzly Bear G008 Movement and Mining Land Use

GPS locations and their spatial orientation were used to determine grizzly bear occurrence within mining land use areas based on a percentage of total number of GPS locations collected. G008 GPS point data is identified from the FMFGRP 1999-2004 dataset (*before* Cheviot project) to compare to repeated G008 GPS data collected through this 2006 and 2007 (*with* Cheviot project) thesis research collection period.

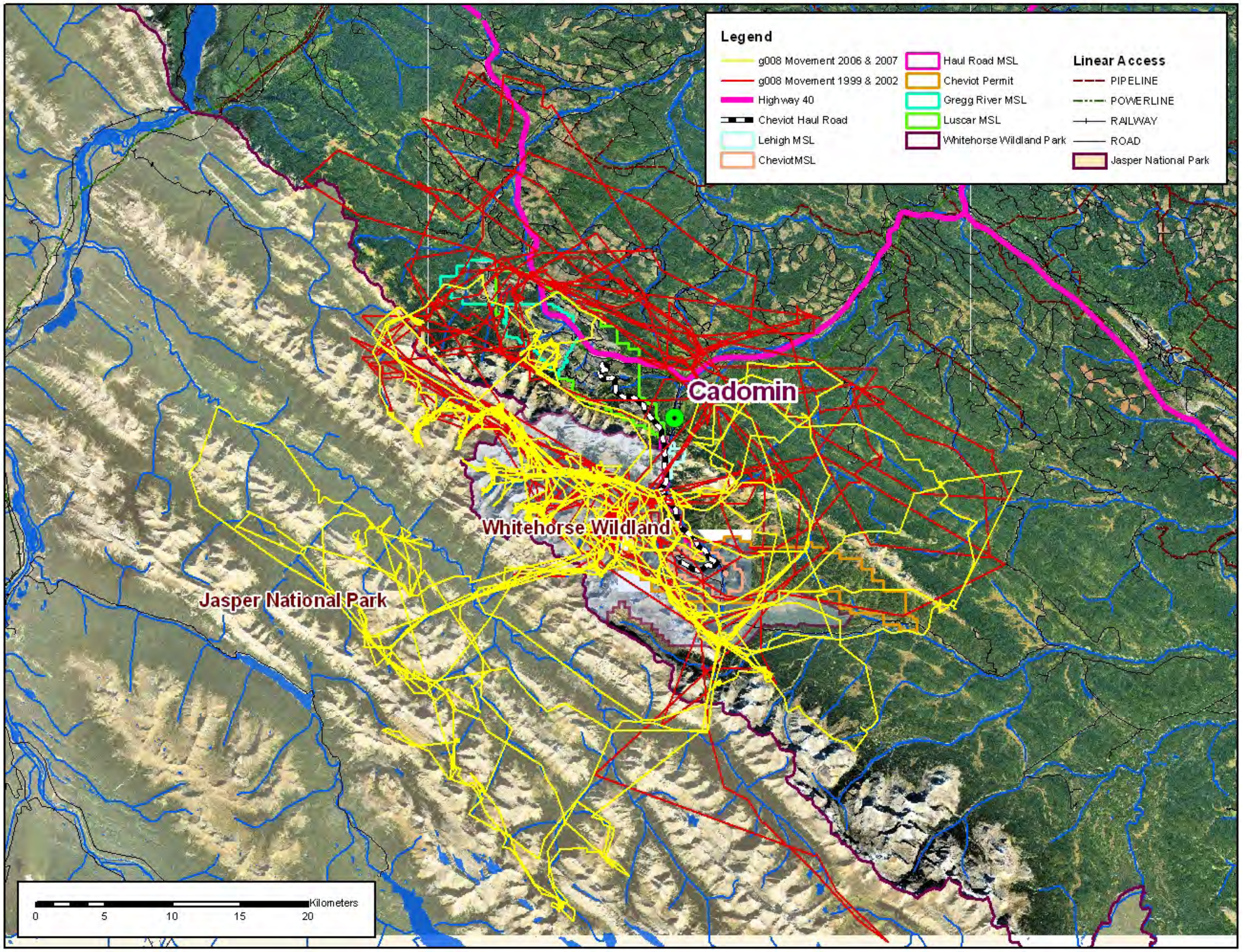

Figure 18. G008: All Recorded GPS Locations and Interpolated Movements and Mining Land Use Areas

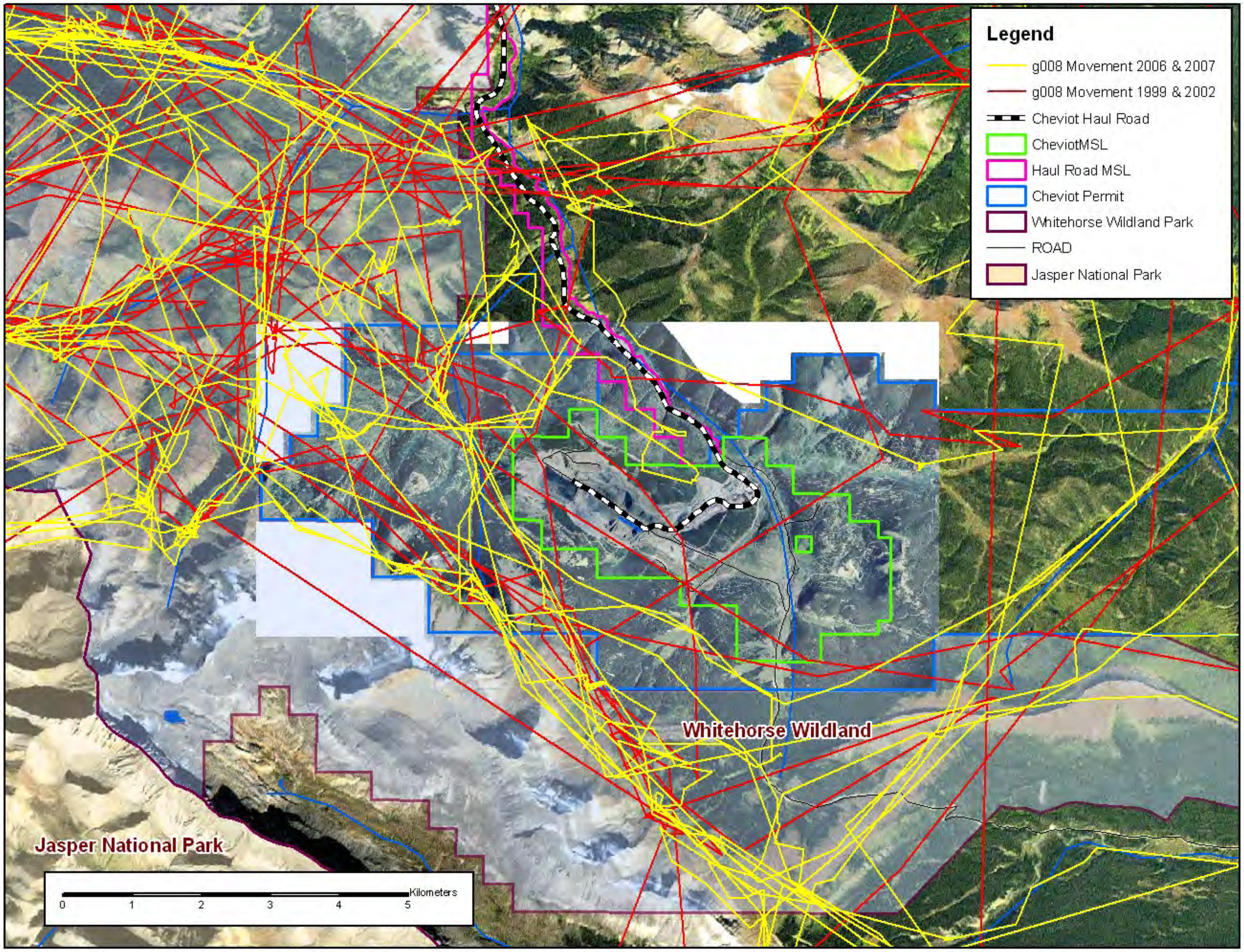

Figure 19. G008: Interpolated Movements *Before* and *With* Cheviot Mining Land Use

Extracting movement paths within and adjacent to this mining land use demonstrates actual grizzly bear movement patterns. GIS overlay of mining land use is used to identify actual grizzly bear movement corridors in and adjacent to active mining land uses.

Additionally, by joining GPS points (4 hour interval) to coarsely identify pre-Cheviot movement paths, we can examine shift or consistency in grizzly bear movement corridors with the addition of the Cheviot mining land use. Figures 18 and 19 identify grizzly bear G008 movement corridors prior to and during active Cheviot mining operations. Movements of G008 are overlaid with mining land use features, including the Cheviot coal transportation haul road.

Grizzly Bear G040 Movement and Mining Land Use

Four years of G40's GPS location data were used to determine use of Luscar and Gregg River mining land use areas as portion of this grizzly bear's annual range. From 2001-2006, G040's locations (Figure 14) occurred within the mining land use area of the Luscar and Gregg River MSL over 55% of all locations (range 25%-66.5%, n=4 years).

For G040, using the multiple per day collected GPS points along with sensor data which records continuous movement path, grizzly bear movement within and adjacent to mining land use was examined at finer scale.

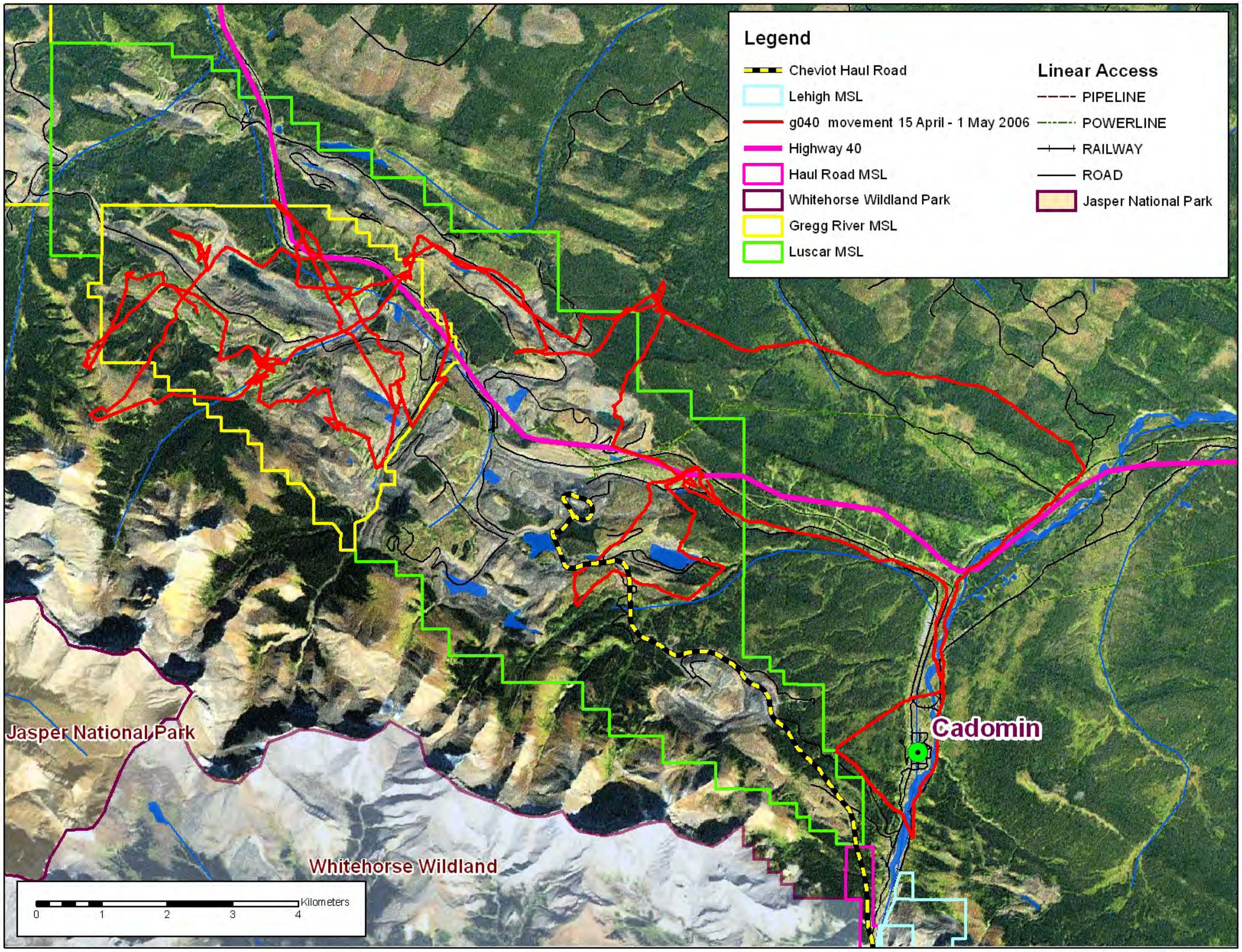

Figure 20. G040 Movement Within and Adjacent to Luscar/Gregg River Mining Land Use (2006)

This continuous movement path was processed for a two week period, from April 15 to May 1 2006. Extracting continuous movement paths within and adjacent to the Luscar and Gregg River Mines demonstrates actual spatial and temporally correct grizzly bear movements within mining land use.

Discussion

Grizzly Bear Occurrence

Grizzly bear G008 has been referred to as a ‘Cheviot bear’, due to his use of the Cheviot permit area prior to, and now during the development and operation of the Cheviot project area as a portion of his home range. Interestingly, empirical analysis of his GPS locations prior to the Cheviot project also indicate an average of 2.7% (3.6% and 1.9%, 2 years) of his annual locations occurring within the Luscar and Gregg River mining land use areas. His average use of the Cheviot mine permit area in relation to total GPS locations collected per year increased slightly following the start-up of the Cheviot project (8.6%, n=2 years; 9.0%, n=2 years).

Grizzly Bear Movement

Eight (8) grizzly bear annual ranges for 2 grizzly bears were analyzed. This offered recent data and reduced potential bias of limited sample size given individual bear behavior variability (Mueller, 2001). It is acknowledged that correlation of grizzly bear movement and mining land use features is weaker for the 1999-2004 FMFGRP dataset as GPS (typically collected at 4 hour point intervals) alone may not provide resolution for studying behavior or understanding use within the zone of influence of specific mining land use activity.

Actual movement of grizzly bears within mining land use was examined at a fine resolution and scale using the 2006 and 2007 data. Multiple per day collected GPS points along with sensor data which records continuous movement path within and adjacent to active open pit mining had been intended for this analysis. This new geomatics technology development, however, presented data processing challenges requiring further effort to resolve. This thesis analysis thus proceeded primarily using GPS locations and interpolation between these points based on time sequence.

The frequency of point intervals meaningfully increased for the 2006 and 2007 grizzly bear program. This has increased the capacity of the analysis to initiate definition of actual movement paths. Availability of continuous movement data was limited to G040 over a two week period in 2006. This technology demonstrates a marked and significant improvement in resolution of monitoring of actual grizzly bear movement from which behavior and habitat selection may be researched empirically. This study does serve to augment a robust empirical dataset for association of bear use and mining land use features. Further outputs of the continuous movement sensors will greatly enhance the ability to examine individual grizzly bear behavior based on movement, activity and habitat selection.

Conclusion

How a grizzly bear reacts to human activity depends on many variables including the type and intensity of human activity, where the interaction occurs, the distance between the activity and the grizzly bear, the amount of cover, inherited tolerance, age and sex class and individual personality and experience (Mueller, 2001). Wielgus, Vernier, & Schivatcheva (2002) studied grizzly bear selection of use of open, closed and restricted forestry roads and suggest that cessation of all resource development activity in grizzly occupied areas may not be necessary to maintain habitat effectiveness. Grizzly bears did not select against restricted roads, and no grizzly bears were shot from restricted roads. This thesis supports similar findings. Although active mining may present inherent temporary habitat loss and episodic local movement barrier, such as active mining pits, the analysis conducted suggests that mining land use has not resulted in landscape level movement barriers for grizzly bears within the current Cheviot or Luscar/Gregg River mine areas. Continued use of adjacent high quality habitat indicates no sign of displacement. Repeated grizzly bear crossings have occurred across the active Cheviot haul road. Based on continuous movement data (Figure 20), these crossings have been during diurnal grizzly bear activity, occurring in routinely as late morning (ie. G040, 2006-04-24, 09:15) or mid afternoon (ie. G040, 2006-04-23, 16:38).

Aside from the active Cheviot haul road, it is important to qualify the mining activity occurring within active mining land use areas. Figure 18 identifies G008 movement within and adjacent to the active Cheviot project. Within the Cheviot MSL is intensive land alteration as the mine is in its early development phase of coal extraction in its life cycle. Large areas of landform re-development and reclamation have not yet been fully initiated. During this pit development, vehicular traffic of mine support equipment and coal hauling are underway on the Cheviot haul road, generally on a 24 hour/day basis. Further, these mining land uses within the Cheviot area were only initiated in late 2004. Construction of the Cheviot haul road, pit development and operation: these are all recent activities within the area. There is no significant shift of movement or avoidance observed.

Figure 20 identifies G040 movement primarily within the Luscar and Gregg River MSLs. Active coal mining occurred over 30 years on these MSLs until 2004. Although not currently under active coal development, the Luscar mine site still supports industrial activity through the site, including explosives manufacturing, electrical substations, maintenance shops, main office complex and site access, and 10 km of the Cheviot haul road. It also features Highway 40 which provides public travel through the site. While much of the reclamation of the Gregg River site was completed by 2006, a large portion of the Luscar site currently remains in a disturbed state, without yet having been fully reclaimed.

Maintaining movement connections across fragmented landscapes is important for the long-term conservation of grizzly bear populations (Schwab, 2004). In mining land use or timber harvest areas, fragmentation may be caused by human disturbances, such as a network of highly used roads that can disrupt the ability of individual bears to efficiently move between feeding areas. At the regional scale, fragmentation may occur when movements along or across major valley systems are blocked, and interbreeding populations are cut off from each other (Kansas, 2002a). This thesis research indicates no significant observed barriers to grizzly bear movement as a result of mining land use such that their use of areas is impeded. G040 moves through reclaimed, unreclaimed, and undisturbed areas within mining land use areas. This includes occurrence in unreclaimed disturbed areas with active mine activity including active mine haul roads

Caution must be applied when examining the effects of this specific land use on grizzly bears in isolation. Prior to the Cheviot project, and within the future development footprint, there exist multiple other lands uses. It is important to ensure that researchers remain cognizant of these existing human uses within adjacent areas and not engage in project level impact assessment without due consideration of regional influences on grizzly bears. Finally, this Chapter has affirmed with empirical research that the inductive models used to predict mining land use effects on grizzly bears are erroneous. Grizzly bear occurrence on active mining land use areas, as demonstrated, may serve for *projection* of effects due to planned mining projects.

Although we are uncertain of her mother's identity, it is known that G040's father, G017, had used portions of the Luscar and Gregg River mines as part of his range. During G040's use of public lands away from these mining land use areas in 2006, like her father before her, G040 was removed from the regional grizzly bear population. In fact, along with her removal were both her male and female cubs. One cub was suspected to have been shot prior to G040's capture and translocation along with her remaining female cub. Studying grizzly bear occurrence and movement in one type of human land use, especially at a mining project scale, is not sufficient to ensure persistence of grizzly bears. The regrettable fate of G040, both of her cubs, her father, and many other grizzly bears in the region warrant further exploration in Chapter Five.

Chapter Five: Implications of Research Results and Recommendations for Mining Land Use and Regional Grizzly Bear Management

Results of empirical testing of grizzly bear occurrence and mining activity demonstrate regular grizzly bear use of mining land use areas and its resultant landscape development. This Chapter will review the state of knowledge regarding managing human-caused grizzly bear mortality and explore opportunities for regional post mining landscapes that would be supportive of safe, long term grizzly bear conservation areas. The Cheviot project application raised issues, which resulted specifically from scientific uncertainty regarding regional grizzly bear response to mining and regional human land use influences. This discussion will suggest that grizzly bear conservation is not a project specific endeavor, but rather a regional commitment. This is especially important in retrospect of the Cheviot project CEA. This Chapter offers a brief retrospective of that CEA process, reviews the policy and framework development, and commitments made and their current status.

Nielsen et al. (2006) defines safe-harbours as those which are source-like or secure. This review will consider how the Cheviot project, predicted to contribute to regional adverse impacts to grizzly bear, may infact, with the other nearby existing mining land use areas, provide opportunity for long term safe-harbours for grizzly bear conservation in a region undergoing rapidly increasing resource and recreational land use pressures. Finally, this Chapter will conclude with *Recommendations for Mining Land Use and Regional Planning for Grizzly Bear Protection*. These are based on these research findings, the current state of knowledge for protection of grizzly bears, and my own experiences. These recommendations may serve industry, governments, and public by providing detail to augment the existing Alberta Grizzly Bear Recovery Plan. My recommendations focus on potential opportunities that exemplify sustainable mining by exploring post mining land use areas as potential critical long term conservation areas for grizzly bears. An important component to this is attentive accommodation and integration of recreation and other land uses.

Managing Human-Caused Mortality

Grizzly bears, because of their omnivorous food habits and ability to move long distances, will likely find any permanent human habituation within their home range and obtain food there if possible. Often when this occurs they usually are removed by appropriate authorities as “nuisance bears”. Management removals of "nuisance" grizzly bears are a leading cause of death in many populations. Whether these bears are killed or simply removed from the population unit, they must be viewed as a reduction to the existing population. Management is typically invasive and often includes translocation of these animals to remote areas and sometimes even their destruction (Kloppers, St. Clair, & Hurd, 2005). These sites may become “population sinks”; sites that bring grizzly bears into contact with humans (by food attractants) and often result in removal of grizzly bears from the population (Knight, Blanchard, & Eberhardt, 1988).

Horejsi (1989) provides a critical commentary regarding Alberta’s provincial grizzly bear management, suggesting “Fish & Wildlife Division of Alberta has managed the grizzly bear in isolation, has manipulated the ecosystem’s population on behalf of people’s needs, ... bear management continues with almost no input from the public, and land use decisions strongly maintain the status quo.” Nearly twenty years following his comments, Alberta is developing new initiatives and policy for grizzly bear conservation. Many of the initiatives for enhancing knowledge and conservation measures for grizzly bears in the region resulted from the 1996 CEA for the Cheviot project and its conclusions regarding impacts to grizzly bears. This included development of *A Strategic Framework for Grizzly Bear Conservation in the*

Yellowhead Ecosystem (2000). New policies based on regional DNA inventory data, 10 years of mapping and modeling work, coupled with unsustainable regional grizzly bear mortality rates resulted in the *Draft Alberta Grizzly Bear Recovery Plan* (2005). This thesis has shown that some of the predictions regarding mining land use impacts were not only inaccurate, but were erroneous. It is, however, valuable to understand the state of science for grizzly bear protection and what implications and opportunities might exist for mining land use in the region that might support grizzly bear conservation.

Human-caused grizzly bear mortality: State of the science

Conservation biologists have studied grizzly bear human caused mortality throughout North America for several decades. Without reductions in human-caused mortality after 1970, there would have been no chance that core grizzly bear range would be as extensive as it is now (Mattson & Merrill, 2002). Although rarely considered under the perspective of source-sink theory, there is the possibility of ecological sinks resulting from high mortality in otherwise good habitats, where resources are abundant and reproduction could be high (Delibes, Gaona, & Ferreras, 2001). Mortality rates and causes in the interior mountains of British Columbia, Alberta, Montana, Washington, and Idaho identify that trends of grizzly bear populations are found to be most sensitive to female survival; thus understanding rates and causes of grizzly bear mortality is critical for their conservation. Servheen & Sandstrom (1993) found that accidental killing was most often the result of collisions between grizzly bears and motor vehicles or trains. Intentional human-caused mortality can include legal hunting, control killing for being close to human habitation or property, self-defense, and malicious killings. (McLellan et al., 1999).

The sex and age distribution of deaths and the magnitude of losses in relation to recruitment are key issues in evaluating populations (Knight, Blanchard, & Eberhardt, 1988). Human-caused mortality, especially of adult females, is the primary factor limiting grizzly bear populations (Knight, Blanchard, & Eberhardt, 1988; Mace & Waller, 1998; McLellan et al., 1999). The best prospect of reversing downward trend in grizzly bear populations is by reducing mortality, particularly that of adult females (Knight et al., 1988).

Human-caused mortality increases significantly for areas with open public roads (Benn & Herrero, 2002; Mace et al., 1996). Roads increase access for legal and illegal hunters, the major source of adult grizzly mortality (Alberta Grizzly Bear Recovery Team [AGBRT], 2005). When roads are developed for resource industries in grizzly bear habitat, the bear population becomes highly vulnerable unless access and people with firearms are controlled (McLellan & Shackleton, 1988). Even within protected and largely unhunted areas, such as Banff National Park and Kananaskis, humans caused 75% of female mortality and 86% of male mortality (Garshelis, Gibeau, &Herrero, 2005).

In the Swan Mountains, Montana, Mace and Waller (1998) found that from 1987-1996, the annual mortality rates for grizzly bears utilizing the rural and wilderness zones was 21 and 15 times higher, respectively, than for bears using only multiple-use lands. Their mortality, movement, and occupancy data suggest that the multiple land use zone was a population source area, and that wilderness and rural zones are sink areas. Mortalities in the wilderness zone were from mistaken identification during the black bear (*Ursus americanus*) hunting season and self-defence kills, primarily by ungulate hunters. In the rural zone, mortalities were from malicious killing and the management removal of habituated or food-conditioned bears (Mace & Waller, 1998).

An ecological trap (or "attractive sink") is a habitat that is preferred over other available, high quality habitats, but is low in quality for reproduction and survival and cannot sustain a population (Battin, 2004). Human-caused mortality can transform high quality habitats into traps by increasing adult mortality. Such traps may be masked by immigration from adjacent, less-preferred areas, maintaining high densities in preferred habitats even as the population as a whole declines (Battin, 2004). Habitat degradation can have rapid and severe impacts on population dynamics and traditional monitoring programs may not be adequate to detect the consequences of degradation (Doak, 1995).

Alberta

Grizzly bear populations in Alberta are threatened by permanent habitat loss and high rates of human-caused mortality (Benn & Herrero, 2002). Human-caused mortalities account for 90% of all known grizzly bear deaths in Alberta. Of those, with known locations, all occurred within 500m of a road or 200m of a trail (Benn & Herrero, 2002). Intentional killing in Alberta includes illegal forms of mortality such as poaching, malicious killing, mistaking grizzly bears for legal game. It also includes removal of nuisance grizzly bears by management agencies and bears killed by individuals in defense of life or property (AGBRT, 2005).

Human-caused mortalities account for 90% of all known grizzly bear deaths in Alberta (Benn & Herrero, 2002). Modeling the spatial distribution of human-caused grizzly bear mortalities in the Central Rockies ecosystem of Canada reveals that overall, relatively little of the system is secure from human-caused mortality for grizzly bears. Researchers suggest that this might be most directly remedied by controlling human access (Neilson et al., 2004).

NES Region

Selected areas within the FMFGRP area have concentrated high and very high categories of attractive sink, indicating a co-occurrence of high mortality risk and highly probable animal occupancy. Even where occurrence of these high and very high risk areas are fewer, such as Banff and Yoho National Parks, rates of human caused mortality within these protected areas which lack hunting and industrial resource development, are high. Human-caused mortalities combined with natural causes of death can be a significant conservation concern (Nielsen, Stenhouse, & Boyce, 2006). Boulanger's (2005) analysis of empirical data suggests declining grizzly bear survival rates over the course of the 1999-2004 FMFGRP study area. The FMFGRP data suggests that within the study area high quality habitats (as indicated by RSF score) also display higher road densities. Survival rates decrease in proportion to increasing human access and associated mortality. Mortality rates in non-protected roaded areas are higher than protected non-roaded areas. Mostly younger grizzly bears are found in non-protected roaded areas. Older bears are generally found in lower road density habitats, which also have lower habitat quality. Boulanger (2005) suggests that either older bears are selecting for protected, lower quality habitats, or historic mortality has removed older aged bears from areas of higher road density. Boulanger (2005) determined that a large proportion of females live in highly protected areas compared to males and the majority of grizzly bear fatalities occur to those that have a low percentage of their home range protected.

As roadless lands decrease, secure habitat for grizzly bears and other wildlife species sensitive to roads decreases as well (Bechtold, Havlick, & Stockmann, 1996). Spatial models of human-caused mortality risk suggest that the use of clearcuts and similar habitat in west-central Alberta result in an ecological trap situation, where animals lack the cues necessary to distinguish the high-risk condition (Nielsen, 2005).

Neilsen (2005) modeled forest resource development scenarios, including road density and clearcuts over a predicted 100 year period for different development scenarios. Despite a potential 10% increase in animal density and potential carrying capacity, effective (secure) territory units will decline by over 50%. All effective territories, even by year 30, will be located within or adjacent to protected mountain parks, suggesting a substantial decline in foothills populations. Without addressing habitat occupancy and mortality concurrently, attractive sink conditions may be developing where animals are drawn to locations where survival is low (Knight, Blanchard, & Eberhardt, 1988). This low survival is due primarily to human-caused mortality. To be effective, a grizzly conservation strategy must consider the status of the entire regional metapopulation over an area that encompasses both the source and sink populations (Carroll, Noss, & Paquet, n.d.).

Managing Human-Caused Mortality to Optimize Mining Land Use Gains

Fate of Grizzly Bear G040 and Cubs in 2006.

Gibeau (2000) examined movement patterns of adult female grizzly bears in the Bow River Watershed, Alberta and concluded that bears within an area of restricted human access used higher quality habitat and traveled less than bears in unregulated areas. While G040 demonstrated high annual fidelity to mining land use areas (average 71% of all GPS locations, n=4 years), she and her two cubs did also venture into public lands. In the Spring of 2006, G040 and her two cubs discovered dog food at a private residence on the outer fringe of the Hamlet of Cadomin. Later, her male cub was killed along Highway 40. In the early summer, having found this food source, G040 and her remaining female cub were repeatedly returning to the Cadomin residence to consume dog food. With this repeat behavior, based upon the provincial bear response matrix, the government agency deemed that she presented a human safety risk and intervention was warranted. She and her female cub were therefore captured by Alberta Fish & Wildlife and translocated; and thus extracted from the regional grizzly bear population. G040 had spent 8 years on this landscape within the same vicinity without prior concern or adverse human interaction. Arguably, this food conditioning in 2006 might have been most readily mediated by alternate means of intervention, such as ensuring proper storage of dog food, rather than removal of the two grizzly bears. G040's fate, and that of both of her cubs, was similar in nature to that of her father, G017, who was illegally killed in 2003; furthering the loss of mature grizzly bears to the population. Wilson (2003) found that grizzly bear deaths in the U.S. tend to be concentrated on the periphery of core habitats. While not necessarily on the periphery of these mining land use areas, this is a similar fate for many bears within the region. Schwartz et al (2006) demonstrated that humans are the single greatest cause of grizzly bear deaths and suggest that efforts to minimize conflicts between people and bears represent a major component of any management program directed at long-term conservation.

Mining Land Use and Regional Grizzly Bear Protection

A key mining land use attribute, independent of habitat quality, is public access management. Currently, all existing and recent mining land use areas in this case study remain under existing MSL disposition; thus restricting public access and prohibiting hunting. In the thirty five years of continuous open pit mining in the area, there is no record of any human-caused grizzly bear mortality (vehicular or other) as a direct result of mining activity. Although human-caused mortality has not occurred within mining land use areas, some grizzly bears whose home ranges included the Luscar and Gregg River mines studied from 1999 to 2004, have been killed. These consisted of 2 females and 5 male grizzly bears. All grizzly bears were killed outside of the MSLs and on public lands under provincial jurisdiction.

Table 7: Summary of Known Mortalities (1999-2005) of Grizzly Bears Within the Yellowhead Ecosystem

Grizzly Bear ID	Sex (Male/ Female)	Age	Date	Season	Nearest Road (m)	Cause of Death
GUNK011	F	adult	24-Sep-99	fall	430	Illegal
GUNK004	M	coy	24-May-00	spring	111	Illegal
GUNK005	F	adult	24-May-00	spring	16	Illegal
GUNK003	F	adult	01-Oct-00	fall	2,134	Illegal
G024	M	adult	23-Jan-02	spring	224	Illegal
G105	F	subadult	30-Sep-02	fall	6	Illegal
G020	F	adult	20-Sep-02	fall	56	Illegal
GUNK001	F	adult	11-Sep-99	fall	44	Illegal
na	M	adult	17-Sep-01	fall	7,765	Illegal
na	M	na	03-May-99	spring	6,285	Legal Harvest
na	M	subadult	24-May-00	spring	10,722	Legal Harvest
na	M	adult	25-May-01	spring	26,456	Legal Harvest
GUNK022	F	adult	02-May-05	spring	138	Legal Harvest
na	M	subadult	08-May-05	spring	914	Legal Harvest
na	F	na	12-May-05	spring	10,744	Legal Harvest
G102	F	subadult	16-May-01	spring	211	Legal Harvest
na	F	adult	22-Apr-03	spring	978	Legal Harvest
na	M	na	23-Apr-05	spring	194	Legal Harvest
na	M	subadult	04-May-04	spring	1,377	Legal Harvest
GUNK012	M	subadult	31-May-00	spring	541	Legal Harvest
na	F	subadult	31-May-00	spring	14,407	Legal Harvest
G021	M	adult	31-May-01	spring	21,935	Legal Harvest
na	M	adult	02-May-02	spring	1,377	Legal Harvest
na	M	adult	20-Apr-03	spring	5,562	Legal Harvest
na	F	subadult	15-May-04	spring	2,295	Legal Harvest
G036	F	subadult	27-May-02	spring	8	Legal Harvest
G029	M	adult	28-May-02	spring	3	Legal Harvest
G027	F	adult	14-May-05	spring	1,514	Legal Harvest
G046	F	subadult	27-May-01	spring	321	Natural
G208	M	adult	01-Sep-05	fall	66	Problem Wildlife
G032	F	subadult	31-May-00	spring	9,523	Research
G015	M	adult	16-May-99	spring	160	Research
G011	F	adult	30-Jul-02	summer	93	Research
GUNK002	F	coy	21-Oct-99	fall	69	Road Kill
G054	M	subadult	09-Oct-02	fall	357	Road Kill
na	M	na	09-Oct-99	fall	24,927	Self-Defense
G026	F	subadult	19-Oct-00	fall	28	Unknown
G057	F	adult	17-Jul-03	summer	4	Unknown
G017	M	adult	13-Sep-03	fall	227	Unknown

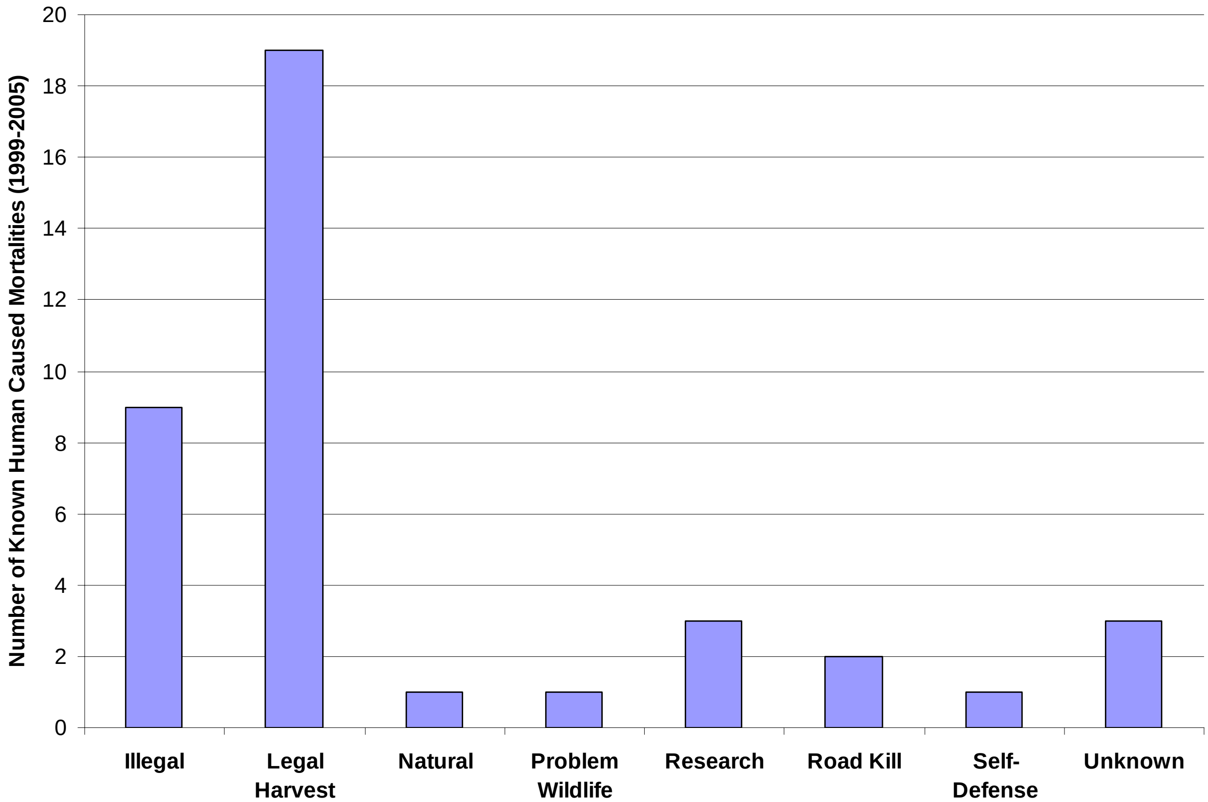

Figure 21. Summary of Known Mortalities (1999-2005) of Grizzly Bears within the Yellowhead Ecosystem

This known illegal mortality is under-stated as many of these deaths go unreported (McLellan et al., 1999). It is believed that illegally killed grizzly bears account for the greatest percentage of known mortalities. The highest rates of known illegal kills in the region occur during the fall ungulate hunting season (AGBRT, 2005).

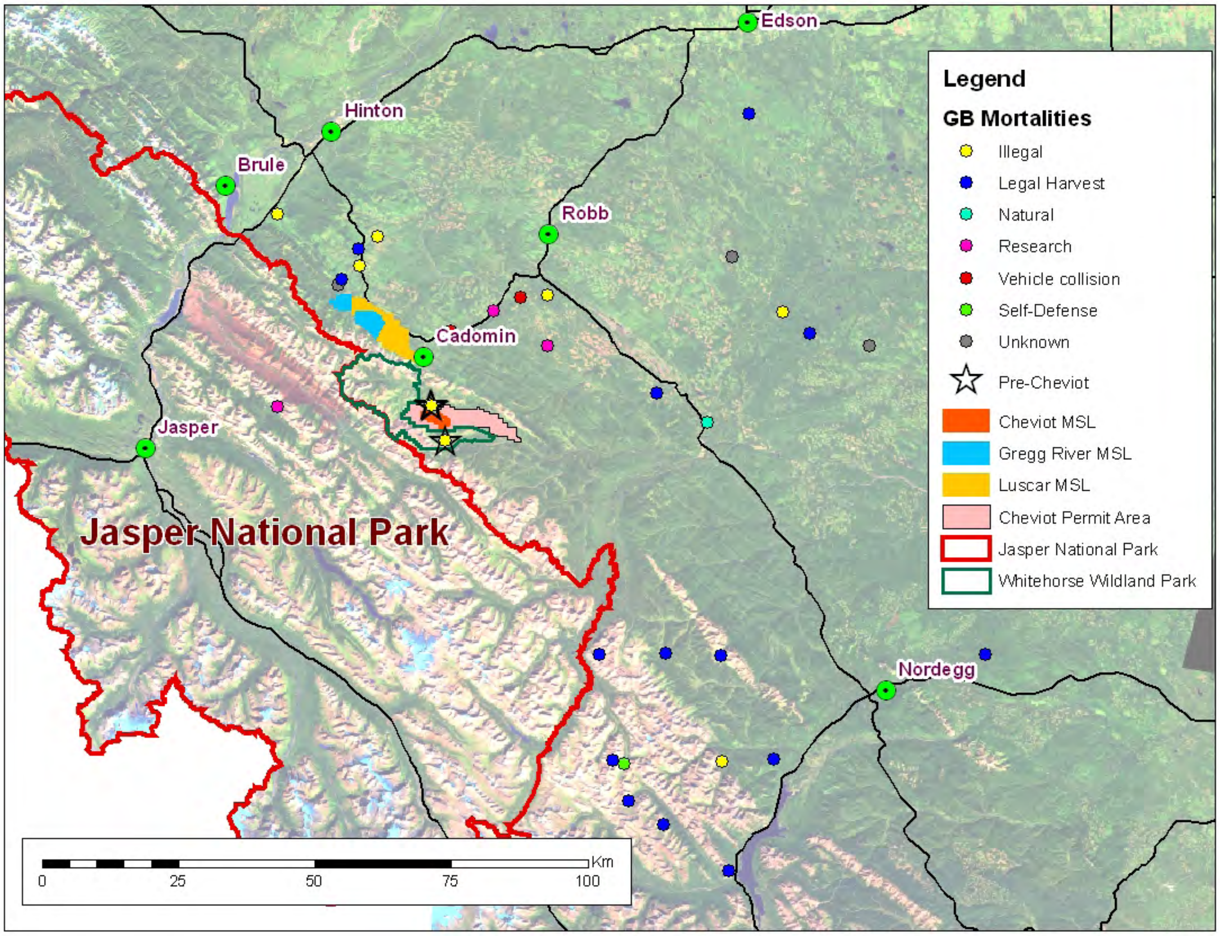

Figure 22. Locations of Known Grizzly Bear Mortality Locations (1999-2004)

Some grizzly bears forage within close proximity to human developments such as roads. These bears suffer much higher mortality rates (Mace & Waller, 1998). It is of critical importance to review the current state of knowledge regarding human-caused grizzly bear mortality and its implications to the persistence of this species within the region.

Path Forward for Grizzly Bear Management: Post-Mining Land Use Closure Planning

The Cheviot 1996 and 1999 CEAs employed what was deemed fitting and scientifically appropriate tools of the day. Since that time, there has been an evolution of knowledge and tools appropriate for use in conservation of grizzly bear populations in the region. We now know that the reclaimed portions of mining land use areas are attractive food sources for grizzly bears (Stevens & Duval, 2005; Kansas, 2005). Grizzly bears forage routinely on abundant high-energy food sources (ungulates and herbaceous forage) available on the reclaimed mine areas. Stevens & Duval (2005) and Kansas (2005) identified that grizzly bears ingest significantly greater amounts (2.5 times more) of animal protein and herbaceous forage in the Luscar and Gregg River MSL area than in the un-mined Cheviot project area.

It has been learned that the greatest human-caused effect on grizzly bears is mortality. It is imperative from a regional conservation perspective that appropriate recognition of grizzly bear values within mining land use areas be garnered by decision makers. Existing and future public access management must be considered within local and regional context, for protection of habitat effectiveness, and for long term management of human-caused mortality. It is especially pertinent for post-mine closure planning of the Luscar and Gregg River mines as these mature operations complete reclamation and approach mine closure. It is also valuable for the mining proponent to incorporate desired landscape features for a clearly identified post-mining land use plan.

Throughout the life cycle of mining land use, these lands remain under a specific public access management regime. Under private disposition by the mining company, public access is limited to the use of specific designated access trails for recreational use, with the entire MSL area closed to hunting. The resulting mining use activities have not resulted in direct mortalities, and have prevented illegal or vehicular incidents by public. However, upon completion of the mining life cycle, these lands once again revert to the Province of Alberta. Management of access and development are key to grizzly bear population persistence in the region (Gibeau, 2000). The challenge then becomes: can grizzly bears persist with re-establishment of open access to the public? Is prevention of grizzly bear and human interaction, such as through public access restriction, the only solution to protecting grizzly bears?

Protecting continued grizzly bear habitat use and managing human caused mortality should be a critical consideration for post-mining land use closure planning. Reclaimed lands typically have regulatory objectives to provide both wildlife and recreation uses. While literature may suggest that the most effective ways to protect grizzly bears is to impose continued access closure, I suggest that other creative tools exist to achieve the same objective. The post mining land use planning exercise, engaged as early as possible within the mining life cycle, affords the opportunity to consider desirable physical landform design within reclamation planning. This can include re-establishment of key wildlife movement corridors, development of line of sight breaks, intentional land surface roughness and funneling to discourage or direct motorized use, and vegetation community selection. Depending on site-specific feasibility, these considerations can be considered by the mining proponent. However, closure planning requires a critical component: access management planning. Limiting human access to high-quality sites helps address risk of human-caused mortality (Neilson, Boyce, & Stenhouse, 2004). Limiting, however, does not necessarily infer restricting human access.

Much of the literature cited suggests that a key component to reducing human caused grizzly bear mortality requires public access restriction and area closures. Weaver, Paquet, and Ruggierp (1996) affirm that for large carnivores to persist, human disturbance must be constrained within the bounds of the species’ resilience. Mining land use does not test the threshold of grizzly bear species resilience. We know that safe-harbours are most common to the front slopes of the Rocky Mountains (Nielsen, Stenhouse, & Boyce, 2006). Adjacent to the Luscar and Gregg River mines, the Whitehorse Wildland Park (WP) has been identified as a high-valued safe-harbour habitat for grizzly bears. The protected Whitehorse WP averages the highest safe-harbour values for management zones, indicating the significance of this park for grizzly bear conservation (Nielsen, Stenhouse, & Boyce, 2006). I selected data collected for this thesis research to determine potential occurrences of the overlapping non-motorized recreation trails within the Whitehorse WP with my case study grizzly bear's (G008) movement data.

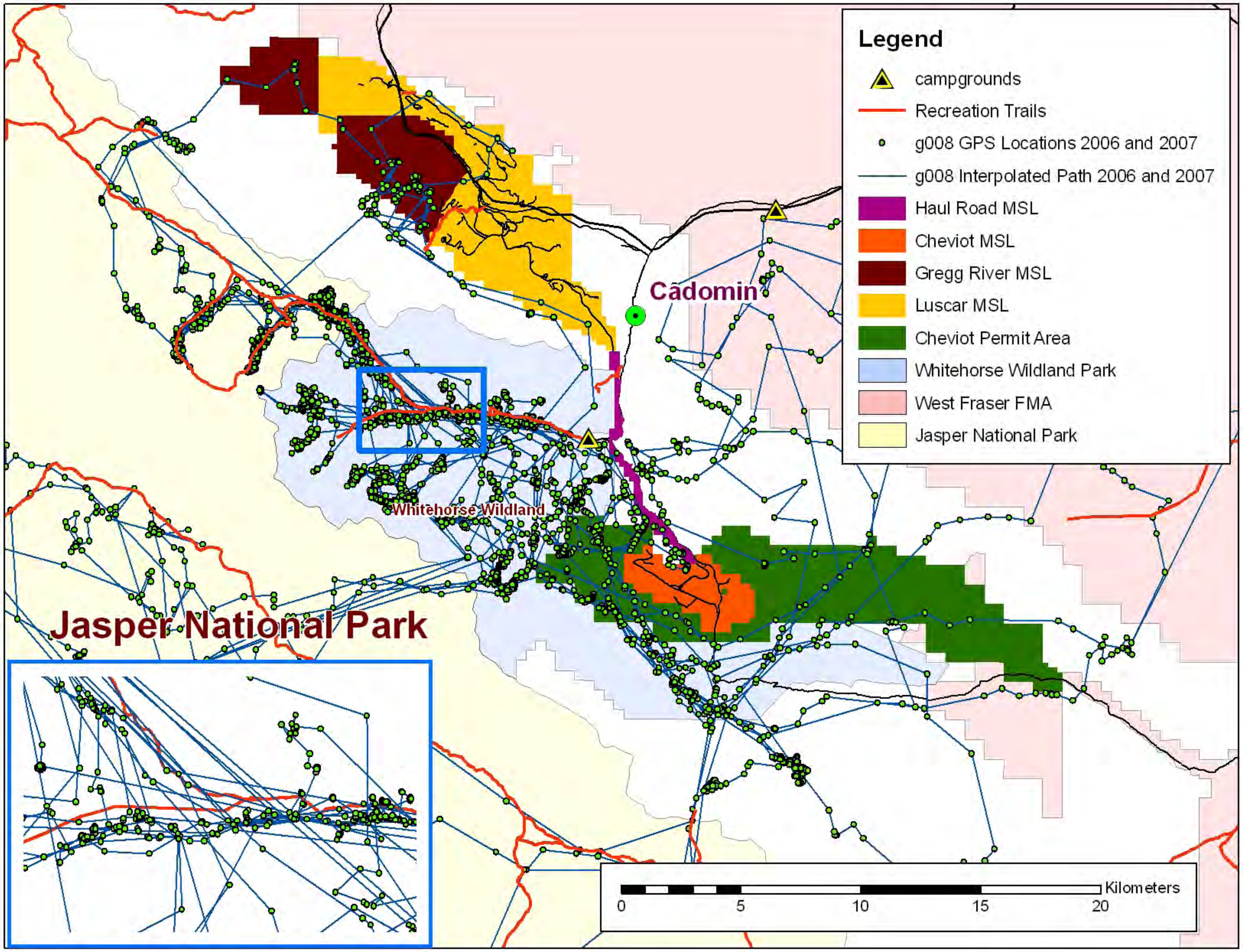

Figure 23. G008 Movement Corridors in Whitehorse Wildland Park and Public Recreation Trails

The annual 2006 and 2007 movement data clearly identifies that G008's movement paths frequent corridors of high recreation use. Despite occasional interactions, this 22 year old grizzly bear has not been killed, nor has he been engaged in any documented significant adverse encounters. This is encouraging from a post-mining land use closure planning perspective, primarily for two primary reasons:

- Firearms and hunting are permitted within the Whitehorse WP;
- It is a high use non-motorized recreation area.

To reduce risk of encounters, park officials provide in the field education, awareness, and enforcement. In 2006, Alberta Tourism, Parks, Recreation and Culture (ATPRC) and EVC partnered to establish bear safe recreational campsites within the WWP.

The challenge with access management planning is that creative, costly and resource intensive measures may be required outside of provincial parks and protected areas, along with new policy development, endorsement and long term commitment of provincial land managers and multiple land users. I suggest that scenario development must recognize trade-offs, and can accommodate long term, multiple land uses within these unique post mining land use landscapes. It is imperative that endorsed closure land use plans are effectively resourced. The importance of well-managed, multiple use land to grizzly bear conservation should be recognized (McLellan et al., 1999). There are several tools that have been used successfully to mitigate recreational activities (Gaines, Singleton, & Ross, 2003) that include:

- Temporal separation of humans and wildlife at key critical periods
- Human behaviors that reduce the effects of recreation on wildlife
- Identification of wildlife habitat issues in the early stages of scenario developments that may help address habitat issues proactively through project design.

Recreational and educational activities, such as grizzly bear and other wildlife viewing, may be a desirable land use. Recently, EVC has accommodated requests of commercial ecotourism operators to provide reclamation and wildlife viewing ecotours for their international clientele. Further, both photographers and cinematographers from throughout North America currently visit the mining land use areas for opportunities to view grizzly bear, wolves, elk, rocky mountain bighorn sheep, and even marmots and picas. Grizzly bear viewing is most often being done under conditions that offer acceptable safety to both people and bears. Grizzly bear viewing, where appropriate, may promote conservation of bear populations, habitats, and ecosystems as it instills respect and concern for those who participate (Herrero, Smith, DeBruyn, Gunther, & Matt, 2005).

Illegal mortalities can only be reduced with meaningful education, awareness and active enforcement measures. These must be mandatory requirements with public access and post mining land use closure planning. Managers and policy-makers must develop site-specific plans that identify the extent to which bear-to-human tolerance will be permitted (Herrero et al., 2005). This is especially significant during periods of early vegetation succession, prior to forest cover re-establishment. Under creative and actively managed scenarios; recreational uses, such as legal ungulate harvest, may be accommodated through modification of harvest periods. Late season hunting may greatly reduce potential misidentification or defense of life or property grizzly bear mortalities. Such interactions are least likely when grizzly bears are denning.

Provincial objectives have recently been identified to address threats to grizzly bear populations, and to provide ways to measure recovery success (AGBRT, 2005). These include limiting the rate of human-caused mortality and reducing the rate of human/grizzly bear conflicts. The AGBRT considers these both equally critical and recommends strategies and actions related to these two objectives which should be implemented immediately and concurrently throughout grizzly bear prime protection areas.

Without creative, effective, long term, public access management and in field enforcement that considers grizzly bear protection, it is reasonable to assume that introduced incidents of human-caused mortality could result in this mining land use area becoming another grizzly bear population sink. In some jurisdictions, attempts to employ grizzly bear conservation policy have been fraught with challenges. The US Forest Service's management of its roads system has been found to be inadequate, either due to unidentified travel ways that exist on the ground but not in agency inventories, ineffective road closures, or both (Bechtold, Havlick, & Stockmann, 1996). While under active mining land use disposition, these lands can be managed by the mine proponent. However, following their return to the Crown, these lands must be managed responsibly and effectively by the Province. While this is specific to mine lands, such policy is required from a regional perspective to manage the persistence of grizzly bears in a region of multiple and often competing land uses.

The results of this study provide the current state of knowledge for grizzly bear use and mining land use in the front range of Alberta’s Rocky Mountains. Mining land use is temporary; ultimately these lands will all return to the Crown. It is therefore critical to the viability of these areas as effective grizzly bear habitat, with low mortality, that land use plans be carefully considered by the Province, who as land manager, is responsible for land use planning and policy, with input from Jasper National Park.

Finally, the chronology of Cheviot EIA for grizzly bear is lengthy and arduous. It has included CEA, and therefore it is important to view results of this study within a regional context. The Cheviot project has certainly increased awareness and attention to grizzly bear conservation. It has served as a catalyst to the world class research in the NES region by the FMFGRP. This study has resulted in new assessment and planning tools and a better understanding of grizzly bears. Further, as a result of the 2000 AEUB-CEAA joint review panel decision (AEUB-CEAA, 2000), federal and provincial agencies formalized agreements to work together and implement effective policy for grizzly bear management in the region. Below, I provide a critical review of the Cheviot CEA: the process, outcomes, and commitments by the project proponent and both provincial and federal government agencies.

Development and Implementation of Alberta Yellowhead Strategic Framework

Land use planning controls generally focus on the effects of an individual development project rather than an evaluation of the effects arising from multiple developments proceeding within the same general time and regional setting (Damman, 2002). Each individual project proponent does not have adequate regional influence, and the regulatory approvals required usually do not affect those surrounding activities (Creasey, 2002). A project proponent is generally best placed to respond to concerns regarding project-specific effects that are identified during the review process, however the onus should be on government to address, within the environmental assessment process, any issues relating to mitigation, monitoring and cumulative effects management that are identified in the CEA that cannot be dealt with through the project-specific measures. CRC affirmed this position on several occasions through both the 1997 and 2000 AEUB-CEAA joint review panel hearings. Regarding access management and recreational use of public lands, “CRC stated that it viewed recreation as falling into the category of ‘induced actions’, which it considered ‘unregulated, uncertain, dispersed, regional *and the responsibility of regional land management agencies*’” (AEUB-CEAA, 2000). The measures required to address these issues are generally not within the direct control of the proponent. Actions by other parties are required (Kennett, 2002). In the case of the Cheviot Project, the 1997 and 2000 AEUB-CEAA joint review panels refrained from clearly and unequivocally assigning responsibility for mitigating regional cumulative effects post-Cheviot where it belongs: *to government land and resource managers* (Kennett, 2002). This position is mostly evident by grizzly bear study and the regional conservation measures required.

Government land and resource managers are ultimately responsible for ensuring that the multitude of human activities on the land base results in acceptable cumulative impacts (Kennett, 2002). Ogilvie and Johnston (2002) suggest that the application of adaptive management measures on a regional scale (versus project-specific scale) is a key element in CEM framework, which should be viewed as a consensus, non-confrontational approach delivered through existing regulatory instruments as well as other non-regulatory, collaborative efforts by affected and interested groups. Further, AXYS Environmental Consulting Ltd.(2000) identifies that a critical component in developing a framework for the assessment of regional cumulative effects is government agencies working in partnership to develop a management strategy in areas where future development will likely occur.

The Northern East Slopes (NES) region of Alberta, which lies immediately adjacent to Jasper National Park, is under heavy resource development pressures. It includes 8 FMA, 5 coal mining operations, numerous oil and gas leases and exploration activities, 4 major communities and an extensive network of roads and linear infrastructure including the Yellowhead Highway and the CN Railway line. The area is popular for tourism and recreation and includes parks and protected areas. As a direct result of the 1997 Cheviot project AEUB-CEAA joint panel hearings, the governments of Alberta and Canada undertook to establish a joint management strategy to ensure the long-term persistence of a healthy grizzly bear population (Northern East Slopes

Environmental Resources Committee [NESERC], 2000). *A Strategic Framework for Grizzly Bear Conservation in the Yellowhead Ecosystem* (2000) [Strategic Framework] was subsequently developed. The Strategic Framework encompasses Alberta's Northern East Slopes [NES] region, covering an area of about 41,000 km2 and provides the greatest opportunity for this region of Alberta to increase grizzly bear populations.

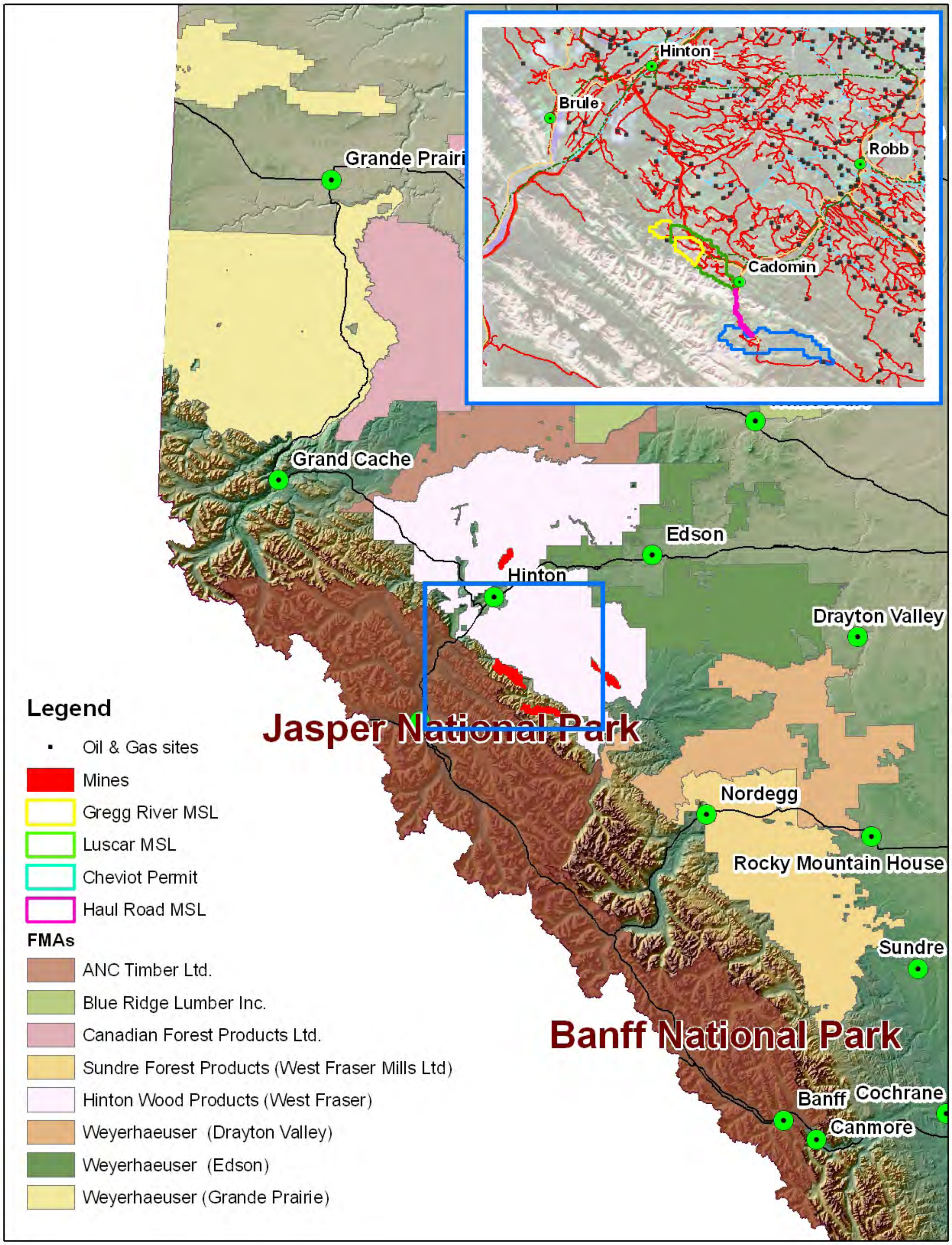

Figure 24. Northern East Slopes Region of Alberta

The work to develop the Strategic Framework was guided by the NESERC of the Alberta government, comprised of regional directors for the NES region. The Strategic Framework was approved by the NESERC on February 17, 2000. It was based on the premise that conservation of grizzly bears requires a cooperative, integrated approach by all land and resource managers and land use stakeholders. Further, it was to serve as an agreement between AENV and JNP on how they intend to work together with key stakeholders to achieve grizzly bear conservation. The Strategic Framework was the product of a government-led initiative and included, as its first guiding principle, the statement that "government agencies must provide the necessary leadership through mutual commitment to sustainable and integrated land use management with the regional ecosystem" (NESERC, 2000). The federal government committed to federal-provincial cooperation to develop a regional plan to restore landscape conditions in order to maintain habitat and travel corridors for grizzly bear and to reduce human-caused grizzly bear mortality (AEUB-CEAA, 2000). While this commitment was made by the federal government, the jurisdiction of all lands east of JNP, including the Cheviot and Luscar/Gregg River mines and all adjacent Crown lands, falls under jurisdiction of the provincial government. Acting as land manager, the Alberta government has no obligation to consult with any parties for land use designation.

During the 1997 Cheviot project AEUB-CEAA joint panel hearings, it was noted that substantial progress had been made since 1996 towards understanding grizzly bear persistence, and establishing conditions for persistence in the Yellowhead Region; a region undergoing substantial industrial activity. The AEUB-CEAA joint panel also accepted evidence that the grizzly bear's future in the Yellowhead ecosystem hinged significantly on the successful implementation of the (then) proposed Strategic Framework (AEUB-CEAA, 1997). The panel stated that both the AEUB and AEP (now AENV) may need to re-examine the process by which new licences are granted to other regional industry players for developments which may also have a cumulative effect on carnivores (AEUB-CEAA, 1997). While private resource developers and other stakeholders are involved in the process, leadership of the Strategic Framework and ultimate responsibility for managing cumulative effects clearly reside with government (Kennett, S., 2002).

Grizzly bear conservation must be part of an overall integrated resource management strategy (Skrenek, Hodgins, & Stenhouse, 2002). Results of scientific studies rarely lend themselves directly and unequivocally to precise management direction or actions, especially for low-density species such as grizzly bears. (Mace, 2004). However, it was determined that the best scientific information available would be used in application of the Strategic Framework along with adaptive management (Skrenek, Hodgins, & Stenhouse, 2002). Adaptive management and monitoring designed to lead to greater understanding would greatly facilitate management goals of conserving these ecosystem processes and functions (Gaines, Singleton, & Ross, 2003).

In the Government of Canada (Canada)'s response to the 2000 Cheviot Project AEUB-CEAA joint review panel decision, Canada committed that it would continue to collaborate with provincial land use agencies to ensure effective, long-term protection of grizzly bear habitat values through the Strategic Framework and other joint land use initiatives (Fisheries and Ocean Canada (2000). Canada would pursue the development of appropriate public accountability mechanisms to report on the progress of the Strategic Framework and related initiatives. Canada declared that this interagency collaboration would be a key tool in the protection of the conservation values of JNP. Given the scale of current and projected future land use activities identified by the joint review panel, Canada affirmed that timely implementation of scientifically-based landscape condition targets were required with or without a Cheviot Project (Fisheries and Ocean Canada, 2000).

Implications of Cheviot Case Study for EIA and Follow Up: Lessons Learned.

Persistence and the maintenance of the current distribution of grizzly bears throughout the region will require managing human caused grizzly bear mortality. Further, inductive modeling for the purposes of project-specific impact assessment continues to be used (Kansas, 2002b) and, as such, may have significant land use management implications. The use of inductive modeling often requires the use of datasets and/or assumptions determined elsewhere, and approaches that are forced to utilize and stress the precautionary principle. Even empirically and regionally specific based RSF models are prone to potentially erroneous assumptions and simplifications made in the modeling process (Kansas, 2003). It is imperative that use of both accurate data and rigorous predictive tools to inform management decisions be utilized. Grizzly bear habitat effectiveness, or implied utilization, alone is not a valid measure of a proposed industrial development’s impacts on local or regional grizzly bear populations. Limitations exist in applying these models at a scale which approximates an individual bear management unit (BMU). Care must be taken in the application of these models for single project EIA (Kansas, 2003). The models are more predictive to indicate overall condition of a larger landscape within and among BMUs. Notably however, the models are not sensitive to small-scale development changes within a single BMU (Cardiff, 2002). This thesis has concluded that the CEA model disturbance coefficients for mining land use were incorrect and thus render the issue of scale of analysis secondary.

It is important for conservation biologists and managers to incorporate into conservation planning an explicit understanding of the relationship between habitat selection and habitat quality (Battin, 2004). The nature of mining land use and subsequent features offers a unique example of how various modeling methods may fall short. Application of science demands that predictions be purposefully tested. Incorporation of the models, followed by comprehensive field studies and model review are exemplary of successful implementation of adaptive management (Jeffrey, & Duinker, 2002).

Recommendations for Mine Land Use and Regional Planning for Grizzly Bear Conservation

Mining Industry

- For project EIA, aside from engaging qualified professionals and experts in their field of environmental assessment, ensure that these individuals appropriately understand mining land use, mining life cycles, and can clearly display expertise to identify precautionary, yet reasonable prediction of impacts under proposed development scenarios.
- Although only one of 99 VEC in the Cheviot EIA, the grizzly bear served as an umbrella species for cumulative environmental effects assessment. Caution should be employed by practitioners during impact assessment when assigning single species as indicators, and further recognize that single species management is not a surrogate for all other ecological values.
- Seldom are impact predictions from project EIAs tested. Retrospective and follow-up, as per the FMFGRP and this study, is an important component of adaptive management. Testing and validation of prediction tools can serve to provide meaningful projection tools for future impact assessments.
- Efforts should be made to develop empirically-based resource selection functions that provide direct evidence of the probability of occurrence of grizzly bears in a given study area

of specific cultural and ecological conditions and the behavioral adaptations of grizzly bears given these conditions. Arbitrary suitability ratings of habitat types should be avoided.

- Throughout an industrial project life cycle, the proponent should regularly engage in a review process and given current state of knowledge, measure performance metrics, and improve plans as appropriate based on the premise of adaptive management.
- Resource development proponents have the shared responsibility to promote the evolution of knowledge and tools to mitigate grizzly bear impacts. Innovation, validation, and application of new tools should be pursued. Partnerships with government agencies, academia, and communities of interest should be encouraged and fostered.
- Share gained knowledge and embrace input from communities of interest. Engage these in planning processes and scenario development. Regulators, academics, and the public at large need to understand the mining life cycle. Awareness dispels myth and allows informed dialogue.

Government

Specific grizzly bear conservation measures

- AGBRT recommendations, as included with the Alberta Grizzly Bear Recovery Plan, should be implemented. Regional programs to reduce human caused mortality in grizzly bear prime protection areas should capitalized. As identified and explored in this research, specific opportunities for mining land use areas are available for highly productive grizzly bear safe-harbours, and should be vigorously pursued.
- Regional enforcement tools and awareness programs should be implemented rather than wide spread public access restrictions and area closures. Enforcement tools should include

meaningfully increased penalties for violation, sufficient resources for preventative measures and investigation, and adequately staffed in field grizzly bear protection stewardship (ie. bear protection wardens).

- Creative measures to reduce human caused mortalities, such as modified late season hunting for ungulates, should apply to areas of grizzly bear conservation and areas of demonstrated firearm mortality. At a minimum, this should be considered in areas surrounding mining land use areas and high fall season grizzly bear use habitats along the Rocky Mountain front ranges.
- Communities, such as the Hamlet of Cadomin, within grizzly bear use areas, should be resourced with appropriate mandatory tools: signage, education, awareness, waste management practices. These should be supported and enforced with legislation. Similar awareness signage should be posted on all roads entering grizzly bear conservation areas, for the benefit of recreation and industry land users.

Land use policy & planning

- Post-mining land use planning should include scenario development which optimizes wildlife values, including grizzly bear conservation, while accommodating future land uses, such as recreational uses.
- Land use plans, mining or regional, will not be successful without adequate enforcement and in-field stewardship to prevent human caused mortality of grizzly bears. Policy is not sufficient to protect wildlife values or the environment. Measurable, in field enforcement, plan stewardship, education, and awareness programs are critical tools to the success of policy objectives.

- A regional focus for data collection and analysis and for ongoing monitoring can provide the continuity in information and the institutional oversight of land and resource use that are required for cumulative effects management. CEA predictions should be reviewed periodically by provincial agencies. Regulatory industrial approvals and provincial land use policy should be amended to reflect results.
- The Cheviot CEA demonstrates that the proponent is only able to manage at a project level; CEA responsibilities require continued commitment of regulatory agencies. Provincial and federal governments must ensure that their commitments to grizzly bear conservation through the Strategic Framework are pursued. The Northern East Slopes Environmental Resource Committee must continue to fulfill its terms of reference, or revise them as deemed appropriate through adaptive management.

Partnerships

- Innovative grizzly bear movement tools, such as those applied in this thesis study, should be directed to specific grizzly bear use within areas of high recreation use in the region, such as within Whitehorse Wildland Park. Similarly, such study could include grizzly bear response to other land uses, including motorized OHV recreational uses.
- Enforcement effort may reduce grizzly bear mortality in areas of open public access. This should be studied to determine if there are key metrics that might then be applied for regional planning. This might include assigned enforcement resources per unit, road density, or grizzly bear mortality risk. Access management and enforcement (or other surrogate programs) may be applied in tools such as RSF and security area analysis.

- Inductive modeling tools should be applied only at appropriate scales and validated using site specific empirical data. These tools may apply assumptions developed and tested elsewhere that do not apply in specific EIA conditions. These models are relatively well standardized and outputs are easily interpreted, making them valuable tools for decision makers and for communication. Caution should be used in their application to ensure that project parameters are well understood by the modeler and that assumptions are appropriate for site specific conditions. These should be supported with empirical data.
- Further technology development for long term empirical monitoring of grizzly bear movements should be encouraged. Monitoring technologies which are less invasive and minimize direct human-grizzly bear interaction should be pursued. These may include multi-year, robust equipment with fully remote data downloading capability.
- The Cheviot project was the catalyst to a world class grizzly bear research program. The FMFGRP has since continued to evolve and expand across the province. This partnership of governments, industry, and academia exemplifies the outstanding innovation and knowledge, and development and application of tools that can result from enterprise with common purpose. Focused research should be based on prioritization of needs by these partners.

Restricting public access into grizzly bear range is presented by many conservation biologists as a cause-effect relationship to reduce human caused mortality. Such a recommendation is not necessarily responsive to the people of Alberta. As a management solution, it may be detrimental to the grizzly bear conservation initiative. Closing areas will not modify human behavior – required to reduce intentional human caused grizzly bear mortality; allowing people to use and respect these areas provide formative opportunities to endorse and encourage support for conservation measures, while promoting education opportunities. This thesis has demonstrated that under mining land use, human industrial activity co-exists within grizzly bear range. The key is regional management of human-caused grizzly bear mortality. Responsible, regional land managers need to balance resource development, public access management, and protection of the environment. Results must be measurable. Land and resource managers must be accountable. Grizzly bear conservation initiatives that lack creativity and supporting resources will lose societal will. These will subsequently fail. This is the regional challenge for grizzly bear conservation.

It is ever important that we ensure that our decision makers consider existing and future conservation or protection of values that society views as important. It is particularly important in endeavors such as land use planning, access management planning, and policies for education, awareness, and enforcement. Creativity and ingenuity is required to find balance, and sustainable outcomes between the competing multiple land use interests.

Our increasing knowledge of mining land use effects on ecological values, the development and application of tools, and the continued testing and evaluation ensure that we learn through adaptive management at Cheviot and continually improve. This framework will ensure continued benefit of the economy and our community, while minimizing impacts to the environment. This exemplifies my learned belief in sustainable mining and sustainable resource management.

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Appendix 1: Animal Welfare and Research Permits 2006

4-2006 14:08 FROM:AB.SUST.RES.DEV. [redacted] TO:17808658331 P.2/2

Memorandum

TO:	Dr. Cattet, Vet Pathology
FROM:	UCACS Protocol Review Committee, Animal Resources Centre
DATE:	01-Mar-06
RE:	Animal Care Committee Review of Your Protocol - The Foothills Model Forest Grizzly Bear Research Project

PROTOCOL ID: 20010016

The Protocol Review Committee of the University Committee on Animal Care and Supply recently reviewed and approved the above-noted protocol for the next twelve months.

Thank you.
Sincerely,

[redacted]

Chair, UCACS Protocol Review Committee
cmm

MAR-2-2006 09:18A FROM:COMHC - HQ [redacted] TO:[redacted] P.2

[redacted]e Development
Fish and Wildlife Division

23191

Licence – CN

COLLECTION LICENCE

District: Southwest Region

FEE $ NIL

NAME: Dave Hobson

ADDRESS: Alberta Fish and Wildlife Division / Foothills Model Forest

Is authorized to collect the following wildlife: Grizzly Bears

This licence authorizes the use of the following equipment and methods: Non-reward bait stations and hair samples for DNA Census

This licence is valid (location) WMU's 303-306, 308, 310, 312, 402, 404, 406, 408, 640, 300, 400, 410

EFFECTIVE DATE: 11 May 2006 DATE OF EXPIRY: 31 March 2007

Collections are to conducted by: Licencee, G.McHutchon, M. Gibeau and assistants they approve.

Date of issue: 11 May 2006

Signature of Licencee (not valid unless signed by Licencee) **Licence must be carried while collecting.**

[redacted]

For M[redacted] Alberta Sustainable Resource Development

Conditions:

1. The licencee must keep the appropriate Fish and Wildlife Officer informed of collection activities as they occur.
2. This licence is not transferable.
3. Persons collecting under the authority of this licence must produce a copy of the licence on the request of a Fish and Wildlife Officer when carrying out collection activities.
4. If any information obtained from the collection of any wildlife under this licence is used in a report or publication of any kind, the licencee shall forward a copy of such publication to the Director of Wildlife.
5. Within 7 days of the expiry of the licence, the licencee shall complete the table below, and any other records required by this licence, and return licence and records to the Director of Wildlife.

Collection Date	Species	Sex M/F	Location	Disposition

IMPORTANT

District Office instructions:

Please photocopy this document once it is issued and forward copies to:

Original – Licencee

Copies to: Licencing Services-Edmonton HQ, Region, Issuing District

[redacted]

25034

Sustainable Resource Development
Fish and Wildlife Division

General Permit – GP

RESEARCH PERMIT

District: Southwest Region

FEE $ NIL

PERMITTEE: Dave Hobson

ADDRESS: Fish and Wildlife Division/Foothills Model Forest

IS AUTHORIZED TO:

Conduct research on Grizzly Bears (DNA census)

DATE OF ISSUE: May 11, 2006 DATE OF EXPIRY: March 31, 2007

Signa[redacted]

For [redacted] of Alberta Sustainable Resource Development

IN ACCORDANCE WITH:

- Collection Licence 23191CN and conditions
- Approved protocol on file with Fish and Wildlife Division

****IMPORTANT**
District Office instructions:
Please photocopy this document once it is issued and forward copies to:

Original – Permittee
Copy to – Wildlife Management, Edmonton HQ
Copy to – Licencing & Revenue Services, Edmonton HQ
Copy for - Issuing District

05-27-06 15:19 J.N.P. ECOSYSTEM SECRETARIAT ID [redacted] P05/05

[redacted]

Special/Restricted Activity Permit

Issued : *20-Mar-06*

Permit Number: 3099 **Issuing Office:** JASPER DISPATCH

Function: RESOURCE MANAGEMENT **Program:** SPECIAL PERMISSION

Special Activity: HELICOPTER AIRCRAFT ACCESS PERMIT

APPLICANT INFORMATION:

Company Name: MODEL FOREST GRIZZLY PROJECT/ PEREGRINE HELICOPTER

Last Name: STENHOUSE **First Name:** GORD

Mailing Address: BOX 6330

City: HINTON [redacted] **Province/State:** ALBERTA [redacted] **Postal Code:** T7V 1X6

Phone Number: [redacted] **Fax Number:** [redacted]

VEHICLE INFORMATION:

Make: BELL 206 **Model:** HELICOPTER **Color(s):**

Licence Vehicle: **Province :**

Licence Trailer: **Province :**

Commodity Carried: [redacted] hen flyi [redacted] 3. Can also send text messages 8816-
[redacted] n

PERMIT INFORMATION:

Route/ Location SOUTH AND EAST BOUNDARIES OF JASPER NATIONAL PARK

Purpose: Overflights to upload and locate grizzly bears and data cnducted monthly from mid April to December. Land helicopter to retrieve GPS collars or ear tags. Land at fuel caches at Warden cabins.

Permit Valid From: 01/04/2006 **Permit Valid To:** 01/04/2007 **Delivered by:** FAX

Permit Issued By: Janis Sherriff **Approved By:** Brenda Shepherd

Comments and/or Special Conditions: **Second aircraft involved is a fixed wing, Cessna 337, owner/pilot is Mike Dupuis.**

GENERAL CONDITIONS

1. The National Parks Act and Regulations apply. Failure to follow conditions of permit may result in prosecution.
2. The permit must be carried by the permit holder and shown to a Park Warden, Park Officer or Peace Officer on demand.
3. This permit may be cancelled at any time by written or verbal notice.
4. This permit is valid only for the dates and locations shown.
5. This permit is not transferrable.
6. If fire permit, all fires must be kept under control and supervised at all times.
7. If overweight vehicle permit, permit is for servicing destinations on Hwy. 93 and does not allow through travel..
8. Not withstanding any other provisions of this permit, the permittee shall indemnify Parks Canada from any and all liabilities, costs, damages, claims, suits or actions arising from:
   a) any damage to property; or
   b) any injury to a person or persons including death occasioned by the permittee [redacted] in his/her use, occupation or by his/her activities resulting from this permit.

Authorization Signature: [redacted]

For additional information contact Jasper Dispatch and Emergency Services:

Phone [redacted]

03-27-06 15:18 J.N.P. ECOSYSTEM SECRETARIAT ID [redacted] P02/05

RESEARCH /COLLECTING PERMIT Amendment and Renewal
Jasper, Banff and Waterton Lakes National Parks

Permit No. JNP-2004-005

Under The *Canada National Parks Act*, this permit is granted to:

Name: Gord Stenhouse
Address: Box 6330
Foothills Model Forest, Hinton, AB

Other Permittees: Field Assistants

To: when collared bears enter the national parks, upload data or retrieve any GPS radio collars or ear tag transmitters that come off any of the study animals (and determine if a mortality has occurred); conduct a DNA inventory in provincial Bear Management Unit 5 (between Highways 1 and 3) to determine grizzly bear population status; conduct aircraft data uploads or land an aircraft in the park pursuant to these activities.

SPECIAL CONDITIONS

1. No bears will be captured in any of the National (Waterton, Banff or Jasper) Parks in 2006 (as proposed by the applicant).
2. The DNA inventory in provincial Bear Management Unit 5 will be planned cooperatively with Banff National Park staff (Dr. Mike Gibeau) and in consultation with Dr. Tony Clevenger (conducting grizzly bear DNA sampling associated with the Trans Canada Highway). This work we will only be able to proceed once all field details of sampling, data collection, and public safety are agreed to by Banff National Park staff.
3. Notify of the park contact after each telemetry flight of bears that are known to be in the respective park.
4. All grizzly bear research will be compatible with and follow protocols established for other ongoing grizzly bear research and monitoring in the national parks described in the following three reports. This will apply to bear capture and handling, media information and closure actions as required.
   - The Grizzly Bear Capture and Handling Protocol for Banff National Park by Dr. Todd Shury, DVM
   - Environmental Screening Report, Grizzly Bear Research Program (2003) Banff National Park, *and*
   - Environmental Assessment Report, Foothills Model Forest Grizzly Bear Research Proposal, J99-012.
5. While working within the national parks, contact must be maintained with national park dispatch on an hourly basis.
6. Capture equipment and firearms are to be operated by qualified personnel only following the attached Authorization to Conduct Grizzly Bear Research.
7. Any grizzly bear mortalities as a results of capture will be collected for laboratory analysis.
8. Any grizzly bear mortality will require that the capture operation be halted and all aspects of the technique and capture environment will be reviewed. If corrective actions are identified, they will be communicated to all participants before the operation is resumed. If corrective actions cannot be verified, the capture operation will be halted until further analysis verifies it is appropriate to recommence.
9. The permittee will adhere to the following Data Protocols:
   - complete a short summary in non-technical terms (format and submission details are provided separately), by November 15 of each year of the permit, for Parks Canada to use in its annual Research and Monitoring Report.
   - within one year of the expiry of the permit researchers will provide Parks Canada with the following:

RESEARCH AND COLLECTION PERMIT

Permit No. RC05WC002

By virtue of the power vested in the Minister of Community Development under the *Provincial Parks Act* and General Regulations (Alta. Reg.102/85), the *Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act*, the *Willmore Wilderness Park Act*, the *Wildlife Act* and Section 20(1) of the *Public Lands Act*, and subject to compliance with all the relevant statutory provisions and conditions noted on the permit, research and Collection permit is hereby granted to:

Permittee Gordon Stenhouse [Foothills Model Forest Grizzly Bear Project] **of** Box 6330, Hinton, Alberta. T7V 1X6

and **Project Members (if applicable):** Bernie Goski, Dave Hobson, Jay Honeyman, Saundi Norris, Rick Booker, Marc Cattet, Erin Moore, Nigel Caulkett, Terry Larsen, Karen Graham, John Saunders

to: conduct a) a capture and collaring program that involves the dispersal of GPS radio-collars on grizzly bears throughout the study area [the spatial information that the collars will provide will be used in developing Resource Selection Function (RSF) maps of grizzly bear habitat throughout the study area]; b) retrieval of any collars that are dropped within the Willmore Wilderness Park.

between the ____03____ **day** ____April____, 2006______ **and the** ___30_____ **day of** ____June_____**2006**_

at : a) From the Wapiti to the Chinchaga Rivers, the Cheviot Mine area and the Swan Hills (as per MAP provided with the application). b) Willmore Wilderness Park (just a retrieval of any collars that are dropped within the Park);

Dated at Spruce Grove **this** 03 **day of** April, 2006

[redacted]

For: Kyle Clifford, Area Manager
ALBERTA
COMMUNITY DEVELOPMENT
West Central Management Area

See reverse side for General Conditions and any Special Conditions

- Parks and Protected Areas staff will have access to bear research information for management, staff and public safety requirements. Locations of capture sites will be relocated in discussion with PPA staff if safety concerns arise.

- Specific trapping sites within Parks and Protected Areas must be pre-approved by the Conservation Officer or Heritage Protection Team Leader in charge.

- In case of accidental bear mortality caused during research, options for disposal of a carcass will be discussed with the appropriate PPA Area Manager (e.g., a specimen may be needed for a museum collection, or for a public education or display purposes).

- The firearms can be used only for the following purposes: chemical immobilization, Euthanization (if deemed necessary), or personal safety.

- Helicopter aircraft may be used within Willmore Wildernes Park, Wildland Provincial Parks, Provincial Parks and Natural Areas for research purposes associated with this project [landing of a helicopter in the Ecological Reserves and Wilderness Areas requires ministerial approval, and is therefore not granted under this Permit].

- If changes in aircraft information or if emergency notification is required, contact appropriate PPA staff listed below. Specific to the districts contact:

[redacted]

For the Edson area (includes the Whitehorse Creek [redacted]

For the Hinton area (includes the Willmore [redacted]

- A written progress report describing the research results that have been achieved by November 15, 2006 will be sent to the Area Manager(s) and to ANHIC on or before December 31, 2006. Also see number 11 above

Agreement

I have read the conditions under which the permit is issued and agree to comply with all the applicable conditions stated within. I agree that failure to comply with the *Provincial Parks Act* and General Regulations (Alta. Reg.102/85), the *Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act*, the *Willmore Wilderness Park Act* and the conditions of this permit may result in cancellation of this permit and/or forfeiture of any applicable bond at the discretion of the Executive Director, Field Operations, Parks and Protected Areas.

(THIS PERMIT IS NOT VALID UNLESS SIGNED AND A COPY RETURNED TO THE ISSUING OFFICE.)

[redacted]

Permittee's Signature

[redacted]ent

20305

General Permit – GP

RESEARCH PERMIT

District: Southwest Region

FEE $ NIL

PERMITTEE: Gordon Stenhouse

ADDRESS: Foothills Model Forest, Hinton, AB

IS AUTHORIZED TO:

Conduct research on Grizzly Bears

DATE OF ISSUE: March 1, 2006 DATE OF EXPIRY: December 31, 2006

Sig[redacted]

For Minister of Alberta Sustainable Resource Development

IN ACCORDANCE WITH:

- Collection Licence 23174CN and conditions
- Approved protocol on file with Fish and Wildlife Division
- Alberta Fish and Wildlife Division Class Protocol 005 (Capture, Handling, Immobilization and Release of Bears)

****IMPORTANT**

District Office instructions:

Please photocopy this document once it is issued and forward copies to:

Original – Permittee
Copy to – Wildlife Management, Edmonton HQ
Copy to – Licencing & Revenue Services, Edmonton HQ
Copy for - Issuing District

[redacted] IS WATERMARKED PAPER AND CONTAINS VISIBLE FIBRES. HOLD TO LIGHT TO VERIFY WATERMARK.

23174

Sustainable Resource Development
Fish and Wildlife Division

Licence – CN

COLLECTION LICENCE

District: Southwest Region

FEE $ NIL

NAME: Gordon Stenhouse

ADDRESS: Foothills Model Forest, Hinton, AB ,

Is authorized to collect the following wildlife: Grizzly Bears

This licence authorizes the use of the following equipment and methods: Aerial helicopter darting and ground capture as per attached conditions.

This licence is valid (location) In Southwest and Northwest Regions (as listed in conditions)

EFFECTIVE DATE: March 1, 2006 DATE OF EXPIRY: 31 December 2006

Collections are to conducted by: Licencee& persons qualified under SRD Capture & Handling Protocol

Date of issue: 28 February 2006

Signature of Licencee (not valid unless signed by Licencee) **Licence must be carried while collecting**

For [redacted] esource Development

Conditions:

1. The licencee must keep the appropriate Fish and Wildlife Officer informed of collection activities as they occur.
2. This licence is not transferable.
3. Persons collecting under the authority of this licence must produce a copy of the licence on the request of a Fish and Wildlife Officer when carrying out collection activities.
4. If any information obtained from the collection of any wildlife under this licence is used in a report or publication of any kind, the licencee shall forward a copy of such publication to the Director of Wildlife.
5. Within 7 days of the expiry of the licence, the licencee shall complete the table below, and any other records required by this licence, and return licence and records to the Director of Wildlife.

Collection Date	Species	Sex M/F	Location	Disposition

IMPORTANT

District Office instructions:

Please photocopy this document once it is issued and forward copies to:

Original – Licencee Copies to: Licencing Services-Edmonton HQ, Region, Issuing District

Appendix 2: Animal Welfare and Research Permits 2007

Memorandum

TO: Dr. Cattet, Vet Pathology

FROM: UCACS Protocol Review Committee, Animal Resources Centre

DATE: 28-Feb-07

RE: Animal Care Committee Review of Your Protocol - The Foothills Model Forest Grizzly Bear Research Project

PROTOCOL ID: 20010016

The Protocol Review Committee of the University Committee on Animal Care and Supply recently reviewed and approved the above-noted protocol for the next twelve months.

Please be reminded that any modifications to this protocol must be approved by the UCACS prior to implementation, using the Application for Protocol Modification Form.

Thank you.

Sincerely,

[redacted]

Chair, UCACS Protocol Review Committee

cmm

2802

Sustainable Resource Development
Fish and Wildlife Division

Licence – CN

COLLECTION LICENCE
FEE $ NIL

District: Foothills

NAME: Gordon Stenhouse

ADDRESS: Foothills Model Forest, Hinton, AB

Is authorized to collect the following wildlife: Grizzly Bears

This licence authorizes the use of the following equipment and methods: Aerial helicopter darting and ground capture as per attached conditions.

This licence is valid (location) In Foothills, Smokey and Peace Areas (as listed in conditions)

EFFECTIVE DATE: March 1, 2007 DATE OF EXPIRY: 31 December 2007

Collections are to conducted by: Licencee& persons qualified under SRD Capture & Handling Protocol

[redacted] Date of issue: 15 March 2007

Signat[redacted]ned by Licencee) **Licence must be carried while collecting.**

[redacted]

For Minister of Alberta Sustainable Resource Development

Conditions:

1. The licencee must keep the appropriate Fish and Wildlife Officer informed of collection activities as they occur.
2. This licence is not transferable.
3. Persons collecting under the authority of this licence must produce a copy of the licence on the request of a Fish and Wildlife Officer when carrying out collection activities.
4. If any information obtained from the collection of any wildlife under this licence is used in a report or publication of any kind, the licencee shall forward a copy of such publication to the Director of Wildlife.
5. Within 7 days of the expiry of the licence, the licencee shall complete the table below, and any other records required by this licence, and return licence and records to the Director of Wildlife.

Collection Date	Species	Sex M/F	Location	Disposition

IMPORTANT
District Office instructions:
Please photocopy this document once it is issued and forward copies to:

Original – Licencee Copies to: Licencing Services-Edmonton HQ, Region, Issuing District

2705

[redacted] Development
Fish and Wildlife Division

General Permit – GP

RESEARCH PERMIT

District: Foothills Area

FEE $ NIL

PERMITTEE: Gordon Stenhouse

ADDRESS: Foothills Model Forest, Hinton, AB

IS AUTHORIZED TO:

Conduct research on Grizzly Bears

DATE OF ISSUE: March 1, 2007 DATE OF EXPIRY: December 31, 2008

[redacted]

Signature of Permittee

[redacted]

Fo[redacted]ce Development

IN ACCORDANCE WITH:

- Collection Licence 28020CN and conditions
- Approved protocol on file with Fish and Wildlife Division
- Alberta Fish and Wildlife Division Class Protocol 005 (Capture, Handling, Immobilization and Release of Bears)

****IMPORTANT**

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Copy to – Licencing & Revenue Services, Edmonton HQ
Copy for - Issuing District