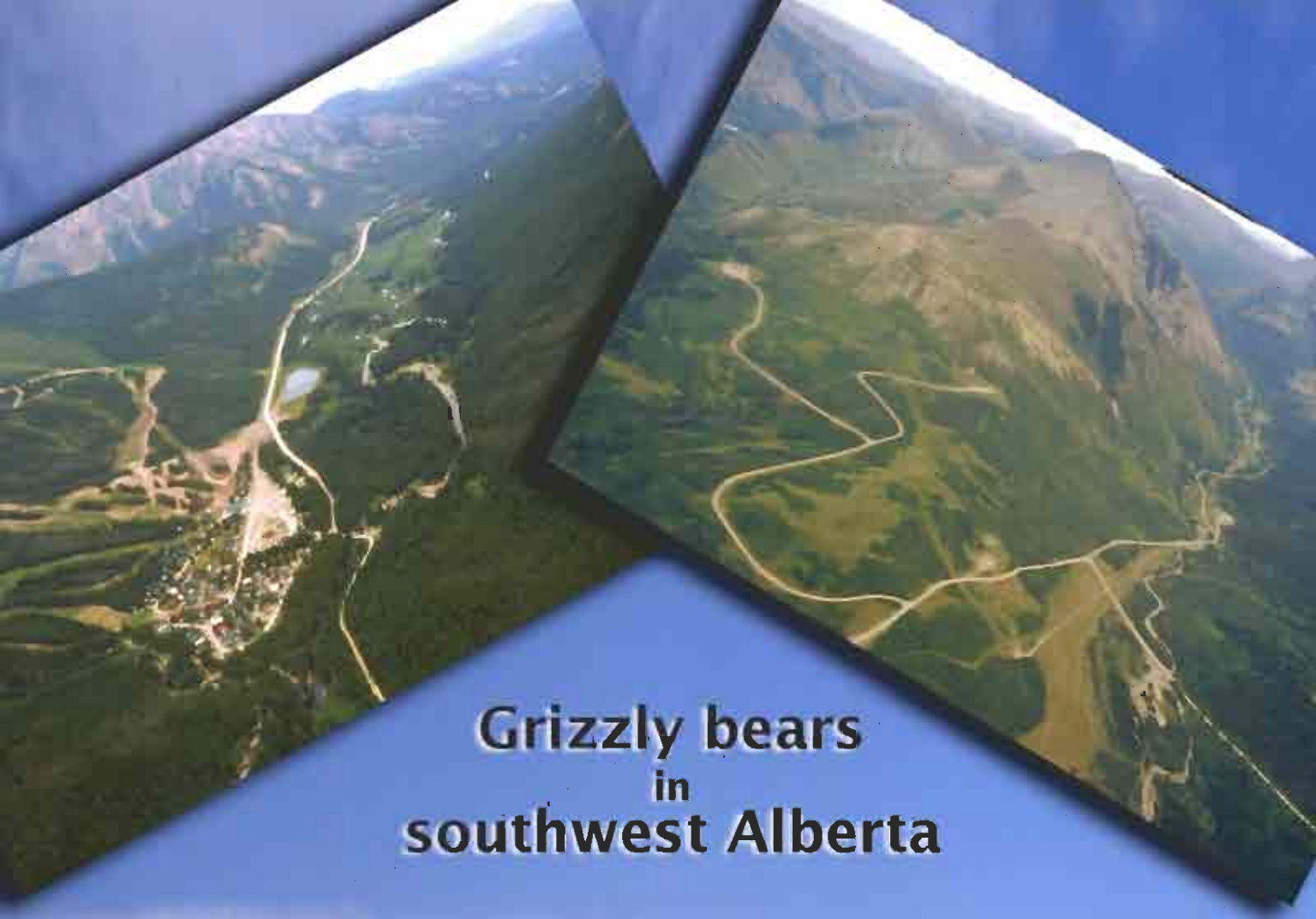

Grizzly bears in southwest Alberta

A vision and plan for population and habitat recovery

2004

Brian L. Horejsi

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Contents

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List of Tables

List of Figures.

Figures continued.

1.0 Introduction

The remains of bears in southwest Alberta and British Columbia have been dated to 8000 years before present (Kennedy *et al.* 1982) but grizzly bears are thought to have roamed freely across the plains and foothills of this region since shortly after the remnants of the Laurentide ice sheet retreated about 10,000 years ago (Pielou 1991). As glacial ice retreated grizzly bears established themselves in the Rocky Mountains and foothills. Together with a productive landscape occupied by millions of bison (*Bison bison*) they formed what truly must have been one the great natural wonders of the west. With this ecological foundation in place, it is reasonable to expect that the community of bears in southern Alberta was behaviorally and numerically impressive.

"A great sort of bear," "grizzled bears but too many," and "grizzly bears of the fierce kind" greeted Europeans (Nielsen 1975) when they first entered the plains and later the foothills and mountains of western Canada. A testament to the richness of this land are the accounts of Isaac Cowie, a Hudson Bay trader who reported "incredible numbers of grizzly bears" were killed in the Cypress Hills on Alberta's eastern border in 1871, "of which our share of the skins numbered 750" (Cowie 1913). He estimated this bounty to represent only one half of the hides that were traded that year at that post. The prolific and detailed diaries of Lewis and Clark, who passed through an adjoining landscape similar to that in southwest Alberta, point also to the immense ecological wealth of this landscape (Schullery 2002). An analysis of the observations of Lewis and Clark gave an estimate of grizzly bear density in the area about three times greater than it is presently in Yellowstone National Park (Laliberte and Ripple 2003).

But as Cowie's trade in grizzly skins indicate changes were already afoot and although they may have seemed benign at the time, that was hardly the case. Europeans first appeared in the region more than 250 years ago but they eventually occupied southwest Alberta with such dominating force that grizzly bears were exterminated from 89% of their southern Alberta range[1]. Through sheer slaughter and persecution, by the turn of the 20th century, bears numbered even fewer than they do today. The remnants of this once vast population are now virtually imprisoned in a small fraction of southwest Alberta.

Scientists and the public are now taking stock of changes in our natural world. "Changes to global ecosystems are having massive impacts on bio-diversity, and these impacts in turn are

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[1] Grizzly bear range in Alberta historically extended about 290 km east - west along the international boundary. About 257 km of this range is now lost to bears. Pre-European colonization, grizzly bears ranged as far east as present day Manitoba.

profoundly affecting human well-being and the planets life support systems. If we are to have real influence on the future of bio-diversity, then we must bring the findings of our research to bear on decisions that influence the root causes of problems, not just their symptoms" (Reid and Mace 2003). Like other parts of Canada, Alberta is not an exception to these chronic ecological and decision making problems. Grizzly bears, the most recognizable and high profile element of biological diversity in Alberta and the trans-boundary ecological region that encompasses southern Alberta, represent the proverbial "canary in the mine shaft."

This report examines the state of grizzly bear (*Ursus arctos*) habitat in southwest Alberta and relates that to the status of the bear population using the science and principles of conservation biology.

My objective is to synthesize current understanding of the issues and provide direction that will lead to the recovery of effective grizzly bear habitat on public lands and adjacent private land. Issues examined include the size and shape of the ecosystem, the extent of physical and ecological fragmentation by access and its consequences for habitat effectiveness and expected risk to bears, the existing causes and levels of bear mortality and the size, composition and dynamics of the bear population. A conservative estimate of the adult female population under natural landscape and conservation oriented management conditions was developed to contrast with the estimates of the number of adult females currently in the population. This recovery estimate provided another reference by which to measure the degree of impact this bear population and its habitat have experienced from cumulative effects of existing land use activities and present and historical management direction.

Perhaps most significant, this analysis and road map to ecosystem recovery challenges the vision, honesty and generosity of our society and culture. Just as importantly, it will measure the institutional integrity of the Alberta government and its commitment to democratic and scientific principles and practices of ecosystem conservation.

2.0 The Study Area

Southwest Alberta grizzly bear habitat is the only ecological link between Canadian and American ecosystems in the Rocky Mountains on the east side of the continental divide (Figure 1). Further contributing to its uniqueness, it represents the southernmost extension of grizzly bear range on provincially managed land in Alberta. It is also contiguous with occupied grizzly bear habitat in southeast British Columbia and is critically situated as part of the Glacier-Waterton National Park complex, which anchors the second largest occupied grizzly bear ecosystem in the United States and the international boundary region. This area and its grizzly bears link together two countries, two provinces and Montana, and the interests of over 300 million North Americans.

Jurisdiction Issues in the Study Area

The southwest Alberta grizzly bear management area consists of a mix of administrative jurisdictions (Table 1) that complicate management of the grizzly bear population and its habitat. Public lands are contained largely within an administrative area known as the Green Zone and it is safe to say that this land plays a pivotal role in the viability of all regional large mammal populations.

Table 1. Size (km^2) of administrative land categories in the study area.

Total Area	3776
White Zone	1855
Green Zone	1198
Poll Haven Lease	43
Waterton Lakes National Park	492[1]
Crowsnest Pass Corridor	188

[1] Without lake surface.

Private land also plays a major role in the ecological integrity of southwest Alberta. The east side of the study area , known as the White Zone, was historically grizzly bear range but is now largely privately controlled and grizzly bears no longer permanently occupy this productive habitat. There are several blocks of public land in the White Zone (Figure 2, Appendix A). They are important contributors to the ecological effectiveness of the Green Zone as well as

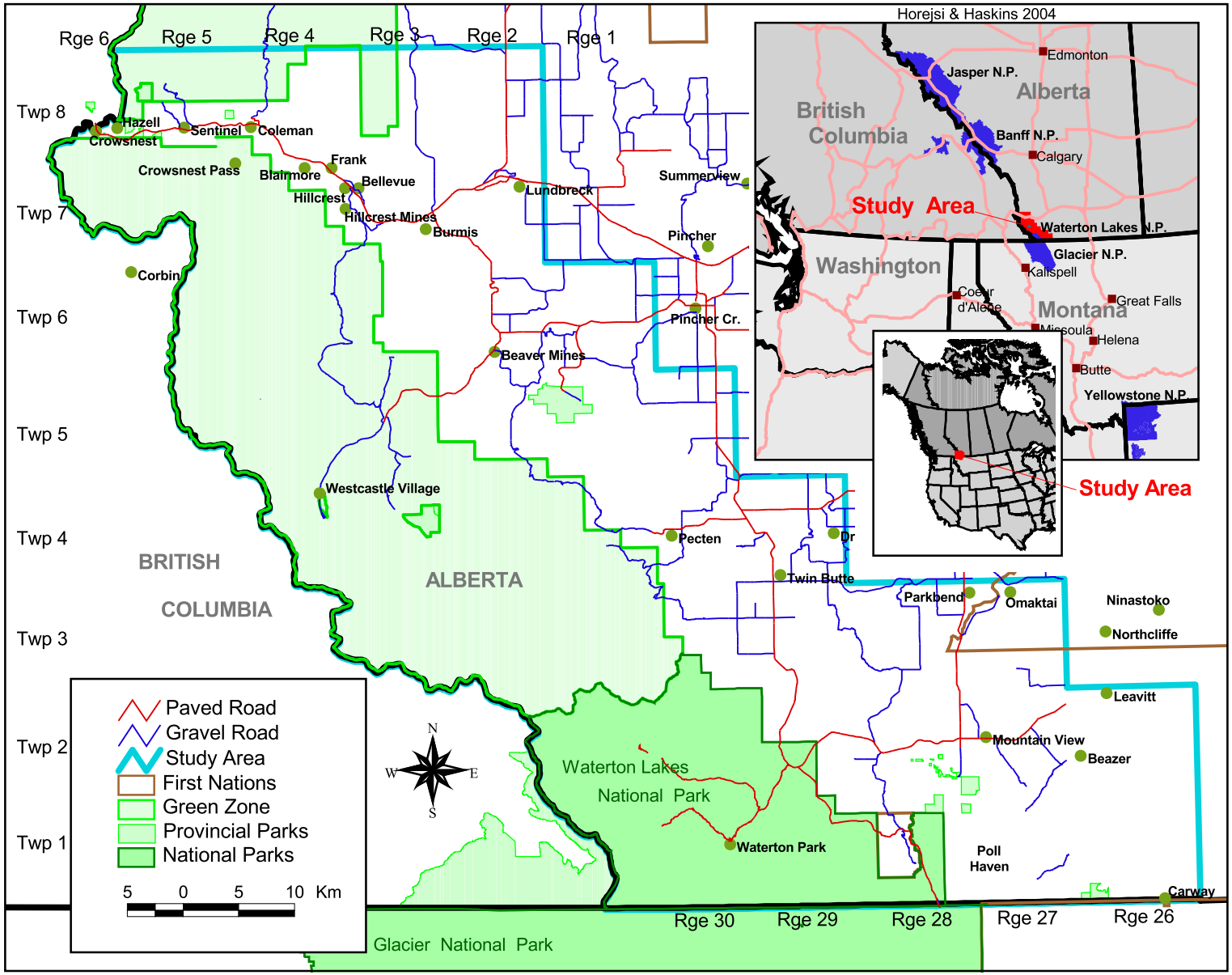

Figure 1. Administrative status of land and location of communities in the southwest Alberta grizzly bear recovery study area.

being important buffer zones to private land activity. The presence of numerous small but growing communities in the White Zone, whose many residents can readily access the study area, is highly relevant to grizzly bear conservation (Figure 1).

The ecological integrity of the Rocky Mountains and foothills of southwest Alberta and the survival of the grizzly bear population is directly linked to the Green Zone, a block of public land managed by a multitude of government Departments and Boards. This land has been in public ownership since the province was founded in 1905.

Waterton Lakes National Park, at one time over twice as large as it is today [2] (Getty 1971), may well be the main reason grizzly bears still survive in southwest Alberta. The Park remains the most legally protected landscape in the area but its wilderness qualities are impaired by increasing human exploitation.

The Crowsnest Pass (CNP) corridor, one of the most dominant political-ecological-geographical features in the study area, plays a significant role in setting land use trends and determining the success or failure of efforts to recover the full suite of native biological diversity. The CNP corridor, as defined here (Figure 3, Appendix A), consists of the Municipality of Crowsnest Pass and extends into the Municipal District of Pincher Creek in the east. The corridor contains Highway #3, a major east - west rail line, and consists of a core of private land that severs the jurisdictional and ecological link between public lands to the north and south.

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[2] In 1914 the Park was increased from 36 km^2 to 1096 km^2 in size but by 1921 it had been reduced to 761 km^2 and, in 1947, it was further reduced to its present size (Getty 1971). The 1921 and 1947 deletions became part of the provincially administered Green Zone.

3.0 Methods

3.1 Management area proportions

The shape and size of a management area have a great deal to do with ecological function and the challenges that management faces in trying to maintain those functions. A measure of management area proportions consisting of length to width ratio was calculated by measuring the length of five equally spaced lines each running north to south and east to west in the ecosystem. One set of measurements incorporated the entire study area; the second set included only the public land Green Zone and Waterton Lakes National Park. Total kilometers of the greatest distance (north - south) was divided by total kilometers of the least dimension (east - west). I labeled this value the perimeter impact ratio but it is also recognized as a measure of susceptibility to edge effect. For comparison purposes, similar measures were made of the Cabinet - Yaak (MT and ID), Selkirk (ID and BC), Yellowstone (WY, MT and ID) and Northern Continental Divide (MT) ecosystems, all of which are occupied by threatened or endangered grizzly bear populations.

3.2 Fragmentation and Road Encounter Risk

Landscape fragmentation by roads and high use non motorized trails was determined by overlaying 13 ellipses representing female grizzly bear annual home ranges (Figure 4, Appendix A) on a map of the existing access routes. Home ranges were about 162 km^2 in size based on the annual modified female with cubs home range size in Aune and Kasworm (1989). Unsuitable habitat, defined as terrain over 2133 m above sea level (Figure 5, Appendix A), was excluded from home range ellipses. This threshold elevation reflected radio telemetry locations of grizzly bears that showed little use above this elevation (Aune and Kasworm 1989). Home ranges were initially placed randomly in either the north and south Green Zone (n = 5 each) and White Zone (n = 3), then adjusted for location in order to meet the sample size objective, stay within the administrative zone, remain largely in Alberta, minimize overlap with each other, and largely exclude Waterton Lakes National Park. Relevant metrics for home range ellipses are provided in Table 2, Appendix B.

I defined road encounter risk (RER) as the number of times a bear moving randomly through its annual home range would encounter a road or be forced to avoid a road in various parts of southwest Alberta. The process is similar to diffusion models which have been used, for example, to approximate the number of movements a bear might make to exit a watershed based on permeability of the landscape (Boone and Hunter 1996). I assumed equal and total

permeability of habitats. Bears do not use habitat or their home range randomly but they regularly use large peripheral areas adjacent to core areas (Powell *et al.* 1997). Given demonstrated avoidance of access routes by some bears, and elevated mortality associated with access, the RER reflects a bears risk of human encounter in both peripheral and core home range, or indicates the extent to which a bear must restrict or abandon use of parts of its home range in order to limit risk. RER could be interpreted as a measure of the probability of being alienated, as a consequence of road density and zone of influence, from habitat that could become part of an intact home range. Risk was determined for each of three seasons; spring, summer and fall. Each season lasted 60 days. I used mean distance moved per day for spring, summer, and fall of 1050m, 859m, and 600m respectively (Mace and Waller 1997). The starting point for movement was selected as a random point within a home range ellipse and initial direction of movement was chosen randomly each day. Day two carried on from the end point of day one, and so on. Every 10^{th} day movement was increased to 2100m to simulate a habitat shift. A bear turned back when encountering either unsuitable habitat (>2133m) or the outside perimeter of its home range. This analysis was accomplished with ARC View GIS software.

3.3 Road Density calculation

Road density was calculated using a GIS moving window program. The procedure is outlined in the Flathead National Forest protocol paper for Moving Window motorized access density analysis and security core analysis for grizzly bear (U.S. Forest Service 2002).

Core or secure habitat is defined as habitat >500m (>.31 mi) from a motorized travel route or high use trail. It does not include any gated or restricted roads but may contain routes that are impassable due to vegetation or barriers (IGBC 1998b; U.S. Forest Service 2001).

3.4 Maximum number of female home ranges

The maximum number of female annual home ranges that could potentially occupy the study area was calculated using a mean home range for females with cubs of 162 km^2 (Aune and Kasworm 1989). Home range shape was established as an ellipse of 10.7 x 19.2 km, and each home range was "wrapped" around unsuitable landscape to contain about 162 km^2 of suitable habitat. No home range was less than 50% in the green zone (public land). Average home range overlap of 24% followed Mace and Waller (1997b). Not more than four home ranges overlapped (for example, B, C, and D could overlap A) and not more than three overlapped a given piece of habitat (B, C and D could be found over area X).

3.5 Population Risk Analysis

The risk of decline in the grizzly bear population in southwest Alberta was modeled using the RISKMAN program developed by Taylor *et al.* (2002) for the Ontario Ministry of Natural Resources and the Nunavut Department of Sustainable Development. The program simulates the dynamics of a bear population based on input of reproductive rate and cycle of females, survival rate, sex and age distribution of the population, selectivity by and vulnerability to hunting and other forms of mortality, and mortality season (spring, fall). Input is required into six major parameters; recruitment, individual survival, hunting mortality, hunt data, other mortality, and initial population. The stochastic option, using variance of input parameters, was selected and parameters were considered density independent. Data for parameters other than initial standing population were combined and entered as an average when bears in select age classes were expected or known to respond similarly to a given variable.

Few of the reproduction and survival input parameters required for RISKMAN are available for the southwest Alberta grizzly population: data on vital rates from the Yellowstone grizzly bear population were used (Table 3, Appendix B). The program is particularly sensitive to initial population size and composition, but less so to errors in vital rates. In simulation outcomes for eight grizzly bear populations, error in vital rates accounted for 2.4% of variation (McLoughlin 2002). Minimum and maximum age of reproduction was set at six and 20, respectively; few old female bears occur in this population and none over 20 years of age are expected. Maximum litter size was set at three.

RISKMAN determines the probability that a population will reach a user defined threshold within a select number of years. The threshold level of population change I used for this analysis was a 50% decline from initial population size within 30 years.

Three population sizes were modeled, based on estimates from the DNA study of Mowat *et al.* (1998). These populations were defined as the Precautionary Estimate (39 bears), Middle Estimate (48 bears) and High Estimate (65 bears). There is considerable uncertainty associated with these estimates (Mowat *et al.* 1998; Sheppard 1999; Mowat and Strobeck 2000) and the grizzly bear population in southwest Alberta could be smaller than the modeled “precautionary” population. The range in population sizes used reflects some of this uncertainty. Each population was subjected to 200 simulations. Runs were terminated if the population declined below the threshold, thus modeled recovery from below this level was not possible. Management related removal of bears, whether resulting in destruction of a bear or relocation from the ecosystem, was treated as “other mortality.” The model treats a population as closed; the grizzly bear population in southwest Alberta is, however, linked to regional bear distribution in Montana and

British Columbia. Movement of bears from these jurisdictions to Alberta, and vice versa, is known to occur, but it has not been quantified.

4.0 Results and discussion

4.1 ECOSYSTEM AND MANAGEMENT AREA PROPORTIONS

The shape of an ecosystem or management area is one aspect of its capacity to buffer grizzly bears from peripheral impacts. I calculated an ecosystem length to width ratio, which I termed the impact ratio, for the study area and U.S. grizzly bear recovery areas for endangered and threatened populations. The impact ratio is one indicator of whether an ecosystem or management area is vulnerable to disproportionate edge effects because of a shape factor, e.g., the area is it too narrow relative to its length. An ideal ecosystem would be close to round with a radius ratio of 1:1 or close to square with a width to length ratio of 1:1. In addition to ecosystem or management area shape, capacity to contain viable wildlife populations is complicated by size and I will make frequent reference to the relatively small size of the southwest Alberta management area (Table 4, Appendix B).

The only ecosystem for which population and ecosystem statistics are available and within which the grizzly bear population is showing signs of increasing is the Yellowstone ecosystem (Schwartz and Haroldson 2000; Schwartz *et al*. 2002). It is essentially square and has a perimeter impact ratio of one (Figure 6). All other U.S. grizzly bear populations, including the endangered Selkirk and Cabinet-Yaak populations, are far more vulnerable to perimeter impacts than Yellowstone; even the threatened Northern Continental Divide population, although occupying an ecosystem more than 23,000 km^2 in size (excluding Canada), is not immune to perimeter impact [3]. The southwest Alberta sub population of grizzly bears is linked to the Northern Continental Divide population but the landscape occupied by bears in Alberta, particularly the public land segment, is highly susceptible to human-activity impact and would not be occupied grizzly bear habitat without its linkage to the greater Northern Continental Divide ecosystem.

[3] Mace *et al.* (1999) identify perimeter impacts for the southwest corner of the Northern Continental Divide Ecosystem, the greater ecosystem to which southwest Alberta belongs.

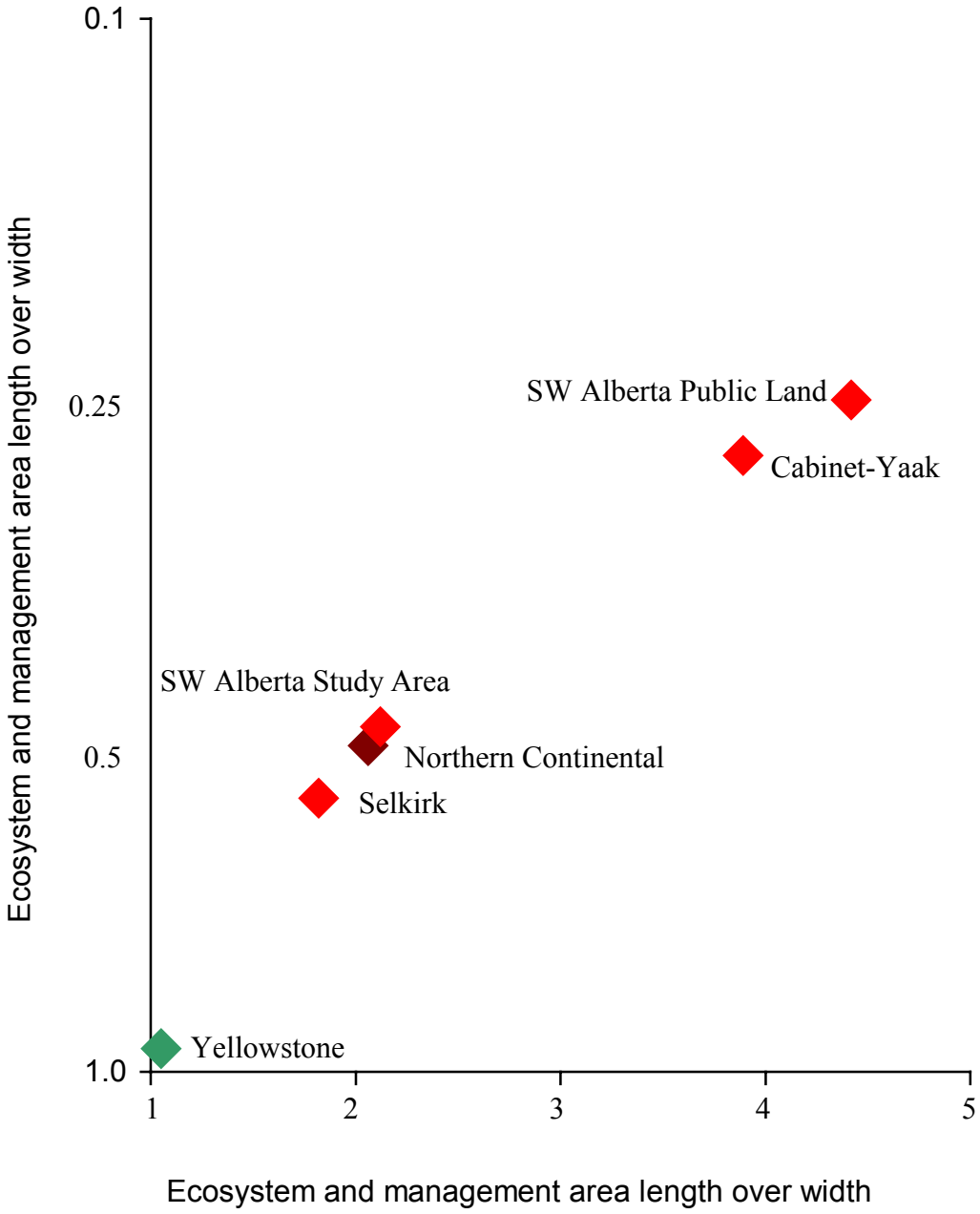

Figure 6. Ecosystem and management area exposure to perimeter impacts (edge effect) as a function of ecosystem shape. 1.0 equals lowest risk.

4.2 LAND USE ISSUES

Roads are a major issue in the management and conservation of grizzly bear populations and their habitat. Many of the land use issues discussed below are road related; this brief introduction leads into those issues.

The known consequences of roads and access for grizzly bears and their habitat

Outside of human population and agricultural centers most contact between bears and humans is facilitated by roads.

Roads have the following effect on bears and bear habitat (Mattson *et al.* 1987; Mace *et al.* 1996; Gibeau 2000):

1. bears die near roads because that's where people often contact bears;
    - *1.1* some bears die from purposeful lethal contact (hunting) that is road dependent,
    - *1.2* some die from inadvertent contact (defense of life and property, management removals) because bears may be attracted to human food and refuse and are drawn into contact with people, or bears of lower social or physical rank may attempt to avoid more dominant bears by seeking refuge near roads, and
    - *1.3* still others die accidentally from collisions with vehicles
2. roads and the human activity associated with them displace wary and intolerant bears from a behavioral and ecological zone of influence along roads (= alienation of habitat),
3. roads result in ecological, behavioral and physical fragmentation of habitat, increasing the "cost" of movement and influencing the occupation of an area by a bear, all of which stand to reduce a bear's fitness [4], and
4. road and parking lot construction physically destroy habitat.

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[4] The relative, life long genetic contribution a bear makes to future generations.

4.2.1 MAJOR HIGHWAYS; HARDENING THE ECOSYSTEM PERIMETER

The white zone in southwest Alberta is becoming increasingly resistant to extended grizzly bear occupation. Part of that alienation stems from the major transportation network that envelopes this area and encroaches on public lands, land that constitutes the heart of this management area. Vehicle speed combines with vehicle frequency to complicate the impact of access on bears. All the roads enclosing the southwest Alberta study area are high speed routes (>100 kph). Traffic frequency on all but one leg of this road network has increased in recent years (Alberta Transportation 2003) (Figure 7) and is sufficient in every case to create a high resistance filter, and in some cases a barrier, to grizzly bear movement (see, for example, Proctor *et al.* 2002).

Research has shown that most bears display some degree of avoidance of roads with traffic levels of 61 to 300 or more vehicles per day (vpd) (Mace and Waller 1996) (Figure 8); sub-adult bears are the least likely to do so. Adult females (3 of 5) have crossed a highway with average daily traffic volume of about 1400 vpd; these bears, along with two sub adults, crossed Highway #2 separating Montana's Glacier National Park and the Bob Marshall Wilderness 42 times in two summers (Waller and Servheen 1999), suggesting a high degree of highway avoidance [5]. Very few male grizzly bears, and virtually no adult female bears cross high frequency highways (average 20,000 vpd) and most female grizzly bears that were known to cross secondary highways with lesser traffic frequency (about 2000 vpd) were habituated to human presence (Gibeau and Herrero 1998).

As a consequence of general avoidance behavior we can expect road kills, particularly amongst adults, to be few even at lower traffic levels. At the traffic levels seen on most highways in southwest Alberta [6] vehicle - bear collisions have been uncommon. As Average Daily Traffic (ADT) count reaches 10,000 on a highspeed roadway like Highway #3, it is becoming increasingly difficult for bears, particularly behaviorally "naive" young bears, to cross safely. Black bears road kills apparently increased sharply at 15,000 vpd (Gilbert and Wooding 1996).

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[5] Five bears, two years, 42 crossing events; average = 4.2 crossing events/bear/year.

[6] And given the size and density of the bear population.

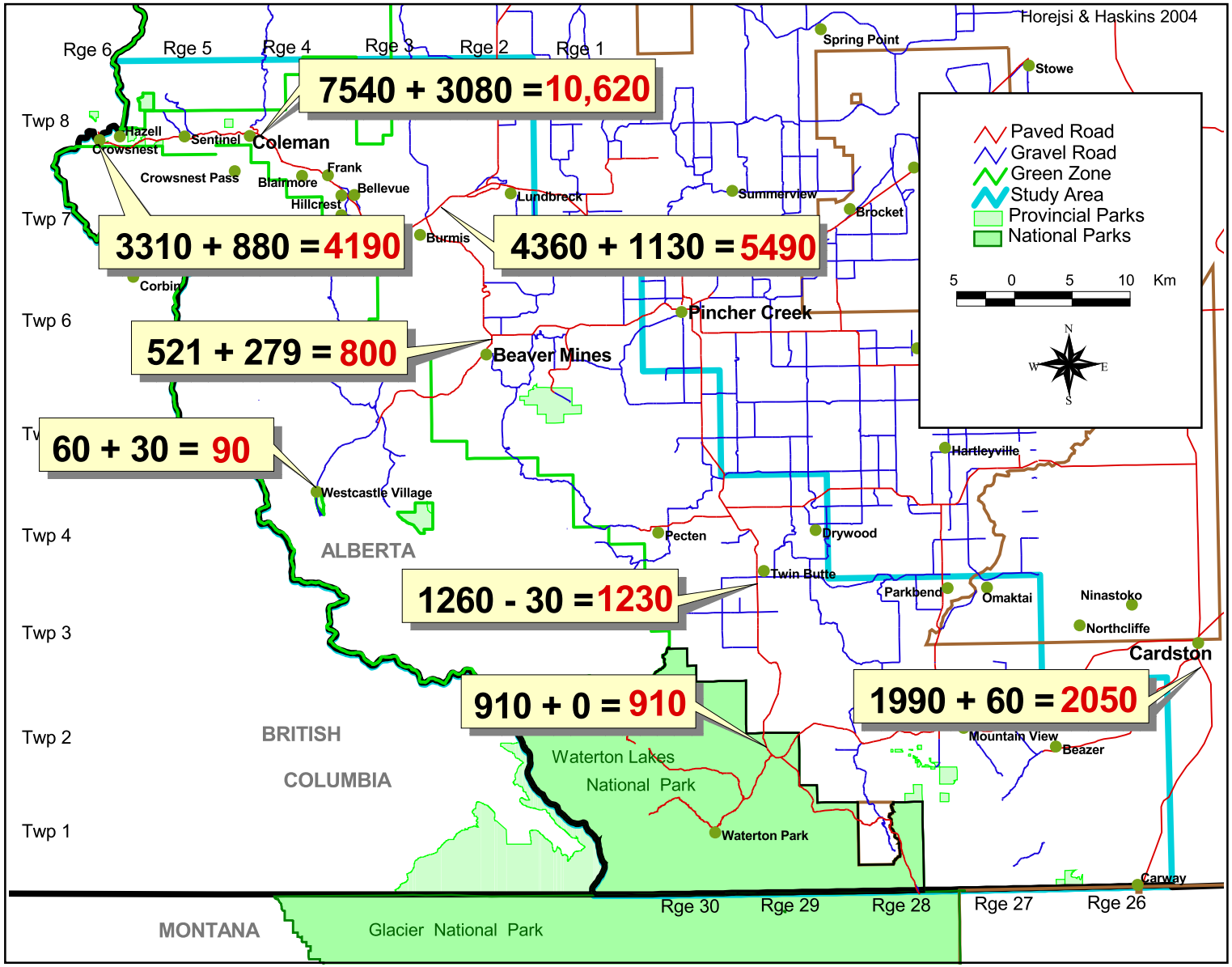

Figure 7. Traffic levels on main and secondary highways enclosing and entering the southwest Alberta Grizzly bear ecosystem. 1993 Average Summer Daily Traffic (ASDT) count plus or minus change over 10 years = 2002 ASDT. Data is from Traffic Volume History records, Alberta Transportation.

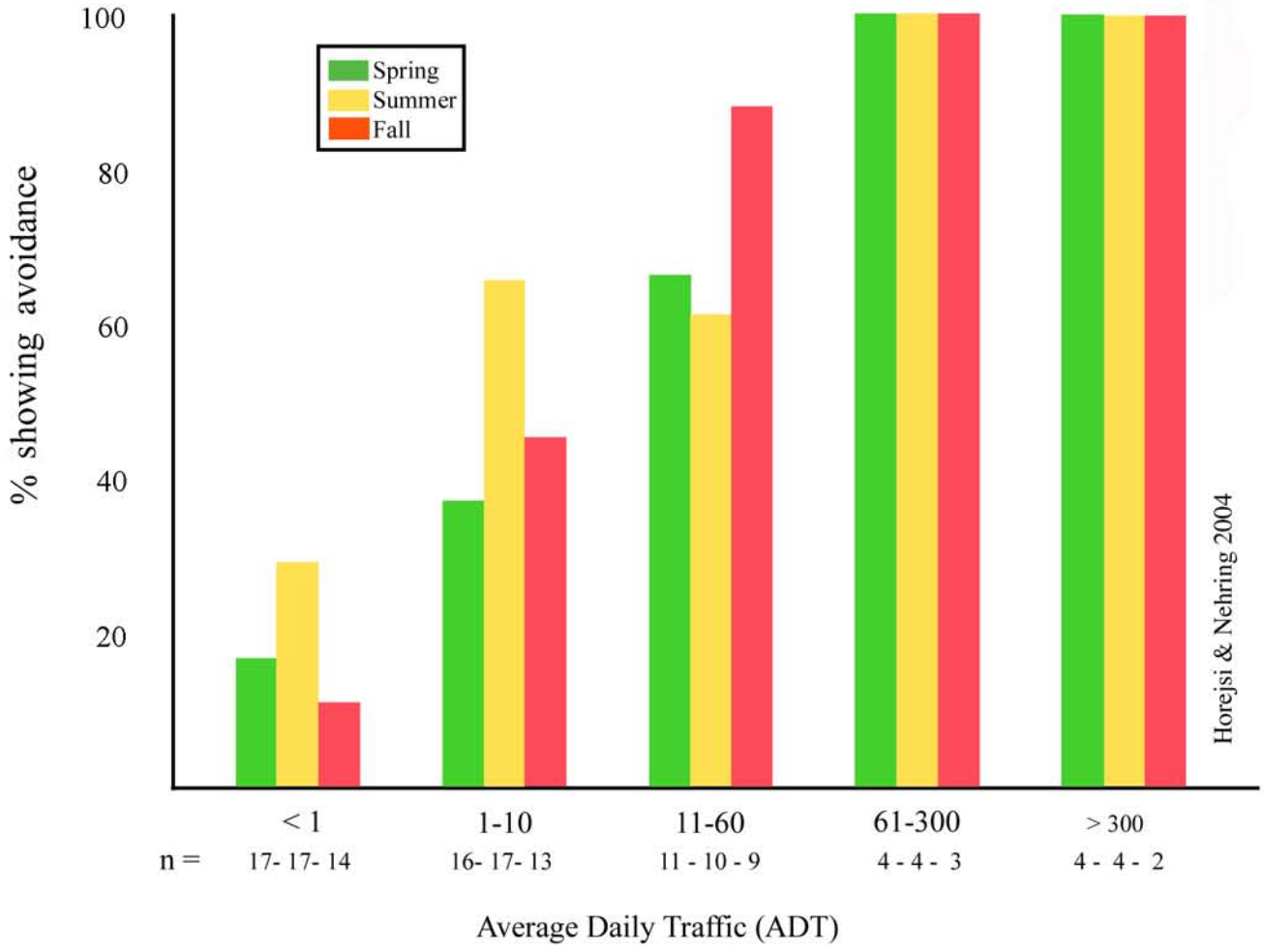

Figure 8. Grizzly bear avoidance of the 500m road buffer zone according to traffic volume and season. n = number of seasonal home ranges. Data from Mace et al. (1996) and NCDE Task Group (1998).

Even when the vehicle speed limit is relatively low, as on the road system in Yellowstone National Park where the bear population is estimated at between 250 and 325 animals, collision- related mortality, particularly of young bears, still occurs; two grizzly bears were killed in 50 and 70 kph speed zones [7] in the park between 1989 and 1996 (Gunther *et al.* 1998).

Highway #3 in the CNP corridor has become a significant factor in the fragmentation of grizzly bear habitat on public lands; at between 4100 and 10600 ASDT (average summer daily traffic) the highway is close to becoming a total barrier to bear movement (Proctor *et al.* 2002) and represents a very high risk of lethal encounter for those younger bears that might attempt a crossing. In the CNP corridor the virtual absence of recorded collision mortality reflects avoidance of highways as well as a relatively low number of bears (See Section 4.3). Genetic and demographic isolation of the grizzly bear population both south and north of Highway #3 has been increasing for several decades (Proctor *et al.* 2002) and existing and increasing traffic levels will aggravate efforts to recover the Castle - Waterton population.

It is optimistic to expect that regular movement by grizzly bears to the east side of the ecosystem would lead to an expansion of the occupied and contributing landscape. However, the potential for land acquisition by bear tolerant land owners exists in townships one, two and three (see Figure 1) and would facilitate expanded occupation of the area by bears. Traffic frequency on Highways #5 and #6 (Pincher Creek to Waterton and Cardston) is well beyond levels that deter regular movement by adult female and adult male grizzly bears but maintaining unimpeded access to the highway right-of-way will keep alive opportunities to ecologically tie the ecosystem together by burying critical sections of the road in full or partial tunnels.

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[7] There are other factors involved in vehicle - bear collisions including roadside vegetation and topography, but they appear to be secondary to vehicle speed and frequency.

4.2.2 WESTCASTLE DEVELOPMENT; TRAFFIC ENCROACHING FURTHER INTO THE ECOSYSTEM

The relationship between ecosystem size and shape and the continued existence of viable large carnivore populations is reasonably well established (Newmark 1975; Mattson *et al.* 1995; Horejsi 2002; Horejsi 2003). The southwest Alberta grizzly bear ecosystem is a vital link between the larger U.S. centered Northern Continental Divide Ecosystem to the south and more expansive grizzly bear habitat to the north in Alberta. While the southwest Alberta management area is presently incapable of maintaining a viable grizzly bear population on it's own any development that threatens to fracture this connecting linkage is to be viewed with alarm. As the destination for most Highway 774 traffic, The West Castle Real Estate and Ski Hill Development [8] has spawned a transportation corridor that threatens to sever the southwest Alberta study area in two (see Figure 1). ADT [9] on Highway 774 has increased by 50% in 10 years (Figure 7) and the 90 ADT count is at a level sufficient to prompt avoidance by most adult grizzly bears (Mace *et al.* 1996).

4.2.3 FRAGMENTATION BY HUMAN BUILT ACCESS

Fragmentation of the landscape by human built access is one of the two most significant threats to the viability of grizzly bears in southwest Alberta. The extent of this threat was measured in 13 average size annual female grizzly bear home ranges superimposed on the road and motorized trail access system.

Three aspects of fragmentation were measured:

density of roads and trails, which is a function of

the length, measured in kilometres, of linear features like roads and trails, and

the extent of the landscape within 500m of an access route (zone of influence).

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[8] This development is referred to by its proponents and the media as the Castle Mountain Resort, but I use the expanded name to more accurately identify the physical nature of the development.

[9] ADT reports for Highway 774 are estimates, not measures, and they pre-date the rapid expansion of housing development in the Westcastle village.

From the perspective of the survival of grizzly bears and native biological diversity the results are ominous.

4.2.3 - 1 Road Impacts and Thresholds

Road Density

Road access impacts on habitat utilization by bears are measured in a number of ways. They include

Road density x percent of a landscape, measured as

Total Road Density (TRD) x percent of the landscape, and

Open Road Density (ORD) x percent of the landscape,

Overall road density of the management area, and

Zone of influence, as a percent of a landscape within or outside a 500m buffer on access routes. Although 500m appears to reflect inadequately research findings on displacement or disturbance (Horejsi 2003) habitat outside the 500m buffer zone is often referred to as Core or Security habitat (IGBC 1998b)(see Methods for definition).

This project evaluates the southwest Alberta study area relative to other management jurisdictions and the results of research on bears for each of these measures with lesser emphasis on ORD. There are few, if any, effective road closures (either administrative, legal, corporate, voluntary or consensual) in southwest Alberta (see also Sheppard *et al.* 2002) therefore I consider ORD roughly equivalent to TRD. Alberta Department of Sustainable Resource Development does not monitor off road vehicle use in the study area and use / non use records are not kept (Hawkes, N., personal communication, e-mail 17 June 2003). Lacking a complete monitoring and policing record of access road status and for the sake of precaution, this report addresses primarily Total Road Density although occasional reference is made to Open Road Density.

Scientific information addressing the harm that road density inflicts on grizzly bears is extensive and continues to accumulate. The U.S. Fish and Wildlife Service (1995) defines harm to “include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering.” It goes on to identify road densities that are considered, based on a very liberal interpretation of

research results, to harm grizzly bears. Harm occurs when:

open motorized access density of > 0.62 km/km^2 (> 1 mi/mi^2) affects more than 13% of the landscape, and

Total motorized access density of > 1.25 km/km^2 (>2 mi/mi^2) affects over 19% of the landscape.

These are permissive interpretations of research results which have been criticized as inadequate and inconsistent with the trend and status of the bear populations from which they have been derived (Metzgar 1998; Horejsi 2001).

In the Northern Continental Divide Grizzly Bear Ecosystem radio collared adult female bears occupied home ranges that averaged 11% and 9% impact from Open Road Density of >1 km/km^2 and Total Road Density of > 2 km/km^2, respectively (NCDE Access Task Group 1998). Female grizzly bears in the Yellowstone Ecosystem, where the population appears to be stable or increasing, occupy home ranges in which six (6) percent of the area was affected by an Open Road Density of >0.6 km/km^2 (> 1 mi/mi^2) and six (6) percent by TRD of > 1.2 km/km^2 (>2 mi/mi^2). Metzgar (1998) concluded long term grizzly bear population viability, for populations occupying ecosystems smaller than the Yellowstone ecosystem, could be achieved with Total Road Density standards of;

> 0 - 1 km/km^2 < or = 8.3% of a home range, and

> 2 km/km^2 < or = 1.7% of a home range.

Research results, including Metzgar's analysis, suggest the need for protective measures dramatically different than evolved U.S. Forest Service standards. I think it is reasonable and sound to conclude that micro-management of habitat intrusions and fragmentation and nit-picking by land management agencies over road density tolerance at the level represented by agency standards are unlikely to provide grizzly bears with the long term security they require.

Road density in southwest Alberta is far in excess of thresholds that harm grizzly bears (Table 5, Appendix B). Although the South Castle area meets the biological threshold for maximum area impacted by TRD of >2 km/km^2 it exceeds by a factor of two the tolerable ORD standard of area impacted by >1 km/km^2. Road densities in Waterton Lakes National Park barely

meet TRD >2 km/km^2 standards but exceed by 300% the biological threshold of not more than 7% ORD of >1 km/km^2 (7% standard versus 24% in WLNP) (Table 6, Appendix B).

Overall Road Density

This is the most crude and least applicable measure of road density since it can produce a high mean road density even if some areas are intensively roaded and others are roadless. The latter situation is not the case for southwest Alberta, however, because road access dominates many parts of the landscape (Figure 9). Mace *et al.* (1996) found that female grizzly bears utilized home ranges that had an average road density of;

0.57 km/km^2 in spring,

0.40 km/km^2 in summer, and

0.34 km/km^2 in autumn.

The threshold for long term grizzly bear persistence on a landscape scale [10] has been identified by other researchers as:

0.20 km/km^2 Total Road Density (Metzgar 1998), and

0.16 km/km^2 Total Road Density (Mattson 1993; Craighead *et al.* 1995).

These thresholds are exceeded by both the South Castle (3.7 times greater) and Waterton Lakes National Park, which can dubiously be referred to as the remaining "strongholds" of effective grizzly bear habitat in southwest Alberta.

Road density in the North end of the Green Zone and the White Zone is 9.5 and 8.8 times, respectively, over long term persistence levels (Table 5, Appendix B) and represents a landscape that is inhospitable to grizzly bears. Based on research results from radio collared grizzly bears in other studies, southwest Alberta has road densities in all parts of the Green Zone and White Zone that represent a high risk landscape; with up to ten times greater road density than bears will tolerate or survive in, southwest Alberta represents a relatively hostile environment for grizzly bears.

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[10] They were addressing ecosystems in which there is no legal hunting of bears and a range of protective measures are afforded by endangered species legislation.

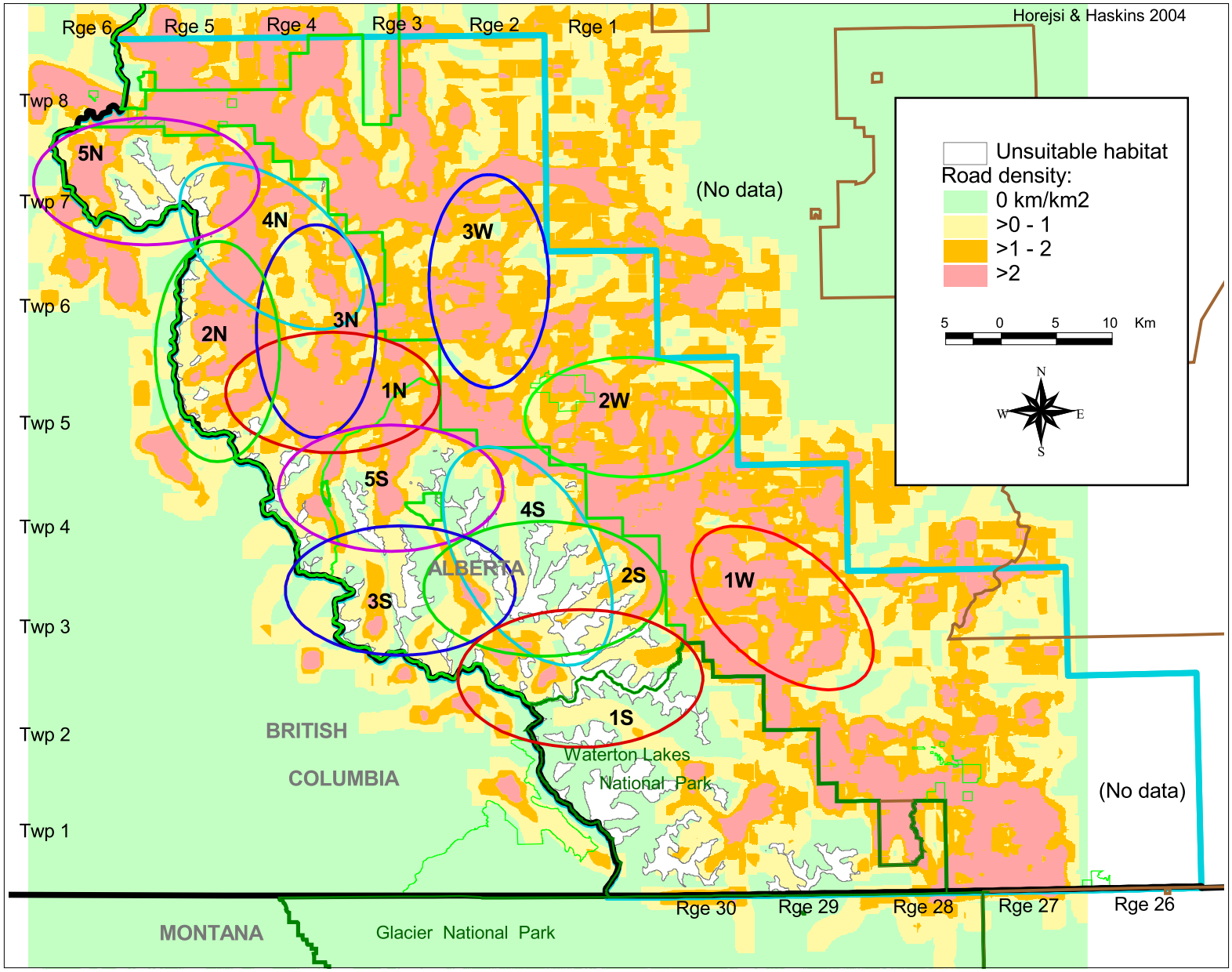

Figure 9. Road density (km/km2) affecting the southwest Alberta landscape; with road risk home ranges superimposed.

4.2.3 - 2 Road encounter risk

The presence of roads and trails in grizzly bear habitat results in displacement of some bears (Mace *et al.* 1996; Mattson *et al.* 1987) and an elevated risk of mortality for most bears (Benn 1998; Mattson and Knight 1991). Road Encounter Risk, defined as a measure of the risk of encountering a road and/or the pressure on a bear to avoid a road encounter, was calculated for southwest Alberta. The results (Table 7) are startling and indicate a very high degree of road encounter risk, relative to unroaded habitat, exists in southwest Alberta. Grizzly bears are repeatedly at risk of encountering humans on access routes or are forced on a regular basis to avoid roads and trails, thus alienating major portions of habitat from predictable and consistent use.

The north end of the Green Zone is a very degraded environment for grizzly bears. Using my measure of road encounter risk, a bear on these public lands could encounter a road 248 times a year and 2.5 times per day; or conversely, it must so restrict its movement and activities that it would be unable to survive. Management has failed to provide even minimal secure habitat [11] for bears in this area.

The White Zone is also a high risk area; some grizzly bears can be expected to use this area on occasion but those that do use it subject themselves to extreme risk of mortality, displacement and harassment. It is a sad indictment of public land management that the White Zone represents a lower road related risk than the north end of the Green Zone. Ineffective habitat in the Green Zone may be responsible for displacement of bears to the White Zone where conflict with residential and agricultural interests often proves to be lethal to bears.

Bears using the south end of the Green Zone are subject to less road related risk than those that use the White Zone but they are still likely to encounter a road or motorized trail every 1.3 to 1.5 days; or alternatively, they must exhibit a consistent degree of awareness and avoidance if they are to reduce road related risk.

Bears in southwest Alberta are faced with an extremely high risk landscape and consequently with near impossible choices. They face either extremely high road encounter risk

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[11] To be secure, habitat must occur in units at least 9 km^2 in size, as well as meeting road related criteria. See Methods.

Table 7. Road encounter risk calculations; the number of times a bear could be expected to encounter a motorized or high use non motorized access route, in three seasons, for each random walk home range.

Home Range	Season			Total
	Spring	Summer	Fall	
1N	90	68	97	255
2N	115	71	80	266
3N	140	66	77	283
4N	74	56	45	175
5N	106	86	68	260
Total	525	347	367	1239
Average	105.0	69.4	73.4	247.8
1S	29	7	15	51
2S	30	79	60	169
3S	41	41	49	131
4S	22	49	9	80
5S	100	11	48	159
Total	222	187	181	590
Average	44.4	37.4	36.2	118.0
1W	51	57	29	137
2W	72	75	50	197
3W	72	49	19	140
Total	195	181	98	474
Average	65.0	60.3	32.7	158.0

or suffer from high levels of avoidance behavior that results in behavioral and ecological exclusion from significant blocks of habitat.

4.2.3 - 3 Road zone of influence

Applying a buffer zone to an access route as a measure of the zone of impact or influence from that access route is a sound practice. Its validity as a measure of impact depends substantially on the research supporting the behavioral and ecological footprint an access route imposes on adjacent habitat. Buffer zones that are currently being applied underestimate the impact of road related activities on surrounding habitat because research results have not been reasonably applied (Horejsi 2003). The 500m (0.31 mi) buffer zone in use on some U.S. National Forests (U.S. Forest Service 1995b) was used as a preliminary basis for assessing access footprint in southwest Alberta. My interpretation, however, is that a 500m buffer underestimates the extent to which road related activities impact surrounding habitats, but in the absence of any formal acknowledgment or application of road effect in Alberta land management, it represents a starting point.

The 500m zone of influence is typically applied to road access in order to identify core/secure habitat. Conversely, a measure of the area within the 500m zone of influence reflects the extent of habitat impacted by access. Core habitat is discussed below, but it is significant that the high level of fragmentation of the southwest Alberta landscape represents a massive ecological and behavioral footprint (Table 8) (Figure 10).

Table 8. The size of the 500m behavioral and ecological zone of influence caused by motorized roads and trails and high use non motorized trail access in southwest Alberta.

% of area within 500m buffer			
Green Zone North	Green Zone south	White Zone	Waterton Lakes National Park
78	43	86	39

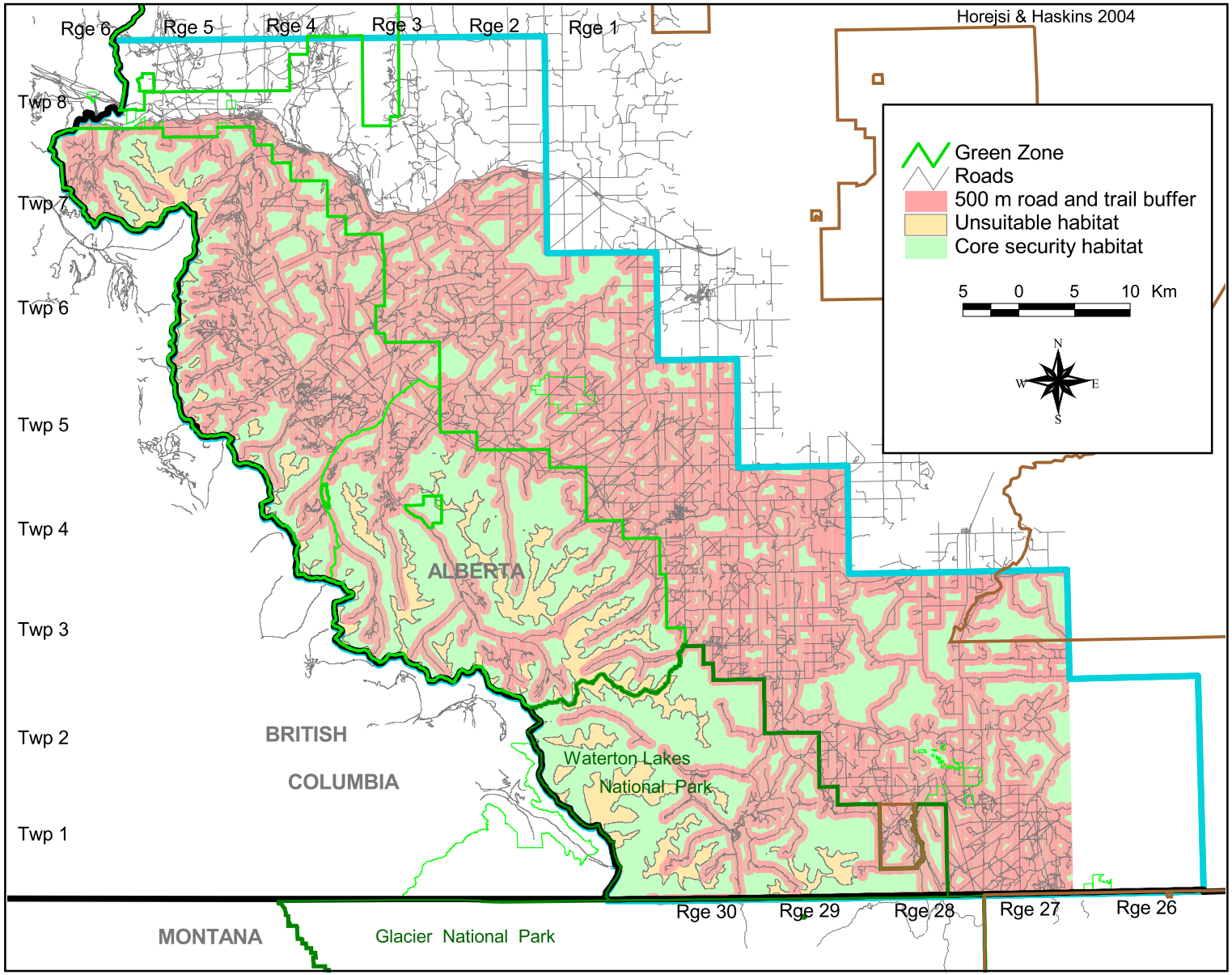

Figure 10. The 500 m road and trail zone of impact and remaining security (core) habitat.

4.2.3 - 4 Core Security Habitat

Core grizzly bear security habitat has been defined as habitat greater than 500m from any road or trail receiving motorized use or high frequency non-motorized use. While the scientific validity of this definition is questionable (Horejsi 2001; Metzgar 2001) the definition has worked its way into general usage and is used here as a minimum reference point. The terms core habitat and secure habitat are used interchangeably in the management literature. There is a proviso attached that has a biological basis and a substantial effect on useable core availability; the core area must be about 10 km^2 (> 2500 acres) in size (U.S. Fish and Wildlife Service 1995; see also Gibeau 2002), about the area used by an adult female grizzly bear in the course of a days activity.

There is no evidence that grizzly bear populations can be sustained or returned to viability over the long term when a threshold level of habitat is not maintained as core secure habitat. Grizzly bears in the Selkirk ecosystem (ID, WA and BC) are endangered and occupy home ranges with an average of 56 to 78% core (Wakkinen and Kasworm 1997). In the Flathead National Forest portion of the Northern Continental Divide Ecosystem, female grizzly bears occupy home ranges that are from 58 to 86% core. In Yellowstone National Park females occupy home ranges with 84% core (U.S. Forest Service 1999).

There is insufficient core habitat in the Green Zone North and in the White Zone (Figure 11) to support extended occupation of these areas by female and adult male grizzly bears. The Green Zone south and Waterton Lakes NP appear to be at the threshold necessary to support resident adult grizzly bears.

4.2.4 SECURE AND ROADLESS HABITAT CORE

A relationship exists between endangered and threatened grizzly bear populations and the presence or absence of roadless security habitat, some of which is designated as wilderness, in the United States and trans-boundary grizzly bear ecosystems (Mattson *et al.* 1995; Horejsi 2003). Grizzly bear populations that appear to have prospects for long term viability are those occupying large ecosystems (n = 2, > 20,000 km^2) (see Mattson *et al.* 1995) that are at least 50% roadless. Populations (n=2) in the U.S. occupying smaller ecosystems with less than 50% roadless protection are biologically endangered and legally defined as endangered under the federal Endangered Species Act. Eleven grizzly bear populations (each of <100 animals) in British Columbia are recognized as “threatened” and each occupies a landscapes in which roadless protected areas are not adequately represented. Weilgus (2002) estimated an ecosystem

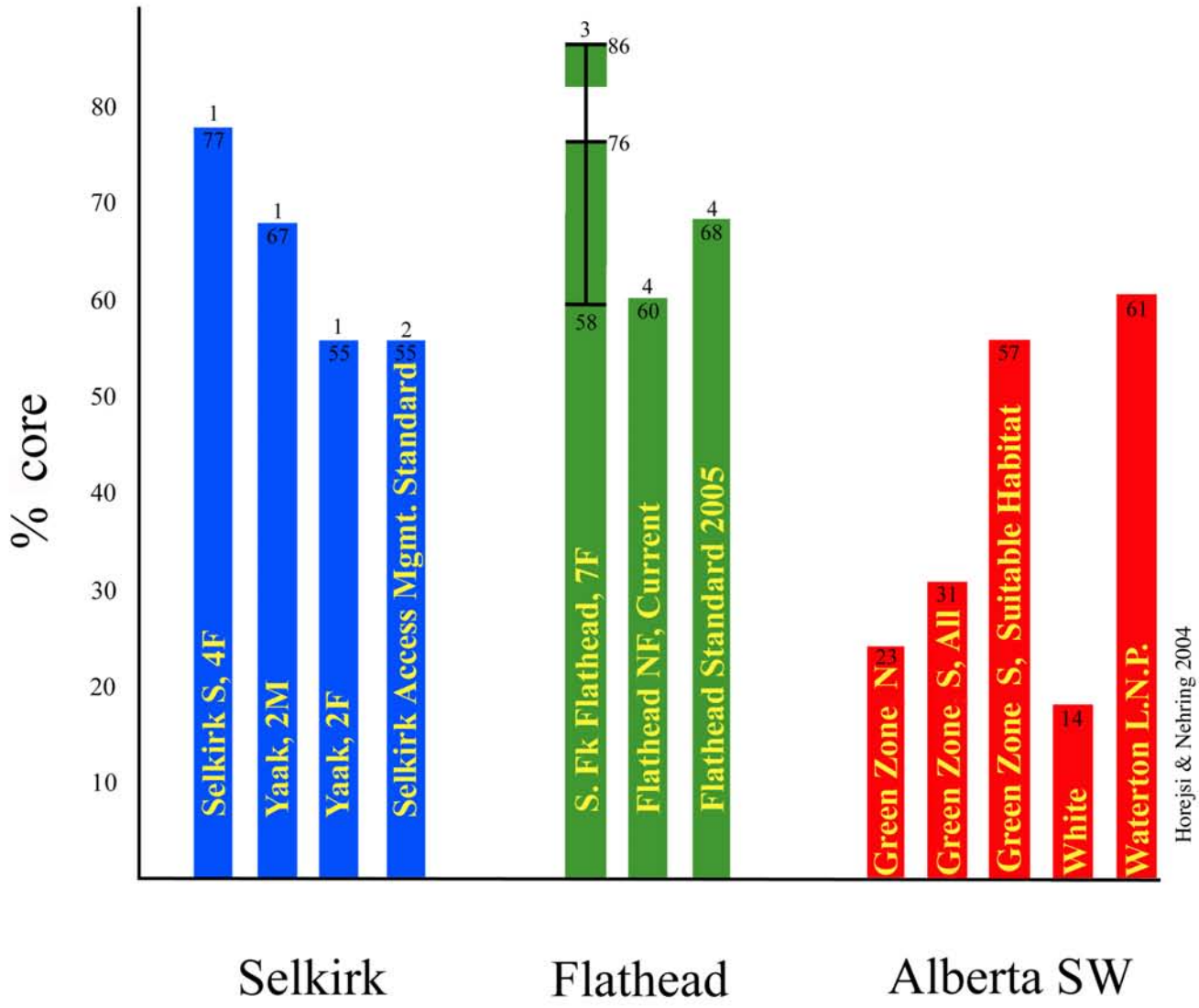

Figure 11. Core / Secure habitat (>500m from access) in southwest Alberta, as used or available to research bears and as required by Access Management Rules (U.S. Forest Service). Top of bar: 1 = Wakkinen 1997; 2 = Interagency Grizzly Bear Committee 1998; 3 = U.S. Fish and Wildlife Service 1995. 4 = U.S. Forest Service 1995. Inside bar: F = female; M = male.

necessary to maintain short to mid term persistence of a grizzly population of at least 100 bears [12] would be 8556 km^2 to 17, 843 km^2 in size, contingent on population density.

Against any of these reference points the grizzly bear population in southwest Alberta is in extremely dire straits. Its future lies in collaborative management of southwest Alberta with the Northern Continental Divide ecosystem in Montana and southeast British Columbia. But it can contribute to regional bear populations conservation by becoming less of a drain, in terms of poor habitat effectiveness and mortality, to the regional meta-population. To achieve this objective will require a substantial upgrade in habitat security in part of the southwest Alberta grizzly bear range and re-calibration of management direction.

"Roadless areas are probably the most important areas for bears," even for the much more tolerant and tolerated black bear (Powell *et al.* 1997). Wilderness underpins grizzly bear population viability primarily through provision of security; security is the result of the separation of often large numbers of humans, many of whom may be armed and supported by motorized access, from bears. This allows bears to safely exploit the full range of habitats that are available. Consequently not only do bears of all ages suffer lower mortality rates when security is high but their reproductive status and population recruitment improves. Population viability also depends on access to large scale security habitat that can act as a source of bears for surrounding areas.

Functional representation and distribution of habitat that can serve as a "source" area [13] for regional bear populations (and all other wildlife populations) does not exist on southwest Alberta public land. To be effective a source area must include low elevations [14] and habitat that sheds winter snow cover early.

Landscapes that have typically been established as wilderness in North America, Alberta included, are high elevation areas that in most cases have remained free from human use by default, not by design. In many cases it is the least productive land in a region but its relative

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[12] It has been estimated that long term population viability requires 500 interbreeding adult bears, which would typically be represented by a total population of about 2000 bears (Allendorf *et al.* 1991)

[13] A source area is one in which habitat is secure and bears are sufficiently productive to provide bears that disperse to surrounding areas.

[14] Ninety two percent of grizzly bear mortality in the Central Rockies Ecosystem south of the Bow River occurs at lower elevations (<2000m) where most roads and trails occur; 89% of mortalities occur within 500m of a road or within 200m of a trail (Benn 1998).

effectiveness as bear habitat is high because of the absence of motorized and industrialized human use. In the Northern Continental Divide Ecosystem that includes southwest Alberta, this relationship has been investigated using radio collared grizzly bears (Mace *et al.* 1997). Realized habitat effectiveness for grizzly bears is higher in wilderness than in fragmented landscapes in every season even when overall productivity is relatively low. Wilderness areas also suffered very low loss in habitat effectiveness due to human activity whereas non wilderness public lands and private land suffered losses in habitat effectiveness that could exceed 50% (Mace *et al.* 1999). Based on these research results the State of Montana Department of Fish, Wildlife and Parks Grizzly Bear Management Plan for southwest Montana "will support keeping existing inventoried roadless areas in a roadless state and work with local groups and land managers to identify areas where roads could be reclaimed" (Montana FWP 2002)

While Waterton Lakes National Park may act as a refuge from some forms of threat (hunting, grazing) for some bears, its greater role may be as a source refugia for the regional bear population. It is, however, too small to be a source of bears for all of southwest Alberta and the presence of high intensity use areas like Crandell Mountain campground and the Red Rock Highway erode its already limited capacity to produce bears.

More than 44% of the grizzly bear recovery areas in the U.S. west (about 110,000 km^2) is currently protected from road construction either as designated wilderness or inventoried roadless area [15] (U.S. Forest Service 2000). Even if all of Waterton Lakes National Park were roadless or wilderness, it represents about 18% and 28%, respectively, of the area used by grizzly bears and of all public lands in the southwest Alberta management area.

In summary, this section identifies these critical issues:

1) road density in the north half of the green zone is greater than in the private land White Zone (1.90 versus 1.76 km/km^2),
2) road density in the south half of the green zone (0.75 km/km^2) exceeds by a factor of three the road density considered to be the ceiling (about 0.2 km/km^2) for long term grizzly bear population persistence (Craighead *et al.* 1995) and habitat occupation (Mattson 1993).
3) over 77% of the public lands in the north end of the green zone are within 500m of an access route. Few grizzly bears will occupy this area and even fewer will survive here until dramatic improvements in land management are made,

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[15] Defined as undeveloped areas typically exceeding 20 km^2 (2000 ha) or 8 mi^2 (5000 acres) in size.

4) the White Zone is highly fragmented and dissected by roads; only 14% of the area would meet security standards even if the minimum definition of 500m from an access route were used as the measure of secure (refer to Horejsi 2003 for discussion of why this is an inadequate measure). Grizzly bears cannot presently live securely here. And lastly,

5) the south half of the Green Zone, often viewed as the most secure part of the ecosystem, exceeds maximum allowable road density thresholds. Because it is topographically dissected by unsuitable habitat and access is concentrated at low elevations, as is suitable habitat, 43% of this area is still within 500m of an access route.

4.2.5 OFF ROAD VEHICLES

These quotes from a resolution passed in July 2003 by the National Association of Counties (U.S.) identified some of the threats associated with the ORV invasion and destruction of public lands (and private land), the likes of which have never been seen and were never anticipated when multiple use land policies evolved. “The growth in popularity and advances in all-terrain vehicle technology have resulted in increased resource impacts and user conflicts on public lands. The range and ability of off highway vehicles to access remote public lands have helped to spread noxious and invasive weeds, have resulted in conflicts with other recreational users, ranchers, hunters, wildlife and caused environmental damage.” “Motorized recreation poses one of the greatest threats to public land.” Southwest Alberta has not escaped this motorized invasion and its significant consequences for wildlife, including grizzly bears, and their habitat.

Off road vehicles, perhaps more than conventional vehicles, create and reinforce the zone of influence associated with roads and trails. They are poorly if at all muffled and therefore loud, often present a more erratic visual image (driving slowly, stopping, then resuming movement), have people activity around them, which results in human voices altering ambient sound levels, and leave odors foreign to the natural environment. All the impacts associated with traditional vehicles on roads and trails occur at an elevated level with ORVs.

Motorized use sufficient to affect bears has been defined as one vehicle per day for greater than or equal to 25% of the active bear season [16] (NCDE Access Technical Group 2002). Vehicle frequency of less than one vpd (a low use road) can result in a 35% average loss of

[16] Should be defined as March 15th through November 30th.

Habitat Effectiveness (HE) in low elevation habitats in spring but some bears suffered a 90 plus % loss of HE. Mid elevation loss of HE at moderate use levels (one to 10 vpd) ranged from an average of 10 to 22 % in spring, summer and fall with some bears experiencing up to 30% lost HE (Mace *et al.* 1999). In the context of broadcast ORV use of the extensive network of roads and trails in southwest Alberta, it is safe to say that no part of public lands in southwest Alberta escapes this impact.

While the impact of ORVs on public lands was already an issue 15 years ago, no appropriate measures have been implemented to effectively control their impact even though use and impacts have escalated sharply. The Castle River Access Management Plan, introduced in 1996 without the benefit of an Environmental Impact Statement or public hearings [17], allows ORV access to all major and most minor watersheds in southwest Alberta except four east-side drainages from township two south. The plan has no legal status and is based on voluntary compliance and although regulation exists to establish legal closure[18] the Alberta Department of Sustainable Resource Development has failed to act on the capability. Winter use, which has the potential to impact late denning and early den-emerging bears, is even more extensive than wheeled use and provides multiple access routes (n = 27 at least) to subalpine and alpine habitats in East Slopes Policy Prime Protection Zones (Zone 1) (Alberta SRD 1996)

ORV registration in Alberta (Alberta Transportation 2003b) in 2003 was 2.6 times greater than it was in 1987; in Lethbridge, the region's largest community, it has increased by 6.2 times (Figure 12, Appendix A). There has been a parallel increase in all small communities that box-in the southwest Alberta grizzly bear ecosystem (Figure 13, Appendix B). Increases in registration since 1987 range from 2.4 to 11.4 times and averages 4.9, almost twice that of the provincial average. There are now at least 600 registered ORVs in communities that are within one hour driving time of grizzly bear habitat. These numbers underestimate the true number of ORVs and impact of ORV users on grizzly bears and their habitat; the Insurance Bureau of Canada estimates that less than 50% of these kinds of vehicles are legally registered, indicating that, if proportional use of registered and illegal vehicles occurs on public land, many public land impacts result from illegal use of ORVs.

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[17] Alberta Natural Resources Services and Land and Forest Service state the plan was developed by "a group of recreational user associations, industry, and provincial government agencies" (Alberta SRD 1996).

[18] Much of the southwest Alberta public land is included in the Castle Special Management Area Forest Land Use Zone.

4.2.6 DENSITY OF HUMAN RESIDENCES

Human residence location and density are related to the status and viability of grizzly bear populations because contact between humans and their property and grizzly bears is the cause of almost all grizzly bear mortality outside of public land. The majority of this mortality occurs within one km of a road or some form of human occupied area, which includes residences. The latter projects a particularly lethal zone of influence for bears when livestock are kept and when residents are armed. Bears are commonly killed by people who feel or think they or their property are threatened but indirect impact on the bear population from management removal can be even more significant.

The number of residences in the area outside of major communities has increased over time. Residence density in the CNP corridor, a critical land use fracture in the ecological landscape, as well as in the White Zone outside the corridor, where residences are more dispersed, was examined. No grizzly bears home ranges occur entirely within the CNP corridor; the few bears that presently venture into the corridor are likely transients [19]. The presence of 4.36 residences/km^2 (Figure 14) is sufficient, particularly in combination with a highway and rail line, to create a nearly impassable filter for bears except for very limited exceptions. Adult female grizzly bears, including those accompanied by young, are particularly sensitive to displacement by vehicles (Gibeau and Herrero 1998) and humans (Mace *et al.* 1996); the CNP the corridor is a barrier to their movement, effectively isolating southwest Alberta from the bear population and bear habitat to the north (Proctor *et al.* 2002) [20].

Human residence density in the White Zone is almost nine times lower than in the CNP corridor (0.46 versus 4.36 residences/km^2) but this low level of residence is deceptive; it has not allowed sustained or consistent use of the area by the same grizzly bears. This is a reflection of human intolerance of bears and increasing numbers of humans, a landscape that is increasingly hostile to bears, [21] and a historical path of intervention management established by local conservation officers. Under these circumstances this apparent low residence density is far too

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[19] A bear is considered a transient if it is out of its normal home range or visits an area infrequently or has not yet established a home range.

[20] Proctor *et al.*(2002) obtained 220 DNA samples from grizzly bears both north and south of Hwy #3. Only two bears, both males, were “captured” on both sides of Hwy #3.

[21] As residential development expands habitat is broken into smaller fragments by road construction and there is a proliferation of attributes that are not “friendly” to bears, including free ranging dogs and cats and yard lights (Mitchell *et al.* 2002).

Horejsi & Haskins 2004

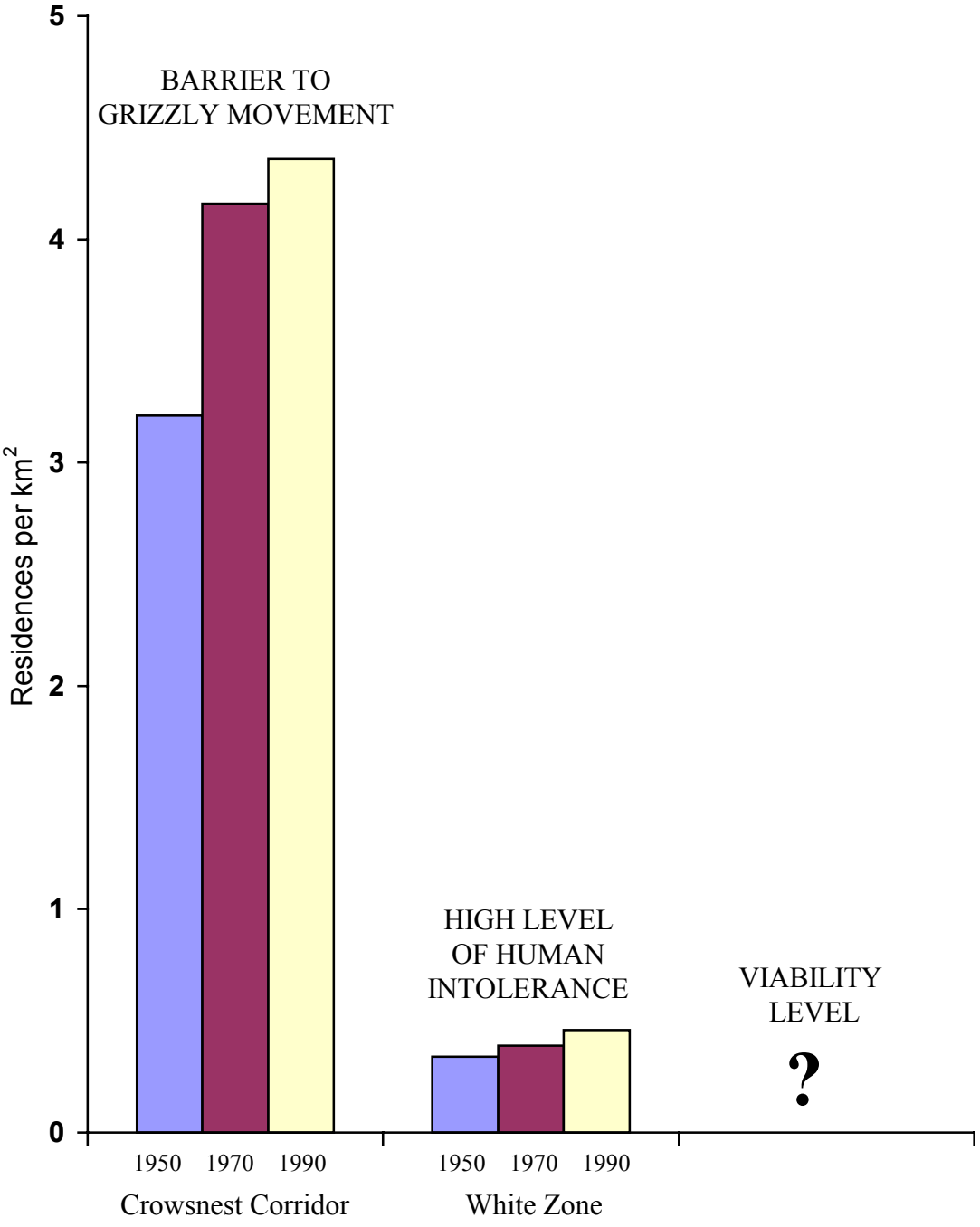

Figure 14. Human residence density relative to grizzly bear population viability in southwest Alberta.

high to ensure long term grizzly bear presence or make a positive contribution to local or regional bear population viability.

4.2.7 TOLERANCE ZONE

Assuming that less than two residences per quarter section (1.5 residences per km^2) could allow grizzly bear occupation under ideal circumstances [22] it is possible to envision a tolerance zone within the White Zone where there is contiguous land with fewer than two residences per quarter section (Figure 15). This amounts to 1488 quarter sections (964 km^2) in the White Zone including the CNP corridor. The location of the Tolerance Zone is encouraging; with progressive management similar to that seen on the East Front in Montana (immediately south of the Alberta study area) the habitat base for grizzly bears could be substantially broadened and play a dual role by greatly *increasing* the contribution of low density private property as a public land buffer while *decreasing* the resistance to and lethality of the tolerance zone for bears. This would certainly put to test the oft proclaimed "environmentalist" stance of the ranching and rural residential community but "put up or shut up" may be the way to go.

The tolerance zone also draws attention to the cumulative effects contribution of major highways in confining bears to the west end of the zone. Many residences are closely associated with main road access; this is particularly evident in Townships two to four Range 29 west of the 4th meridian and Townships five to seven Ranges two and three west of the 5th meridian. Even if bears are unable to reclaim some consistent and safe use of habitat east of the road system (particularly highways #6 and #5 and even highway #507 east of the Burmis - Beaver Mines line) access to the tolerance zone would still substantially improve habitat availability west of the main road system.

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[22] Ideal is defined as the absence of free ranging dogs, virtually immaculate sanitation of homesteads, no vulnerable livestock, and residents informed and open minded enough to tolerate relatively close proximity to bears. The latter may require the buy-out of select land owners who are simply "bad apples" when it comes to keeping grizzly bears alive and appear to be set in their view that their own interests must unequivocally override the public interest. Additionally, it would require management agencies like Sustainable Resource Development, and particularly Conservation Officers, "taking their finger off the trigger" in the sense that the presence and acceptance of grizzly bears would be given much greater consideration, bringing co-existence between land owners and bears into greater balance. The latter is most likely to be resolved by placing a full time bear management biologist in the region, similar to those in like situations in Montana.

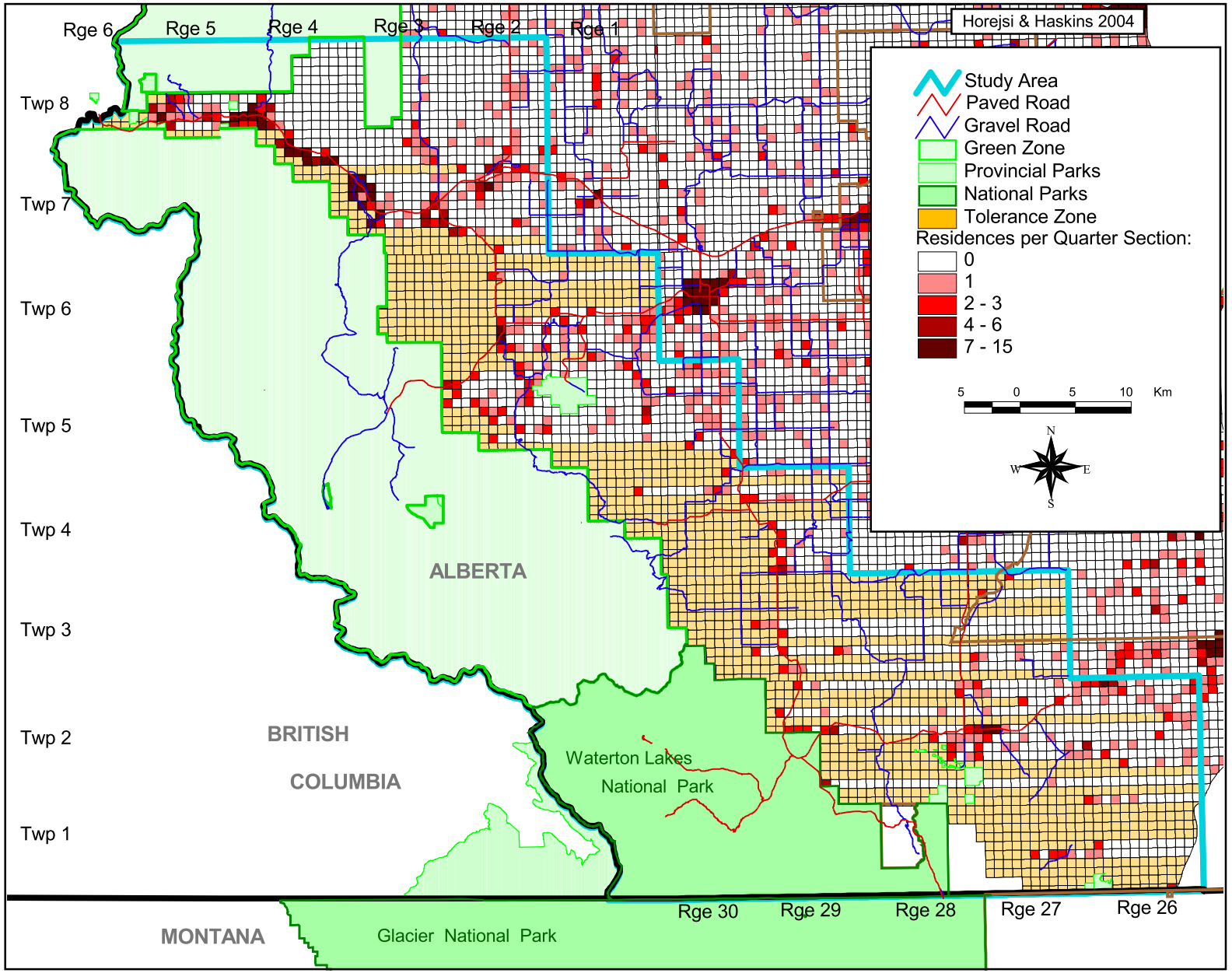

Figure 15. Possible tolerance zone represented by quarter sections with fewer than two residences (<1.5/km2).

4.2.8 OIL AND GAS EXPLORATION AND EXPLOITATION

There are unique aspects associated with the oil and gas industry that come into play when assessing the cumulative effects of human and industrial impacts on an ecosystem. The long term history of the industry in the southwest Alberta study area exemplifies these impacts.

The oil and gas industry is an issue in grizzly bear conservation because it:

a) depends heavily on access construction for seismic exploration and exploitation infrastructure in the form of roads, pits, drilling pads, and pipelines and power lines,

b) generates high levels of human presence associated with maintenance and monitoring of roads and facilities, and

c) imposes movement, noise and odors on the landscape. These are frequently related to motorized access on roads but often are associated with facility operations and can involve extensive helicopter overflights and multiple landing / takeoff events.

The impacts of the oil and gas industry manifest themselves through this access and the activities of those who exploit that access. There are, however, additional characteristics attached to the oil and gas industry that aggravate and are additive to these basic impacts. These compounding features include;

1) exploration access, via seismic line construction, that does not conform to the pattern of traditional access at low elevations and parallel to drainage features. Because the resource the industry seeks is not related to surface values [23], seismic roads and drilling access routinely breech subalpine and alpine habitats and ridge top locations [24], neutralizing any beneficial effects that topographical buffering might have on movement, sound and overviews. They routinely run directly up slope providing view-scapes either from below or above, and they routinely dissect landscapes from height of land to height of land at right angles to drainage direction, providing opportunities to observe or obstruct wildlife movement along drainages and in riparian habitats.

With few exceptions [25] wheeled motorized access that breeches subalpine and alpine habitats in southwest Alberta was constructed to facilitate exploration for oil and natural gas.

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[23] Unlike, for example, the timber industry.

[24] Seismic disturbance continues in the Castle region; it is presently helicopter dependent.

[25] In August 2003 an important exception was made by the present day equivalent of the Alberta Forest Service, now known as Sustainable Resource Development, when they built at least one major access route into the alpine during efforts to suppress the Lost Creek wildfire.

All surface activity associated with this industry on public land is authorized by the Alberta Forest Service without the benefit of environmental impact assessment [26]. In the southwest Alberta study area every single major tributary drainage has lost its roadless status as a consequence of this kind of activity [27].

2) because the resource the industry seeks is not perishable, access can be and is maintained over many decades as markets for oil and gas change and develop; for example, the recent rush to exploit coal bed methane stands to extend access life by up to 50 years over vast parts of the landscape.

3) exploration access and exploitation development is progressive and cumulative and, on a field wide basis, can extend over a century (Figure16) (IHS Accumap 2003). For example, the first wells in southwest Alberta were drilled in the 1901-1910 period, but drilling continues in the region with 17 wells being drilled between January 2001 and May 2003. As energy marketing, consumption and deregulation advance, the industry produces a so-far endless expansion of roads and drilling most often associated with preceding efforts (Figure 17). This step-out activity results in full field development that has not yet peaked in the foothills of southwest Alberta. The 1951-60 decade saw a major expansion of the industry in southwest Alberta, spurred by growing marketing of natural gas (as opposed to oil) and, in 2000 and 2001, the first coal bed methane wells were drilled just north of the study area, portending an extended and intensified aggravation of landscape fragmentation and degraded habitat effectiveness. Neither of these scenarios had been predicted just ten years prior to their appearance and neither have been reflected in habitat or wildlife management practices.

4) motorized access, once in place, can be reactivated as new drilling and extraction technology appears, as markets change, as governments increase subsidies and incentives to the industry, as companies, their strategies or their management or ownership change, or as the regulatory environment changes. For example, a well first drilled in 1957 (06-17-006-02w5) was

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[26] Lease acquisition and drilling and extractions permits are handled by the Alberta Energy and Utilities Board. There is no coordination with land management departments. I estimate that not more than one in 1000 permits is the subject of an environmental impact assessment.

[27] This practice is so pervasive in Alberta and British Columbia that thousands of drainages has lost roadless characteristics and ecosystem related values associated with intact landscapes.

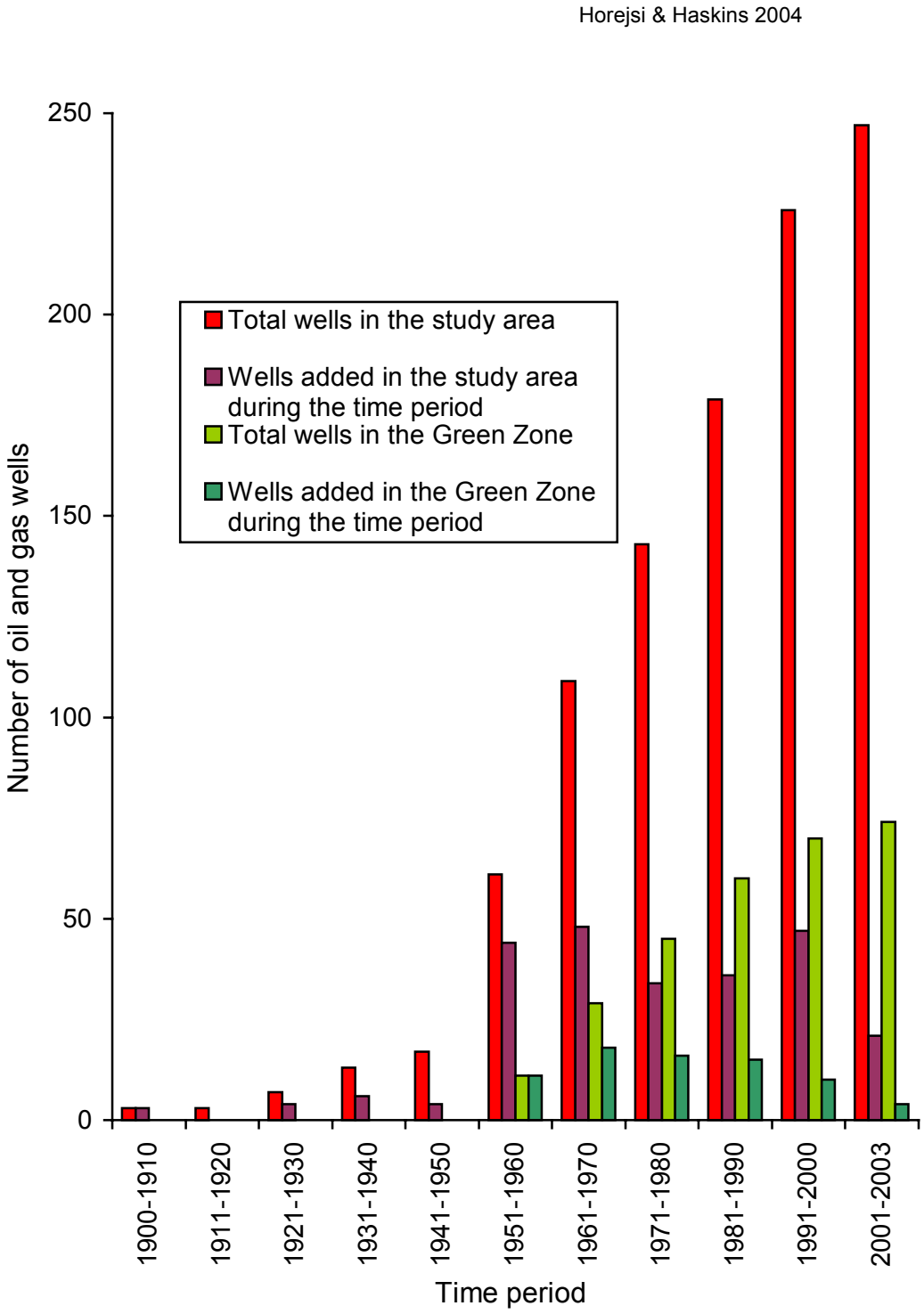

Figure 16. Number of oil and gas wells in the study area, 1900-2003. Note the most recent period includes only three years.

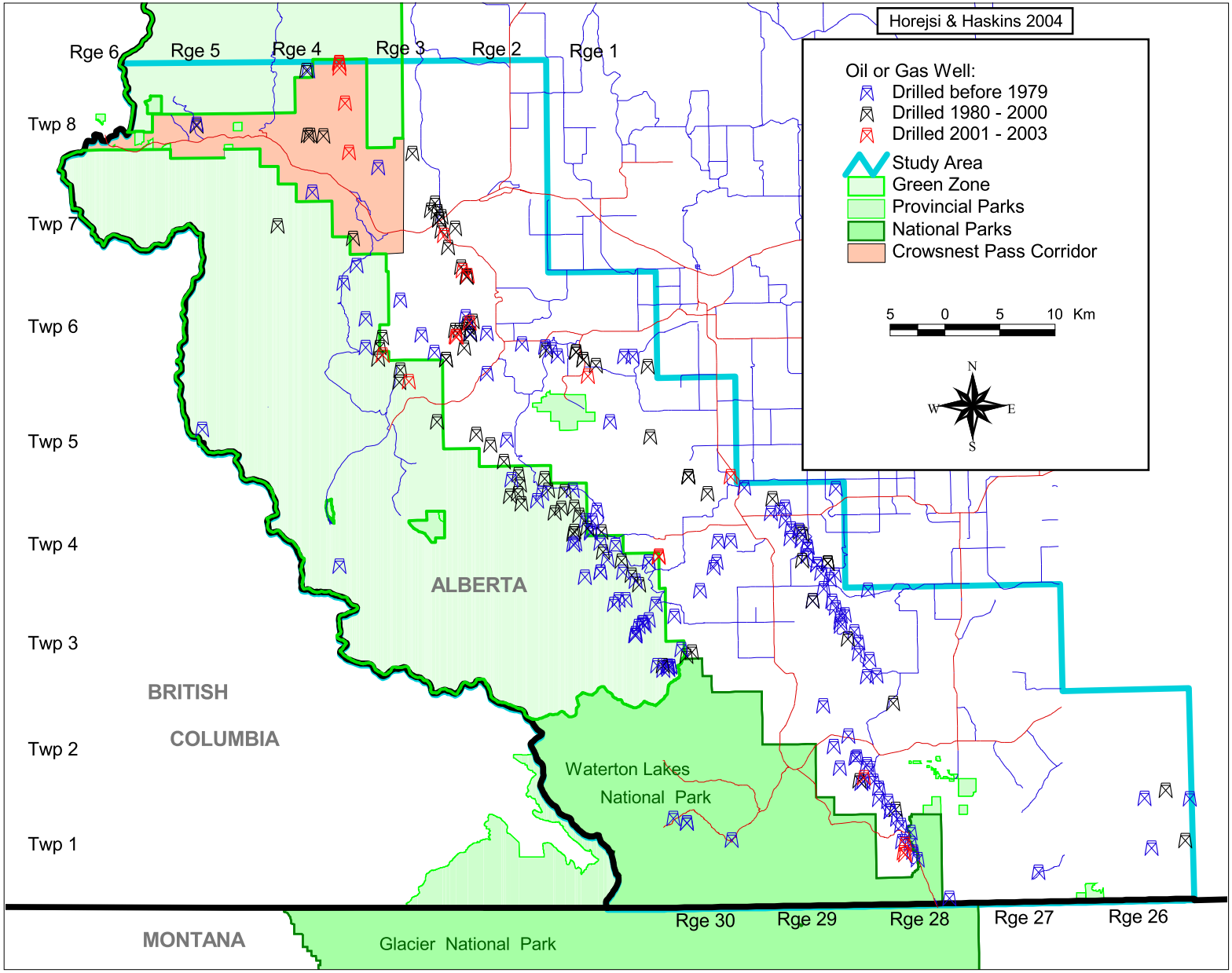

Figure 17. Location of oil, gas and non producing wells in southwest Alberta as of 2003.

recently re-drilled in 2002. Bigger, heavier and more equipment is commonly in use today relative to historical deployment, and roads, pipelines and compression and drilling locations often need to be upgraded.

5) access buildup or add-on has also been an expanding and occupying presence in southwest Alberta. For example, in 1951 there was not a single well in the mountainous parts of the Green Zone but the presence of drilling activity just to the east set the stage for one of the most intensive and long lasting energy related occupations of a mountain ecosystem yet seen in Alberta (Figure 17). There have now been 68 wells drilled in this area.

A chilling aspect of this scenario in Alberta is the interaction of the oil and gas industry with the regulatory process, leading to exploitation by the industry of what was widely recognized as some of the best historical bighorn sheep, elk, mountain goat and grizzly bear habitat in North America (Russell 1972).

6) access quality. The oil and gas industry builds access to maximum engineering standards. They recognize motorized access on many parts of the road system will be required for more than half a century, they have step-out expectations built on historical performance, they receive subsidies on costs, and equipment is large and heavy; these are all factors that lead to construction of wide, durable surface all-weather roads. These roads are attractive to other motorized users and governments that promote “development.” Both parties readily employ as justification the perception that certain segments of society will exploit the road system immediately and others view it as a stepping stone to even greater exploitation. The roads and their advocates create perhaps the greatest environmental impact the industry has; a “hardened,” not just figuratively, carved-in-stone high quality and long lived fracturing of a landscape that inherently entrenches and compounds cumulative effects.

These entrenched impacts are aggravated by the spikes of human activity associated with access and location construction, drilling, and construction of development infrastructure. It took an average of 143 days to drill a well (n=25) in southwest Alberta between 1990 and 2003. This phase of oil and gas activity can generate traffic levels that number in the 10's of vehicles per hour. Additionally, it can produce post drilling / servicing vehicle use of up to four vehicles per daylight hour that can be prolonged for years (Horejsi and Hornbeck 1987).

4.2.9 LIVESTOCK AND GRAZING

Domestic livestock and their owners are a source of consistent and often lethal conflict with grizzly bears in southwest Alberta. Additionally, livestock can have substantial impact on grizzly bear habitat.

Grizzly bear management and conservation issues associated with livestock and their owners in southwest Alberta are many but they fall into two main categories;

1) grizzly bears on private land, and

2) livestock and their owners on public land.

The capture and relocation of 109 grizzly bears in southwest Alberta (1974-2002) on a land base of 3100 km^2, less than one percent of the occupied grizzly bear habitat in Alberta (Nagy and Gunson 1990; provincial land only), represents a historical rate of management actions against grizzly bears 64 times greater than occurred in the remainder of the province. The intensity of management actions in southwest Alberta worsened between 1980-1992, when it was 48 times that seen province wide, to 112 times the province wide rate in the 1993-2002 period. This indicates that southwest Alberta is an area begging for new direction and for means and resources to reduce the intensity and negative impact on bears of existing conflict management.

Table 9. Livestock related captures and relocations of grizzly bears according to land ownership zone, 1993 - 2002. Data from: Alberta SRD 2003c.

	Number of Conflicts		
Where	Wildlife mgmt unit	Livestock / Total	% livestock
Green Zone	400	3 / 40	8
White Zone	300 + 302	33 / 40	82
CNP Corridor	303	4 / 40	10

In the ten most recent years (1993 - 2002) 92% of management capture actions against grizzly bears in the White Zone and CNP Corridor have taken place because of livestock and livestock related issues. While these areas are a danger zone for many of the grizzly bears that use the management area I have, perhaps optimistically, labeled parts of the White Zone the Tolerance Zone. This optimism reflects the critical role this area plays in deciding the future of the grizzly bear population and the recovery of the entire ecosystem. In this area livestock are predictably present, are often concentrated, are not uncommonly fed forages attractive to bears, and give birth to their young. The intensity of livestock use and presence, along with storage of

livestock feeds [28], creates a strong attraction to some bears and while not all bears present will exploit these attractants, almost all are perceived by livestock owners to be a threat. This is an issue that has created a significant drain on the bear population and presents a stumbling block to wildlife managers and conservation officers. The recent intensity of this conflict is reflected in these numbers; 61 grizzly bears were captured and relocated (23 females, 38 males), of which 44 (18 females, 24 males, two unknown) had been moved out of the ecosystem and have been lost to the population. These ten years have been a period of particularly aggressive actions against grizzly bears (Figure 18) in this part of Alberta although there have been earlier years in which large numbers of grizzly bears have also been removed from the ecosystem (see Table 10, Appendix B).

In 1997 the Southwest Alberta Grizzly Action Strategy (SWAGS) was introduced (Alberta NRS 1997b; Alberta NRS 1998); since 1998 an effort has been made to keep bears in the ecosystem and 19 captures (five females, 14 males) have led to bears being moved within the ecosystem. This is proving to be problematic given the scarcity of secure habitat in the area, the high mobility of male bears, and a history of constant relocations and suspected in-migration, all of which can be predicted to break down the stability of inter bear relationships and result in social turmoil. It is reasonable to expect that one result of this turmoil has been increased and more erratic movements and distribution, leading to more bears and/or more bear visitation, and subsequently more conflict, in the White Zone.

Grazing by livestock on public land is another management issue in southwest Alberta. At present it involves primarily bear habitat-related impacts resulting from livestock use (Horejsi 2003). Relatively few direct conflicts between livestock [29] and their owners occur in the Green Zone.

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[28] In recent years some operators have increased the use of pellets containing molasses. These may be particularly appealing to bears.

[29] Includes cattle and sheep and grain and forage feeders and storage for these animals.

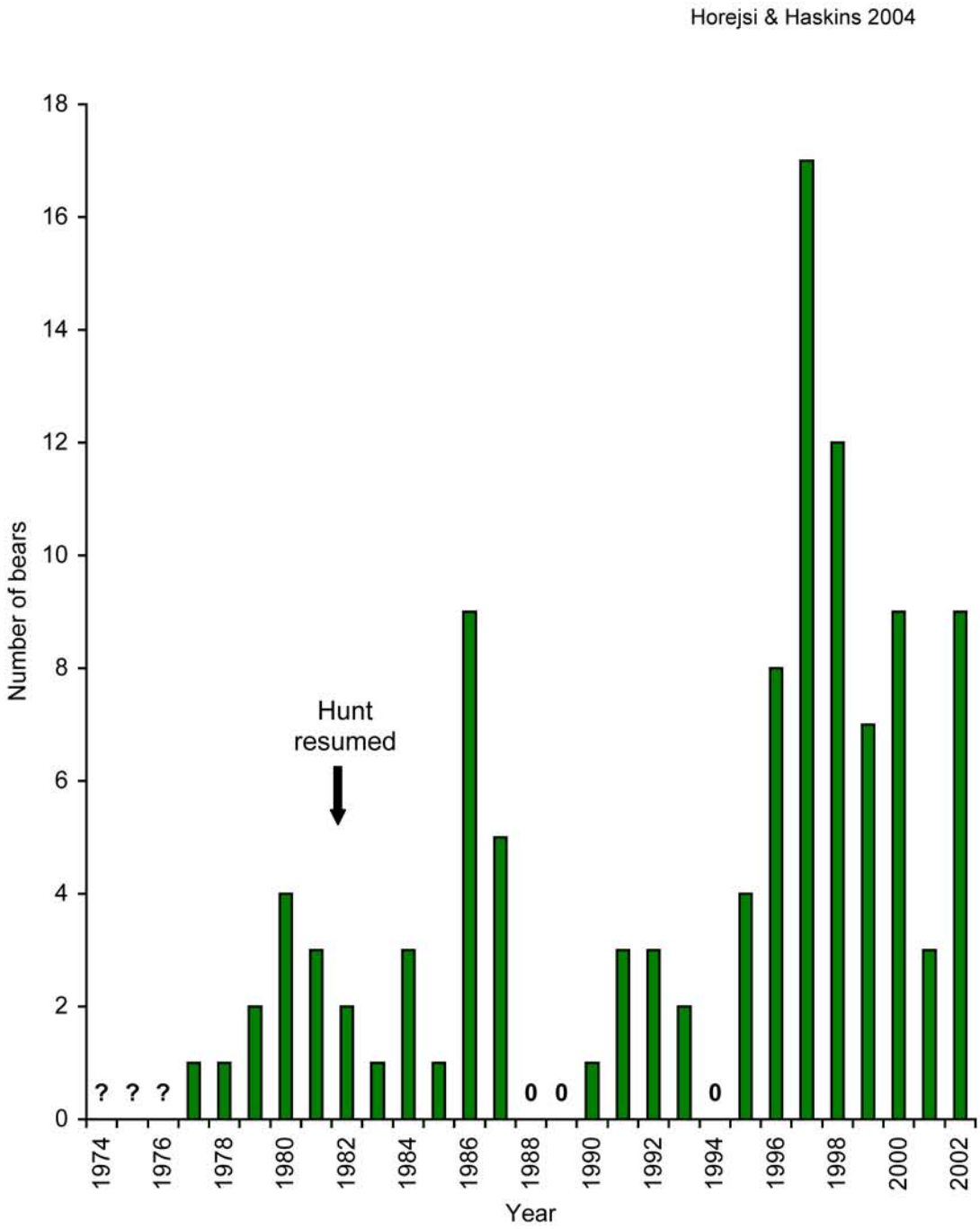

Figure 18. Relocations of grizzly bears (n=109) in southwest Alberta (WMUs 300, 100, 302, 400 and 303), 1977-2002. Included are relocations to (n=1) and within (n=22) the area.
Data from: Alberta NRS 1997 and Alberta SRD 2003c.

There were seven active grazing allotments in the southwest Alberta grizzly bear management area in 2002 plus the public lands administered Poll Haven grazing lease east of Waterton Lakes National Park along the international boundary (Figure 19, Appendix A).

Most of the cattle that utilize these allotments and the Poll Haven lease belong to people who reside immediately east of the Green Zone or north of the Poll Haven. In recent years about 1570 adult cattle have been grazed annually on Green Zone public land allotments and another 635 animals use the Poll Haven Lease (Table 11). The number of cattle using grizzly bear habitat in southwest Alberta represents a minuscule fraction of the regional livestock population (Table 12).

The overall presence of livestock on public lands is much greater than records indicate; a number of calves equal to the number of adults occupy the allotment but they are not included in counts of animals (Table 11). One adult female of 1000 lbs (454 kg) grazing for one month is considered one Animal Unit Month (AUM). The provincial government uses a rule of thumb that one animal requires 455 kg of dry weight forage per month, or about 15 kg per day. A female grazing with a calf for a month, even in September when that calf may be eight months old, is still calculated as only one AUM.

Table 11. Number and class of cattle permitted, and approximate period of use, 2002, for southwest Alberta grazing allotments and the Poll Haven lease.

Allotment	Number of animals	Number of permit holders[1]	Class of animal[2]	Period of use
Southend	430	10	C + C + B	June 15 - Oct. 1
Castle	863	18	C + C + B + Y	June 13 - Oct. 7
Mill Creek	60	2	C + C + B	July 1 - Oct. 15
Byron Ck	64	2	C + C + B	June 22 - Sept. 22
York Ck	61	2	C + C + B	June 20 - Sept. 15
Star Creek	61	1	C + C	July 15 - Sept. 1
Jackson Ck	31	1	C + C + B	July 1 - Sept. 30
Poll Haven[3]	635	?	?	June 1 - Oct. 1

GREEN ZONE:	TOTAL ADULT ANIMALS COUNTED	= 1083
	Total yearlings counted	= 487
	UNCOUNTED Calves	= 1083
	TOTAL ANIMALS	= 2653
POLL HAVEN:	TOTAL adult animals COUNTED	= 635
	UNCOUNTED Calves	= 635
	TOTAL ANIMALS	= 1270

[1] From Alberta Sustainable Resources Public Lands records.

[2] C + C = Cows and calves; B = Bull; Y = Yearling

[3] Alberta Sustainable Resources, Public lands, e-mail, 7 November 2003, reported 2539 AUMs for a four month season. I assumed cow and calves were the class of stock although the latter information was withheld by the Public Lands Division.

Animals that graze public land in the southwest Alberta grizzly bear ecosystem constitute less than 1.5% of regional cattle numbers (Table 12).

Table 12. Cattle numbers grazing in the southwest Alberta grizzly bear management area relative to the cattle population in Cardston County and Municipal District of Pincher Creek[1], 2001.

Region	Cows + Calves[2]	Cattle in grizzly bear Habitat as a % of column two
Alberta South	2,293,343	0.3%
Cardston County	100,929	-
MD of Pincher Creek	123,882	-
TOTAL, above two districts	224,811	1.3%
In Grizzly Bear ecosystem	4,060[3]	-

[1] From Alberta Agriculture, Food and Rural Development, 2001 Census of Agriculture, Southern Alberta.
[2] Less than 2% are dairy animals.
[3] Includes the Poll Haven Grazing Lease.

Grazing pressure on bear habitat is virtually absent from the grazing management agenda although it is routinely stated that 50% of forage will be allocated to wildlife, which is usually identified as grazing / browsing animals like deer, elk, moose and bighorn sheep. The requirements of bears however, are substantially different and there is no evidence they have been incorporated into grazing plans. Bears and other wildlife (and cattle) have common requirements for grass, forbs and sedges for food but bears also require shrubs for security (cover) and for forage in the form of fruit. They can benefit considerably from an abundance of wild ungulates which can lead to winter killed carcasses that become available to bears in late winter and spring and to newborn young that can be preyed upon in spring and early summer. The impact of cattle on these bear habitat attributes has not been incorporated into land use plans.

Grazing pressure on the Southend and Castle allotments was astonishingly high just over half a century ago (Figures 20 and 21, Appendix A). Between 1947 and 1955 (in the Southend) and 1965 (in the Castle) it had declined by 65 and 60%, respectively. The limited evidence available suggests that some plant communities of interest to traditional grazing constituents had undergone a more or less permanent transition resulting from historical over grazing and present continuing use. “It appears that the past management practices have altered the community

structure so that the desired plant community is now unlikely" (Willougby 1997:). It remains unclear how present day carrying capacity for traditional livestock use has been established but in the Carbondale distribution unit of the Castle allotment percent use is still 120% of calculated carrying capacity (Willoughby 1997b). In the Southend allotment carrying capacity was increased [30] in 1991 from 1400 to 2500 AUMs (Alberta SRD 1998) even though the plan acknowledges grizzly bear "summer range" is present.

Carrying capacity estimates for Alberta public lands have not considered the needs of bears. Combined with uncertainty about carrying capacity for wild ungulates and cattle, and the production-depressing effects of extended drought, the issue of utilization or over-utilization by cattle is a question in need of an answer.

"Ongoing drought conditions in southwest Alberta have seriously reduced forage yield in the foothills region"(Alberta SRD 2002). Albertas Public Lands Division distributed a generalized graph with this quote showing grass yield declining from an average of 1570 kg/ha in 1991-93 to just 350 kg/ha in 2001. In this same note they caution "value of rangeland for wildlife is reduced as protective cover and food supply is diminished." While this appears to be a generic presentation there is no evidence that cautions about drought related declines in productivity of shrubs, grasses and forbs have been taken seriously and applied to stocking rates on public land. There exist suggestions [31] that a positive relationship exists between May - September precipitation and grass and total forage production (Willoughby and Alexander 1998). The inescapable conclusion is that overutilization would intensify the decline in production and impacts on bears and their habitat will follow the same path.

From a bear distribution perspective it is probable that habitat effectiveness on public land has been depressed, perhaps very substantially, by cattle grazing. This may be partially

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[30] As is revealed in Figure 19, utilization apparently did not increase in response to this markup in carrying capacity.

[31] The reference is to Dutch Creek, north of the Crowsnest Pass Corridor. Grass and forb production in an exclosure that excluded livestock, but not necessarily wild ungulates, ranged from 790 ka/ha to 2446 kg/ha and averaged 1682 kg/ha annually. The implications for grizzly bears and other wildlife of this kind of annual variation in production in the face of consistent grazing allocations and utilization is not considered in provincial livestock grazing strategies.

responsible for initiating and aggravating displacement of bears from public to private lands on the east side of the ecosystem, an area where intolerance leading to lethal conflicts with and removal of bears are major factors in bear population viability.

The high level of conflict between people and bears at the transition between public land and the (potential) tolerance zone reflects;

1) the small size of the public land management area,

2) the fragmented and degraded status of the public land base of the ecosystem, and

3) the absence of a more stable adult bear population, and

4) poor management of attractants in the Tolerance Zone.

4.2.10 LOGGING VERSUS FOREST MANAGEMENT?

Data necessary to measure in detail the impact and activities of the timber industry on the forest and ecosystems of the study area were not available.[32] To my knowledge an environmental impact statement addressing this issue has not been completed by government or industry. It is known that logging impacts important to bears have occurred on a regional scale for over 50 years (Cormack 1956; Sheppard *et al.* 2002) and have included habitat alteration leading to substantial low productivity second growth stand creation and access proliferation, each with their attendant caste of ecological problems (Figure 22).

Maintaining ecological integrity means retaining ecological processes, even in managed forests, and ensuring that these processes and the components of the ecosystem (biological diversity) do not deviate from the range of natural variation exhibited before human intervention, in this case in the form of clearcut logging and supporting road construction. Using this definition as a reference point, the southwest Alberta area appears to have undergone widespread and, in some cases, intense habitat degradation.

Logging impacts bears via ecological and behavioral processes. These impacts stem from the interaction between roads, the vegetation and plant communities that are destroyed and those that replace them, the time and spatial scale at which these events occur, and the responses of

[32] Three requests were made to government and government sanctioned organizations for digital copies of the Alberta Vegetation Inventory for the study area. None were successful.

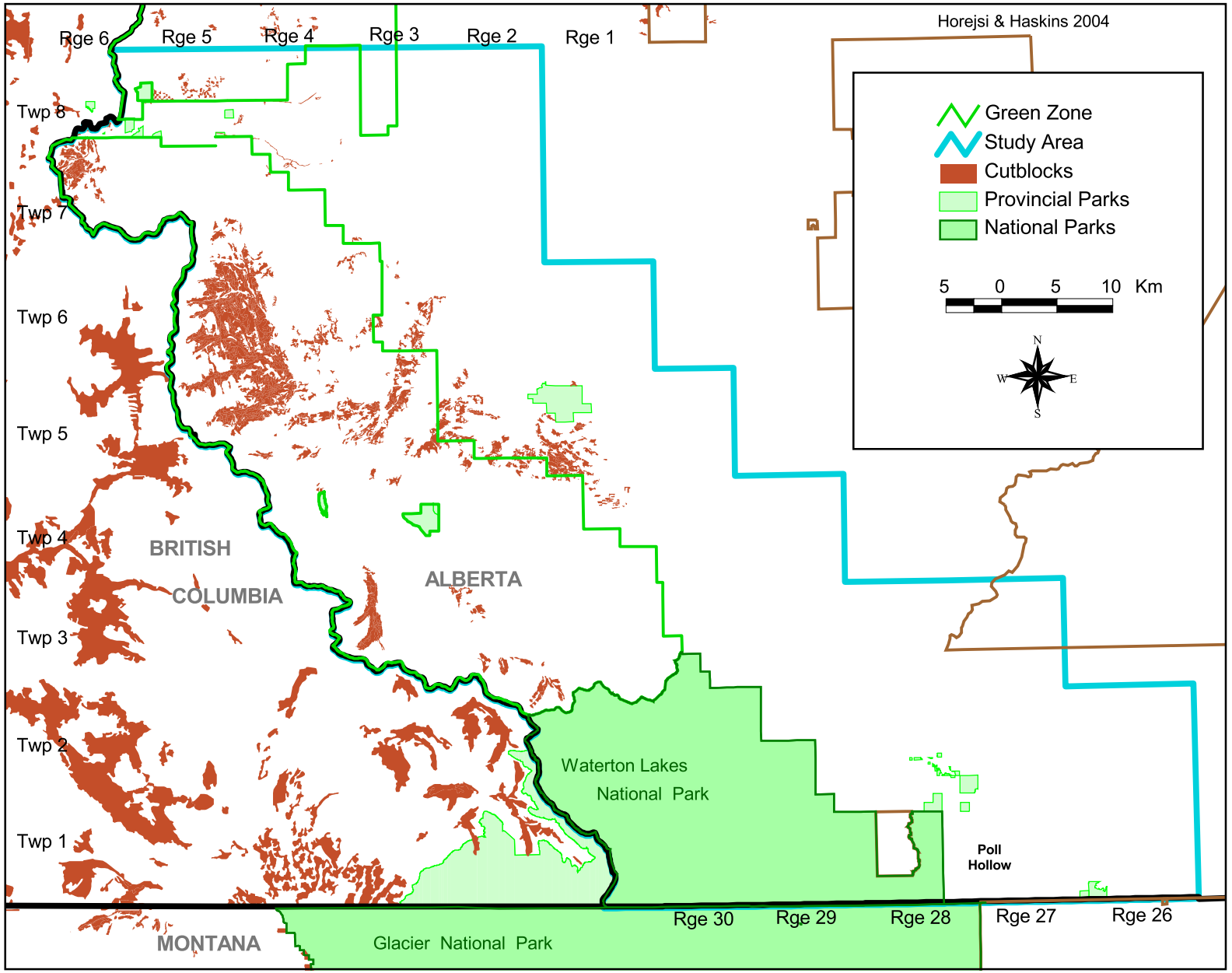

Figure 22. The logged landscape in the study area, 2002.

humans and bears to these changes. Some of the issues are:

1. Typical cutblocks become "open" habitats; areas without the security provided by a vegetation screen can discourage bear use of the cut area and an ecological zone of impact that extends beyond the physical periphery of the cut,
2. Open areas regularly attract more human use and activity than forested areas,
3. Most logging is road dependent and roads result in an increase in the number of human users,
4. Clearcuts attract livestock which impact vegetation in the cut and nearby forest stands,
5. Bears seasonally require thermal relief which is provided by vegetation overstory,
6. Originally present shade-tolerant forage plants are negatively affected by forest crown elimination / reduction, and their recovery or replacement by shade intolerant plants may be intentionally suppressed with herbicides,
7. Logging debris (slash) impairs a bear's ability to move efficiently, making travel difficult and physically obstructing bear access; females with cubs are particularly susceptible,
8. Early stages of recovery of cutover areas can be accompanied by dense tree and tall shrub regeneration which physically discourage bear use, and
9. As succession advances, dense tree and shrub regeneration competitively excludes the growth of shade-intolerant forage plants often touted as substitutes for original plant loss.

"Once a decision is made to road and silviculturally treat stands, i.e., log areas, in a previously unroaded area that area will subsequently be used significantly less by female grizzly bears than expected. Once precise total road densities reach 2 mi/mi^2, use by all age classes except subadult male bears is significantly less than expected" (U. S. Fish and Wildlife Service 1993b).

The cumulative effects [33] of changes in bear habitat resulting from clearcutting and associated industrial impacts, as evidence from road impacts alone would indicate, degrade habitat

[33] Cumulative effects analysis indicates that most human impacts on bears and their habitat are additive, that is, if one impact exists, another worsens the situation. For a broader analysis than just that considering clearcutting, see Suring et al. 1998.

effectiveness and compound the role logging plays in determining bear population viability.

In ecosystems accessible to humans with firearms, both black and grizzly bears rely heavily on vegetation cover for security. There are few, if any, bears in North America whose behavioral profile does not include some exposure to humans and the extensive access system in southwest Alberta forces bears to depend on forests for cover. As humans escalate their use of bear habitat, reliance by bears on forests for security intensifies. Forests provide grizzly bears with security from observation, sound, and probably scent. As well, bears seek forests for relief from heat and sunshine, both of which can cause thermal discomfort. While it is clear that grizzly bears use open (unforested) habitats (Larsen and Markel 1989; Mattson 1997) it appears they do so successfully only if a high quality concentrated food source is available, there is no or very little road access, human users are unarmed, and cumulative human disturbance is minimal.

Much of southwest Alberta public land is covered by lodgepole pine forests and the Lost Creek wildfire of 2003 will increase the presence of this forest type. Grizzly bears have shown great variation in seasonal, annual and individual use of lodgepole pine forests. Major grizzly bear activities - grazing, root digging, invertebrate feeding - have been associated with habitat dominated by lodgepole pine, including mosaics of lodgepole pine and non-forest and wet habitat types. Within lodgepole pine cover types in Yellowstone National Park grizzly bears showed strong avoidance of open habitats as bedding sites, using these areas primarily for travel (i.e., brief exposure) (Mattson 1997).

We should expect that grizzly bears, given unrestricted options, would select for low elevation and riparian forest habitats (Aune 1994) during much of the year however unimpeded access to these habitats is not available in southwest Alberta. Additionally, in ecosystems like southwest Alberta, a high level of mortality has limited population recovery [34] and eliminated bears, particularly adult females, that would otherwise utilize these habitats.

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[34] There is common local belief that the number of bears has increased since the 1950's when persecution of bears was widespread and intense. There is little factual evidence of this "recovery", however it seems reasonable given 1) evolution in the public's understanding of the grizzly bear as a threatened or endangered animal, resulting in 2) greater scrutiny of local bear conflicts by the public combined with local awareness of being scrutinized, and 3) endangered species protection for the grizzly bear in the U.S.

Part of the value of forested habitats is the occurrence of unforested and open canopy microsites (McCarty 2001) within larger forest stands which provide security for bears using these "hot spots." Use of these microsites is difficult to detect without very intensive and fine-scale study. Telemetry evidence that bears use forested habitats (McLellan 1991; Mattson 1997; Waller and Mace 1997), often intensively, reflects the presence of microsites as well as the interaction of a complex set of variables including social, foraging, security and selection versus availability factors. It is common to find 50% or more of radio telemetry relocations (Waller and Mace 1997) in habitats described as forested.

Telemetry indicates that if bears are not directly inside forest stands, they routinely confine their activities to the near vicinity of forest stands. For example bears during four seasons (early spring, spring, summer and autumn) in six habitat types [35] were located in every season closer to coniferous forest cover than to any other habitat type. The average distance of radio-relocated bears to coniferous forest was only 67 m. The *maximum* average distance to coniferous forest for female bears was 54 m (adult females in spring); all other averages were below 50 m and eight were below 40 m. In contrast, the average distance between locations for each class of bear and cutblocks was 438 m (adult males in summer); for female groups the lowest average was 448 m and eight of 12 seasonal average-distance-to-cutblock measures were >550 m (Mace and Waller 1997). This kind of avoidance of cutover areas makes logging history in southwest Alberta a grizzly bear conservation issue.

Grizzly bears respond to human non motorized activity be seeking security in forest habitats during daytime and evening (Haroldson and Mattson 1985); they are also more likely to occupy forest edge than open habitat during these times of the day. At night they appear to be more inclined to occupy open habitats (Schleyer *et al.* 1984). The significance of these results is that the location and extent of forest cover is important to grizzly bear occupation and utilization of a landscape [36].

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[35] Habitat types identified were non-vegetated/grass forb, shrub, coniferous forest, avalanche chute, slabrock, and cutting unit.

[36] Other factors such as degree of exposure or habituation to humans, seasonal foraging strategy, and presence of high quality food sources, for example, may also be important to daily and seasonal movements and location, but the presence of security in the form of forest cover remains relatively constant.

As (or if) regeneration of cutover areas proceeds, high stem counts and dense crown closure reduce or eliminate the penetration of sunlight, moisture and air (temperature) to ground level. If site quality is poor, cover may take much longer to regenerate, or conversely, if regeneration is more rapid, competitive exclusion of understory vegetation by crown closure (Greenough and Kurz 1996; Hamilton 1996) may be more rapid and prolonged. The widespread distribution of second-growth stands resulting from extensive clearcutting creates an ever expanding network of habitats which are not attractive or only marginally attractive to bears. These are conditions, evident in the Castle and Carbondale drainages, that reduce options for bears and limit them to a narrowing range of habitats and habitat quality.

Clearcut logging as most commonly practiced is distinctive in that it produces sharp contrast ecotones and substantial physical and ecological discontinuity of habitat that results in fragmentation of the landscape with subsequent influence on the movement of wild and domestic animals as well as their choice of remaining habitat patches (Miller *et al.* 1996). But it is in conjunction with road access that clearcut logging precipitates a substantial escalation of cumulative effects on bear habitat and populations.

Access routes that are associated with logging have not been distinguished from others in the southwest Alberta study area. However, the long history of incremental and cumulative effects that have occurred in the area can be expected to parallel those measured in similar situations elsewhere. Clearcut logging [37] in combination with roads, over a 40-year history of logging, produced a mean road density of 2.5 km/km^2, very much like that found in parts of southwest Alberta; but it also increased the number of habitat patches (+158%), decreased habitat patch size (-62%), reduced interior patch size from 17.7 to 15.7 ha, and reduced mean perimeter of patches by 50% (Reed *et al.* 1996).

The greatest level of security for bears is provided by intact natural forest stands that encompass riparian areas, travel routes, and small micro-sites or lie adjacent to important feeding habitats such as avalanche chutes.

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[37] The study area in Wyoming was 302 km^2 in size; 32.6 km^2 had been logged, equal to 16% of the log-able area. 32% of the area was protected for stream, slope, wilderness purposes or was not forested.

Few such areas remain in southwest Alberta; as a consequence, remaining forested areas increase in value and become “stepping stones” for continued use of surrounding habitats by bears. The location, extent, and spatial arrangement of forest cutting are therefore important issues in maintaining bear occupancy of the landscape.

Forest management that does not include maintaining a landscape with ecologically and behaviorally functional forested options is a threat to existing forest remnants; removal of some of these remnants by the Lost Creek wildfire in the north Green Zone, and removal of even more stands in conjunction with salvage logging, is an example of ecological damage that can be caused by short sighted and single-minded management.

4.2.11 WESTCASTLE REAL ESTATE AND SKI HILL DEVELOPMENT

A development like Westcastle Real Estate and Ski Hill Area produces a multi pronged impact on grizzly bears and their habitat. Displacement and decline in habitat effectiveness within an extended ecological footprint is discussed below; the other side of the coin is increased mortality of bears that venture into a developments zone of influence. These are most often sub adult bears but occasionally adult females will enter the zone of influence to seek refuge from other bears or because they are attracted into the zone by poor human sanitation. Normal but unpredictable-in-time circumstances such as berry crop failure and abnormal events such as disrupted social order in the local bear population brought on by management removals and relocations will aggravate this situation.

The impact of major tourist facilities has been associated with a six km zone of influence in which mortality rate of grizzly bears was shown to be nine times and two and one-half times greater than mortality rate of bears in back country situations and secondary road three-km buffer zones, respectively (Mattson and Knight 1991). As is the case across grizzly bear range in North America most mortality around developments like the Westcastle Real Estate and Ski Hill Development (RE&SD) results from lethal resolution of human - bear conflict either by wildlife and land managers or residents.

In the valley of the north fork of the Flathead river not far from the southwest Alberta ecosystem, radio collared adult male and female grizzly bears almost entirely avoided a core study area (140 km^2 of which 66 km^2 was privately owned) up to seven km wide; "the lack of adult radio locations within the ...(core study area) ... precluded statistical analyses of adult use of the area" (Kehoe 1995). Subadult bears used the area but they also showed some selection against it. This area resembles the West Castle valley, although it is not as confined topographically and is occupied by relatively widely dispersed residences, outbuildings and some commercial outlets. A two-km buffer extending beyond the human influence zone was used more than expected by adult bears, indicating they were avoiding human presence. No adult bear was located on private property either during daylight or night time hours.

Cumulative effects analysis used by the U.S. Forest Service to evaluate the effects of human activity on brown bears paid particular attention to riparian habitats. These habitats were rated the highest capability of all habitat in spring and summer (Suring *et al.* 1998). In the Westcastle drainage riparian habitat is heavily impacted by roads, random camping, and the Westcastle Real Estate and Ski Hill Development.

Habitat effectiveness (HE) in two zones of impact (1 - 1.6 km and 1.6 - 3.2 km) in forested habitat around human activities associated with urban areas like the Westcastle was reduced by 90% and 80% in the two zones, respectively. In non cover habitats, the 80% decline in HE extended 6.4 km from the development. Human impacts were additive with an 80% reduction in HE resulting from motorized high use linear features (roads) and a 70% reduction in HE due to camp presence (Suring *et al.* 1998). The ecological footprint of the Westcastle development is also aggravated by a relatively high use road (see Figure 7), widespread ORV use and randomly located ORV user and hunting camps nearby.

Habitat effectiveness within 3.2 km of the Westcastle development has been reduced by 90% based on coefficients of habitat effectiveness used by Suring *et al.* (1998; Table 4):

Unimpaired HE = 1.0

20% loss of HE for Westcastle townsite, and

80% loss for high use linear motorized access = 1.0 x 0.2 x 0.8 = 0.16

plus 60% additive loss for presence of random site camping =

0.16 x 0.6 = 0.096

In the absence of site specific knowledge of bear distribution and utilization, this model indicates near total collapse of HE within three to four km of in the Westcastle Real Estate and Ski Hill Development area.

The 6.4 km zone of impact used by Suring *et al.* (1998) is very close to the six-km zone of impact associated with recreational service developments (Mattson *et al.* 1987). The latter documented complex patterns of habitat use around developments with female bears that did venture within three km of a development in spring, summer and fall using less productive habitat than was widely available. Night time use was not monitored and could produce further conflict situations with humans and pets that would be dangerous to bears and humans.

Few human bear conflicts have been reported from the West Castle development area given it's critical location. General knowledge of bear behavior and evidence from similar developments elsewhere indicating elevated levels of conflict in virtually every situation reported upon (Benn 1998; Mattson *et al.* 1987), be they in National Parks or outside protected areas, suggests that the explanation for the situation near West Castle Development is that there are few bears using this part of the West Castle drainage.

The Westcastle subdivision will draw increasing numbers of residents and visitors to the development. The presence of winter activity at the ski hill will also have an impact on bears. Winter visitor use generates effects on grizzly bears in the fall and spring that would otherwise not occur because the presence of facilities and programs encourages additional public visitation in the shoulder season (Olliff and Kaeding 1999). In the Westcastle area, where efforts are ongoing to encourage winter use to flow into summer use, increased conflict with bears and habitat through displacement, road risk, and contact with humans, can be expected.

If is often falsely claimed that ski resorts and other intensive human developments occupy a small physical footprint, as though to imply their environmental impact is similarly confined. For example, the NRCB (1993) considered West Castle Development expansion but, in a truncated perspective, concerned itself with the developments' obstruction to grizzly bear movement near the development. This narrow view was clearly inadequate and has been

identified as such internally by government biologists (Bergman 2001). However, scientific analysis indicates industrial recreational developments like the Westcastle Real Estate and Ski Hill Development are consistently responsible for disproportionate concentration of grizzly bear mortalities (Benn and Herrero 2002). The true ecological footprint of these developments includes the home range of bears that are impacted, resulting in an impact area that can extend to thousands of square kilometres (Knight *et al.* 1988) and have negative effects that ripple through the bear population (Mattson 1993b).

4.2.12 WATERTON LAKES NATIONAL PARK

"Protection of the ecological integrity and cultural resources of the Rocky Mountain National Parks.... is one of our nation's greatest responsibilities" (Copps 2000). Canadians expect that "Natural systems and their component native species are free to function and evolve" in National Parks. "The park supports and is supported by the natural systems of the region around it." "Principles of precaution and adaptive management are exercised when potentially significant effects on the ecosystem are uncertain". "Maintenance of ecological integrity through the protection of natural resources shall be the first priority when considering park zoning and visitor use in a management plan." These are statements from the Waterton Lakes National Park of Canada Management Plan (Parks Canada 2000) and National Parks Act of 1988 (cited in Parks Canada 2000).

These are the statements and existing park management practices that this report examines in the context of their role and impact on the viability of the grizzly bear population in southwest Alberta and this "unique internationally significant ecosystem."

To its credit, and unlike Alberta provincial land and wildlife management departments, Parks Canada has identified some numerical standards for grizzly bear habitat and population management. They include the presence of three females with cubs in the park and habitat standards designating a threshold level for habitat effectiveness (HE) and security areas (SA) for each landscape unit in Waterton. This report addresses Bauerman - Blakiston watersheds within landscape units one (Continental Divide) and three (Crandell - Crypt). These landscape units have habitat effectiveness targets of 90 and 80% and security area targets of 80 and 70%, respectively.

The parks' management plan concedes that targets for both HE and SA have not been met (Parks Canada 2000).

The park is also zoned to provide for various "use" categories. Important to this analysis is the designation of Blakiston Creek and the Red Rock Roadway as "recreation." This designation is not reconciled with stated park objectives (see above). Further, the derivation and appropriateness of using a 200m zone of influence along public roads in the park as a measure of ecological and behavioral impacts of a road on grizzly bears does not conform with research findings. This weakens the foundation of potentially scientifically sound park management.

There are two developments in Waterton Lakes National Park that play a particularly large part in the viability of the regional grizzly bear population and the effectiveness of habitat in the Blakiston - Crandell areas. They are the Crandell Mountain campsite and the Red Rock Parkway (Highway) (Figure 23).

Crandell Mountain campsite

The Crandell Mountain campground occupies what should be critical habitat for grizzly bears in the Blakiston watershed. The Blakiston valley is unique in the park in that it is the longest, topographically most gentle sloping low-elevation riparian habitat in the Park. Riparian habitats are widely recognized as providing critical habitat for grizzly bears if security is high. This valley would have been an important spring range and movement corridor historically, and probably still fills this role but to a much more restricted extent. The Crandell campground, which experiences consistently high human use (Figure 24, Appendix A), has been present for decades and resembles a plug that obstructs the natural ecological flow or processes within this drainage. I suspect park management knows the impacts generated by this campground [38] but it has not taken a pro-active approach to dealing with them.

[38] For data on and discussion of the impact non motorized recreational users have on grizzly bears and their use of habitat, see Mace and Waller 1996, White *et al.* 1999, and Hood and Parker 2001.

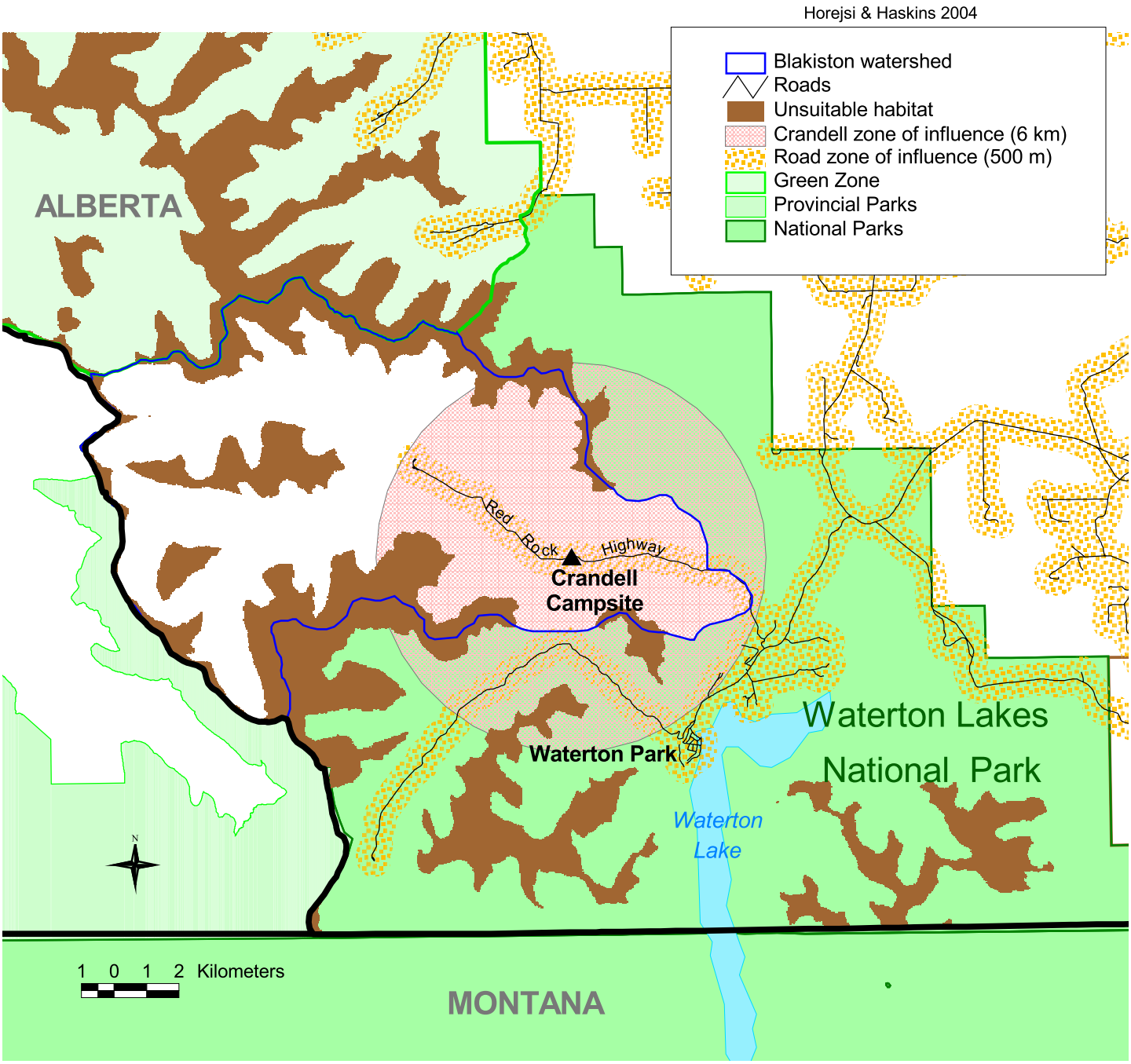

Figure 23. Waterton Lakes National Park with Blakiston watershed and relevant management features.

The Crandell Mountain campground places the ecological equivalent of a small village in the valley starting in May. By this time of year all bears have left their den and would, if provided with unobstructed choice, move to low elevation and south aspects to capitalize on early green-up vegetation, winter killed ungulates and potential availability of newborn ungulate young as prey. Peak human occupancy of the Crandell campground occurs in July and August when about 3800 parties per month are present. As many as 19,000 people use this area during the bears' important berry feeding period of August and September (Waterton LNP 2003). The impact of the Crandell campground is much like that associated with the West Castle Real Estate and Ski Hill Development (see Section 4.2.11). A campsite with about 129 sites, each occupied by an average of 2.9 persons, along with vehicles and pets, can be predicted to have a zone of influence of up to 6.4 km within which habitat effectiveness for bears can decline by up to 80% (Suring *et al.* 1998). In semi-open habitat like much of the Blakiston valley, the extent and intensity of the impact provides the basis for my conclusion that the Crandell Mountain campground creates a significant gap in the ecological effectiveness of the valley.

Approximately one km upstream from Crandell campground, a private church campground (Canyon Church Camp), for which occupancy and visitation are unreported, extends and aggravates the ecological footprint of the Crandell complex.

Red Rock Highway

The Red Rock Highway extends the full length of the Blakiston valley riparian zone. This road brings with it all the road related impacts discussed in Section 4.2.3.

Complete traffic records were not available but vehicle use has been present for decades and appears to be consistently high (Table 13).

Table 13. Red Rock Parkway monthly traffic frequency, 2001 and 2002. Data from Waterton LNP 2002 and Waterton LNP 1979.

	No. of one way trips		Average trips/day			
	2002	2001	2002	2001	1979[1]	1970[1]
June	13,800	14,770	460	492	-	-
July	28,000	28,158	903	908	-	-
August	29,000	27,871	935	899	600	590
September	16,400	12,260	547	409	-	-
October	-	3,169	-	102	-	-

[1] Summer Average Daily Traffic level

Traffic level is well beyond the vehicle frequency known to cause displacement in female grizzly bears (Mace and Waller 1997b) (See Figure 8). Traffic can be expected on the highway every hour of the day between June and September; in 2002 it exceeded one to 3.3 vehicles per hour by 0800 hrs and was still at 11 - 32 vehicles per hour at 2300 hrs. In 2001 there were 15 days during which traffic level exceeded 1000 trips; in 2002 there were 21 days with this traffic intensity.

There are ecological impacts associated with motorized access that are additive to the frequency of vehicles; vehicles routinely stop along the roadway, people frequently exit their vehicles, and vehicles move at varying rates of speed all of which contribute to the unpredictable nature of human use. These are all activities that project sound, sight and odor stimuli that bears are able to detect and respond to.

Vehicle use of the Red Rock highway interferes with a critical ecological event in the valley; ripening of Saskatoons (*Amelanchier spp.*) and Chokecherries (*Prunus spp.*) and the movement to and exploitation by bears of these critical sources of high quality food. August traffic level is very high (Table 13, above) and vehicle frequency records for 2001 and 2002 show only four of 62 days with fewer than 600 trips daily. Access to a super abundance of berries at this time of year has been linked to the nutritional status of bears (Rogers 1976) and appears to be responsible for the reproductive success of some if not all female bears (Rogers 1976; Beecham and Rohlman 1994).

An additional aspect of access to abundant forage resources, particularly in a confined and zoned ecosystem like southwest Alberta, is the role availability of those resources plays in reducing movements and altering distribution (Craighead *et al.* 1995). In this area bears have relatively few truly safe options for foraging and movement. Being able to make extended use of the Blakiston valley, and being able to freely return to it, appears to be an overlooked aspect of the dynamics of local movement, one that has reproductive and conflict / survival implications (Mattson *et al.* 1992). Being wary while slowly choking off reproductive success due to nutritional attrition is not a promising strategy for any bear. While some bears will follow that life-path many others, particularly those that have fewer options when at a behaviorally formative age (subadults), will find themselves taking (knowingly but often unknowingly) high risk actions to feed themselves, often outside the Blakiston valley.

The significance to the regional bear population of unimpeded access to undisturbed utilization of seasonally available food sources in the Blakiston valley appears to be underestimated by park management.

4.3 THE BEAR POPULATION

The size of the grizzly bear population in southwest Alberta has been a contentious issue for decades and remains so today. Until 1997 when the provincial government contracted a DNA hair "capture" study and analysis, there had been no systematic effort made to census grizzly bears using any form of scientific methodology [39]. Estimates of population size had been extrapolated

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[39] This is not a claim that DNA capture / profiling is the only form that science can take in the study of grizzly bear populations; both field and lab processes remain fraught with problems. In reality, there is no substitute for long term intensive radio marking and monitoring study, for the latter can best reveal social and movement dynamics, associations, productivity and survival, interaction with man made changes to the landscape and human activities, and habitat utilization. DNA studies are the "poor boy" version of bear research and that accounts for their being championed by Canadian wildlife departments. They are, however, less physically intrusive than full scale radio marking/ monitoring which, because of its impact on bears, should not be applied to every population every time a conservation issue arises. We already know enough about grizzly bear conservation to not have to repeat this heavy handed approach casually. DNA capture / profiling, while avoiding these impacts, remains only one means of obtaining information, and should be recognized for its limitations.

from other studies (Nagy and Gunson 1990) and were subject to criticism and doubt about reliability and intention (Horejsi 1990). Unqualified claims about bear numbers and density were common and have led to indefensible estimates. For example, an estimated density of 48 grizzly bears /1000 km^2 in the Waterton area could be found on the government website (May 2002) and recent status evaluations persist with claims that the provincial population is increasing (Alberta ESCC 2002). More recently however, Stenhouse *et al.* (2003) provide evidence that refutes previous government estimates and is far more in line with independent estimates of bear population size and trend. Perhaps most important, they concluded all Bear Management Areas in the province support far fewer bears than the province had estimated just one year ago.

The southwest Alberta study area, although ecologically diverse (prairie, foothills parkland, montane and alpine) and located such that it stands to play a critical role in the future of grizzly bears in the Rocky Mountains, is relatively small (3776 km^2). The area presently occupied seasonally or occasionally by grizzly bears is around 2700 km^2 (about 72% of the whole). Applying density estimates obtained by grizzly bear researchers in ecosystems that resemble southwest Alberta provides one reference point when considering the status of this ecosystem. There are no intact grizzly bear ecosystems or populations in the Rocky Mountains of Canada or the U.S. thus grizzly bear density estimates that might be applied come from ecosystems and populations that have a long history of human exploitation and impact, respectively. Density estimates from populations that appear geographically and ecologically applicable are from the Yellowstone and Northern Continental Divide populations. In Yellowstone population growth and distribution has, after 28 years of legal protection, recently begun to show changes in numbers and/or distribution (Schwartz *et al.* 2002). The Northern Continental Divide population that may be showing characteristics similar to the Yellowstone population or it may simply be better understood than previously (Kendall and Waits 2001). Both populations are presently considered biologically and legally threatened. The estimates for the east side of the Rocky Mountains in Montana and for the Yellowstone population (excluding dependent young) are 9.3 to 12.1 bears per 1000 km^2 (Aune and Kasworm 1989) and 12.2 bears/1000 km^2 (calculated from Schwartz *et al.* 2002), respectively. Applied to southwest Alberta, these estimates would produce a population estimate of from 25 to 33 bears assuming that no home ranges overlap outside the area; the latter

does not hold true which would suggest this estimate to be low but other factors, like the absence of habitat protection standards and endangered species legislation in Alberta may well compensate for procedural deficiencies, in which case the estimate could be high.

The analysis in this report relies on the 1997 DNA hair capture data (Mowat *et al.* 1998; Mowat and Strobeck 2000) provided to the author (see Methods). Results from the Mowat study have been inappropriately applied or misinterpreted (Alberta Environmental Protection 1998) and have drawn criticism (Sheppard 1999). More recently, the view has been expressed that in cases of extrapolation from DNA census results, "we suggest that... the numbers used are restricted to using the lower end of the 50% confidence interval" (Stenhouse *et al.* 2003) which is not what past government reports have done. Like many studies of grizzly bears, sparse sample sizes in the southwest Alberta project increase uncertainty and dictate a cautious approach.

Mowat *et al.* (1998) studied an area roughly twice the size of the study area I am using; 39 of the 73 capture cells (8 x 8 km) were located in and south of the Crowsnest Pass. There are marginal differences resulting from my interpretation of the data spread sheets compared to results reported by Mowat *et al.* (1998) and Mowat and Strobeck (2000). I estimated the sex ratio of the population to be equal to the ratio of males to females identified in DNA samples.

Mowat *et al.* (1998) "captured" 37 bears; twenty four (65%) of the 37 captures were in the southwest Alberta study area included in this report. They estimated a population of 74 grizzly bears for their expanded study area, with upper and lower confidence limits of 100 and 60 bears. I estimated the southwest Alberta grizzly bear population using these numbers corrected for the 65% of captures that were south of Highway #3:

60 bears x 65% = 39

74 bears x 65% = 48

100 bears x 65% = 65

These estimates have been labeled as the Precautionary Estimate (39), Middle Estimate (48) and High Estimate (65).

Mowat *et al.* (1998) identified the sex of 18 bears; five were female and 13 were male. I was unable to duplicate the interpretation of five females and 13 males identified to sex, and interpreted the number of bears identified to sex at 20, of which six were females and 14 were

males. Using my numbers the data showed 50% of the females (3/6) and 71% of the males (10/14) were captured south of Highway #3.

The number of females and males south of Highway #3 was determined using the ratio of females and males of known sex; 13 of 20 animals of known sex were in southwest Alberta and three and 10 of these were females and males, respectively, therefore females = 3/13 = 23%, and males = 10/13 = 77%. These percentages x population estimate were used to calculate the number of females and males in southwest Alberta:

Precautionary Estimate of 39	=	9 females + 30 males
Middle Estimate of 48	=	11 females + 37 males
High Estimate of 65	=	15 females + 50 males

The population estimates are striking in two respects; there appear to be very few females in the population, an observation initially made by Mowat *et al.* (1998) and they represent very few grizzly bears when southwest Alberta is viewed as a jurisdictional management entity.

The Precautionary Estimate of 39 bears is treated as the most realistic, even though it could be optimistic, for the following reasons:

1) In 1997, during the DNA study, two grizzly bears were killed and 17 were relocated outside the ecosystem. The following year (1998) was another tough year for bears; 12 more were relocated outside the ecosystem and two more were killed. These two events represent a severe impact that can be expected to have removed a substantial proportion of the entire population, and may easily have reduced the population of bears in the southwest Alberta management area by more than 50%. The removal of this many bears in each of consecutive years can be expected to have severe repercussions that will manifest themselves in population size and growth, a) starting with the year of initial impact and continuing for at least a decade as adult bears that were killed or removed no longer contribute young bears and continuing, b) at five to six years after the kill and removal surge when the cohort that contained the young and sub adults that were removed, would have been recruited into the reproductive population,

2) Mowat *et al.* (1998) state their estimates should be treated as an overestimate,

3) their estimate, like that reported here, violates the closure requirements that can modify population estimates, and while this can lead to underestimates it can also lead to overestimates,

4) this population is not static and without an intensive research effort, has been approximated using the best available data recognizing a relatively high degree of uncertainty is involved, and finally

5) the estimate treats very generously the history of this population and DNA results that are based on low sample sizes.

4.3.1 THE FEMALE POPULATION

Adult females are a critical part of any bear population; they "drive the reproductive engine" of a population and are disproportionately responsible for its success or failure [40]. In doing so, they represent a key part of the effective population, a measure that reflects the number of breeding adults in a population (Allendorf *et al.* 1991).

I estimate that there are between nine and 11 female grizzly bears in southwest Alberta (Figure 25, shows estimate of 11). No data are available on the age distribution of these bears but estimates from other populations indicate that adults (five years of age and greater) constitute from 31% (Aune and Kasworm 1989) to 44% (Pease and Mattson 1999) of all females. The most substantial data base available is that used by Pease and Mattson (1999); using their data, the number of adult female grizzly bears in southwest Alberta is estimated to range from 2.8 to 6.6:

Precautionary Estimate = 2.8 to 4.0 adult females (9 x .31 and 9 x .44),
Middle Estimate = 3.4 to 4.8 adult females (11 x .31 and 11 x .44),
High estimate = 4.6 to 6.6 adult females (15 x .31 and 15 x .44).

As is often the case in wildlife studies results reflect a one time and often short term picture of the state of a population. Further, bear populations are dynamic and change with time; however, the least dynamic characteristic of a population, with one exception, is likely to be the number of adults (versus the number of young or sub adults). The exception is that there can be a

[40] I define successful as a population that is demonstrably viable or growing toward recovery, and failure as a population in decline or one that cannot be clearly and confidently shown to be viable.

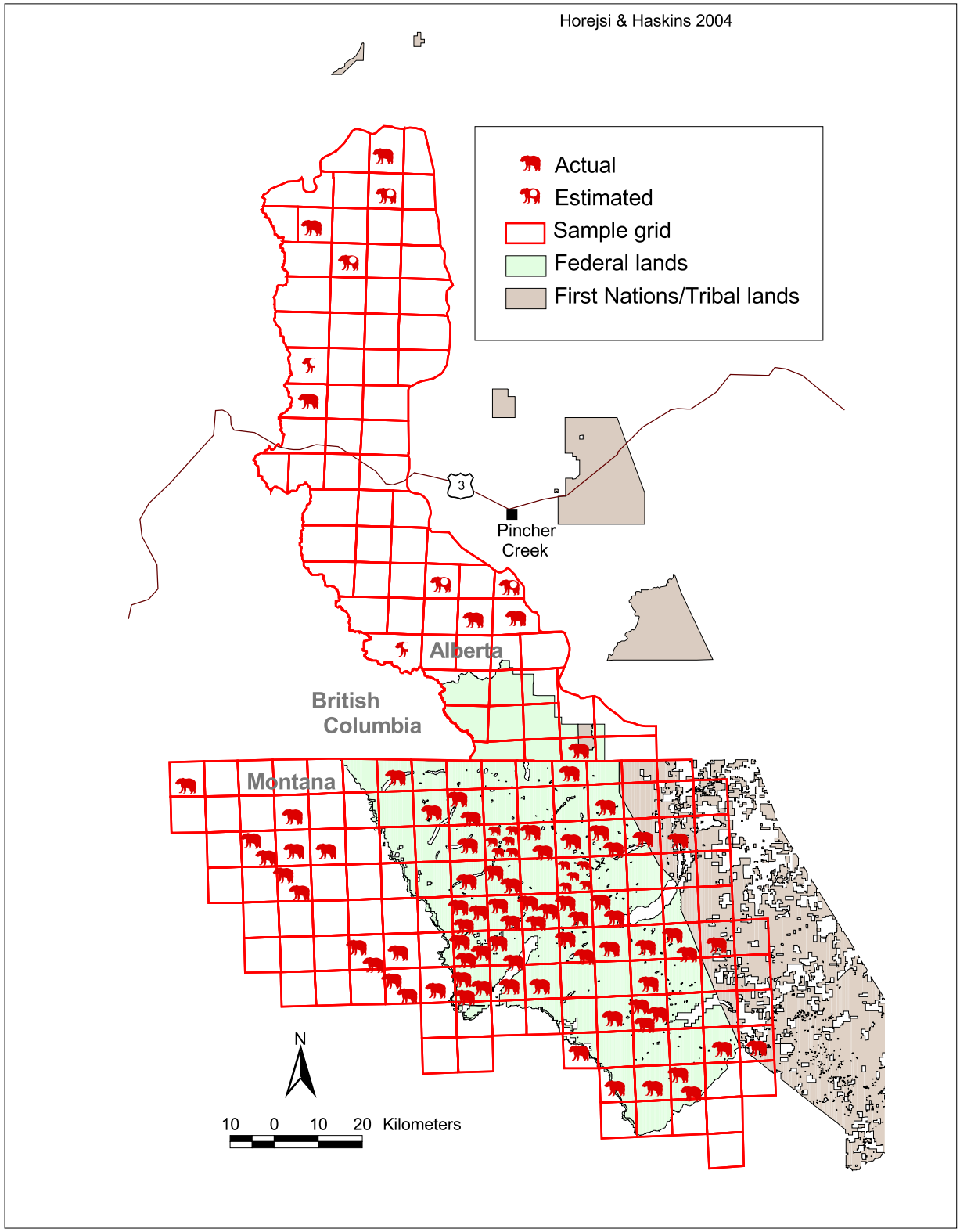

Figure 25. Female grizzly bears identified by DNA profile on grids in southwest Alberta (actual 1997 + estimated; n = 11) and the U.S. Northern Continental Divide Grizzly Bear Ecosystem (actual 1998 and 2000; n = 83; from Kendall and Waits 2001).

sharp reduction in the number of adults as a result of human impact but a sharp increase is not possible as a consequence of significant biological limitations to reproduction (Miller *et al.* 1997).

4.3.2 FEMALE HOME RANGES

One interesting and important aspect of grizzly bear population investigation is a consideration of the size of a population that could or might occupy the landscape given relief, either fully or to some measurable degree, from those human industrial activities that have produced today's modified and threatened ecosystem. A second aspect, and perhaps more important one, is what size of population is necessary to assure scientifically defensible population viability or, in the case of southwest Alberta, a scientifically sound contribution to the regional bear population.

I tried to answer this question by applying scientific knowledge of grizzly bear home range occupation to the study area in order to arrive at an estimate of how many female bears there could be in southwest Alberta.

If the southern Alberta grizzly bear population consisted of a more normal sex/age ratio such as the female:male ratio of 46:52 observed to the south in Montana (Aune and Kasworm 1989) as opposed to the skewed ratio of 23F:77M and adult females comprised from 31 to 44% of all females, there would be from six to 13 adult females [41] in southwest Alberta. However, it appears females are poorly represented in southwest Alberta (Mowat *et al.* 1998), where they constitute only 23% of the sampled population. [42]

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[41] Precautionary estimate = 39 bears x 46% female = 18 females x 31% adults = 6 adult females; or 44% adults = 7.9 adult females.

Middle estimate = 48 bears x 46% female = 22 females x 31% adults = 6.8 adult females; or 44% adult = 9.7 adult females.

[42] Using the density of bears from more intact ecosystems produces the estimate of 25 to 33 bears (see page 63). If 23% were females, there would be between 5.7 and 7.6 females. If 31% of those females were adult there would be 1.8 to 2.3 adult females (5.7 and 7.6 x .31). 44% adults produces an estimate of 2.5 to 3.3 adult females (5.7 and 7.6 x .44).

If the assumption were made that southwest Alberta could or should support as many females as the contiguous ecosystem to the south does, then another estimate of the female population is possible. In Glacier National Park (MT) DNA study revealed 65 female bears (Figure 25) occupying roughly 4416 km^2 (Kendall and Waits 2001), a crudely calculated density of 14.7 female bears / 1000 km^2. Using the range in adult composition of 31 to 44%, an adult female density of 4.6 to 6.5 females / 1000 km^2 is possible. The southwest Alberta grizzly bear ecosystem includes about 2700 km^2 of occupied [43] grizzly bear habitat. A superficial estimate of the potential number of adult females that could occupy southwest Alberta, using Glacier densities, is 12.4 to 17.5 (2700 km^2 / 1000 x 4.6 = 12.4, and 2700 km^2 /1000 x 6.5 = 17.5, respectively).

I used one other means of estimating the potential number of adult females that could occupy southwest Alberta. This estimate was based on superimposing female home range spatial characteristics (see Methods, page 7, and Mace and Waller 1997b) on the study area, relying primarily on public land and some overlap of home ranges with Montana and British Columbia (Figure 26). Nineteen adult females could occupy southwest Alberta if the landscape consisted of highly effective habitat that provided security and access to resources.

4.3.3 BEAR MORTALITY

It is a sad reality that in most cases we know more about dead bears than those that are alive. This is partly why no issue is more relevant to the viability of a grizzly bear population, nor more revealing of habitat security, land use conflicts or management approach, than bear mortality. An understanding of how many bears die and where and why they die opens another window into how a grizzly bear ecosystem functions and is managed. Since bear relocations out of the ecosystem are equivalent to bear mortality this analysis of mortality should be considered in conjunction with data on grizzly bear relocations.

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[43] Includes seasonally utilized.

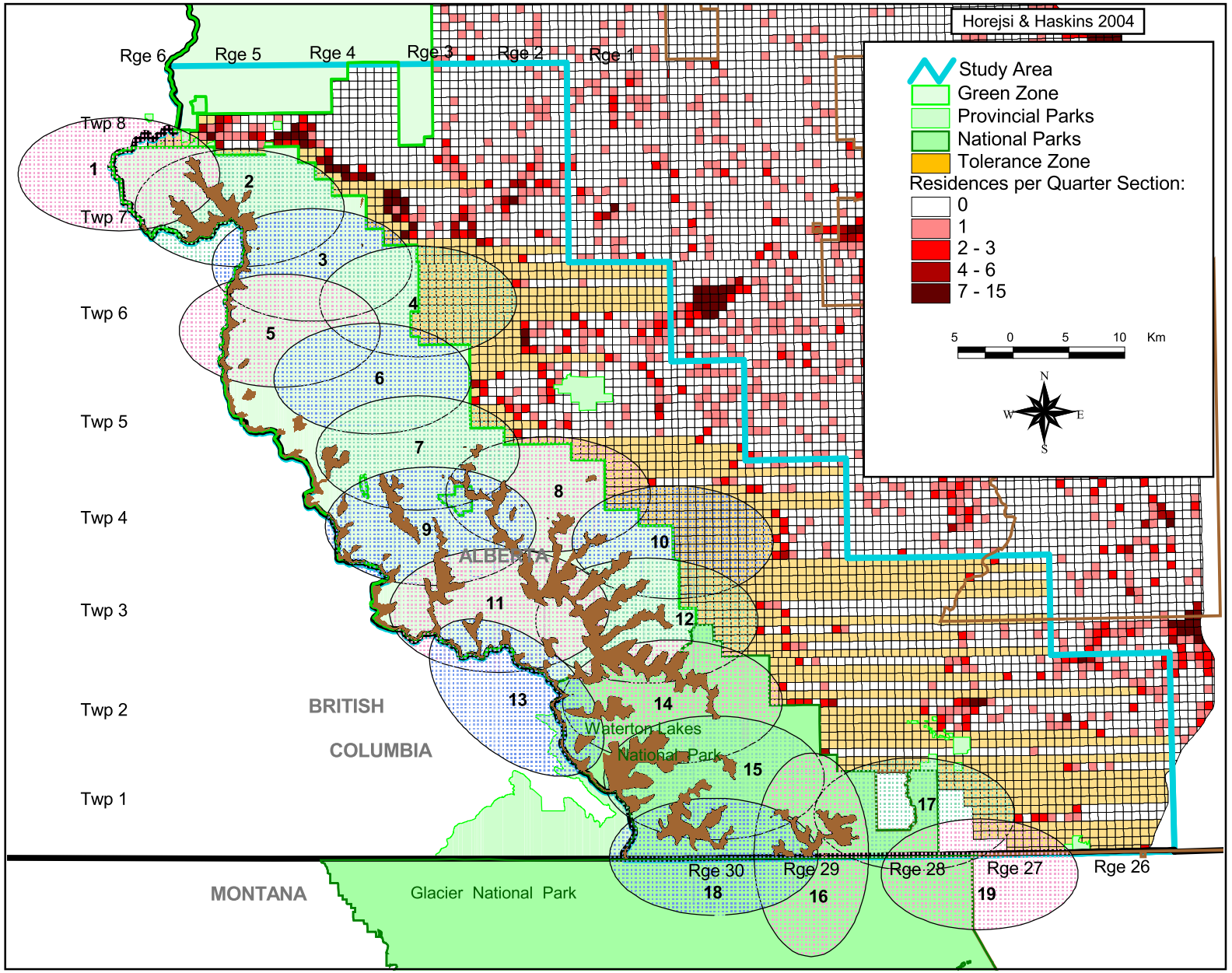

Figure 26. Potential maximum number of adult female home ranges (n=19) in southwest Alberta.

Grizzly bear mortality is difficult to monitor and document. The reported or known kill of bears is unlikely to be a reliable indicator of actual mortality (Mattson 1998; McLellan *et. al.* 1999) however, in the absence of serious research effort, the routinely reported kill constitutes the only record available. I did not make any correction for unreported kill. Stenhouse *et al.* (2003), for example, estimated unreported non hunting kill to be two times the reported non hunting kill. It is therefore important to recognize that reported kill is an underestimate of actual kill, and southwest Alberta is not an exception to this rule. Consequently, bias in the kill record presents another source of uncertainty for analyses and conclusions based on that record.

Reported annual grizzly bear kill in southwest Alberta (Gunson 1995; Alberta SRD 2002b) has varied between zero and 12 bears (Figure 27) (Table 14, Appendix B), averaging 6.3 bears since grizzly bear hunting was reintroduced in 1982. The record shows an average of 1.1 bears killed annually in the years preceding the sport hunt. While it could be encouraging to note the average annual kill has declined to 2.1 in the recent decade [44], from 4.3 in 1983 - 1992, this does not accurately reflect bears lost to the ecosystem and must be viewed in the context of relocation records to get a complete picture of losses to the ecosystem. It does, however, suggest a less lethal form of management has evolved but the critical issue is that the consequences for the bear population remain unchanged.

Where bears die also reveals something about management strategy and ecosystem function. Most grizzly bears in southwest Alberta are killed south of township five in Wildlife Management Units 300 and the south end of WMU 400 (Table 15) even thought they are subject to sport hunting throughout WMUs 300, 302 and 400 (Figure 28, Appendix A).

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[44] If the population has also declined the number of bears killed, even though declining may represent the same or even a greater percentage kill.

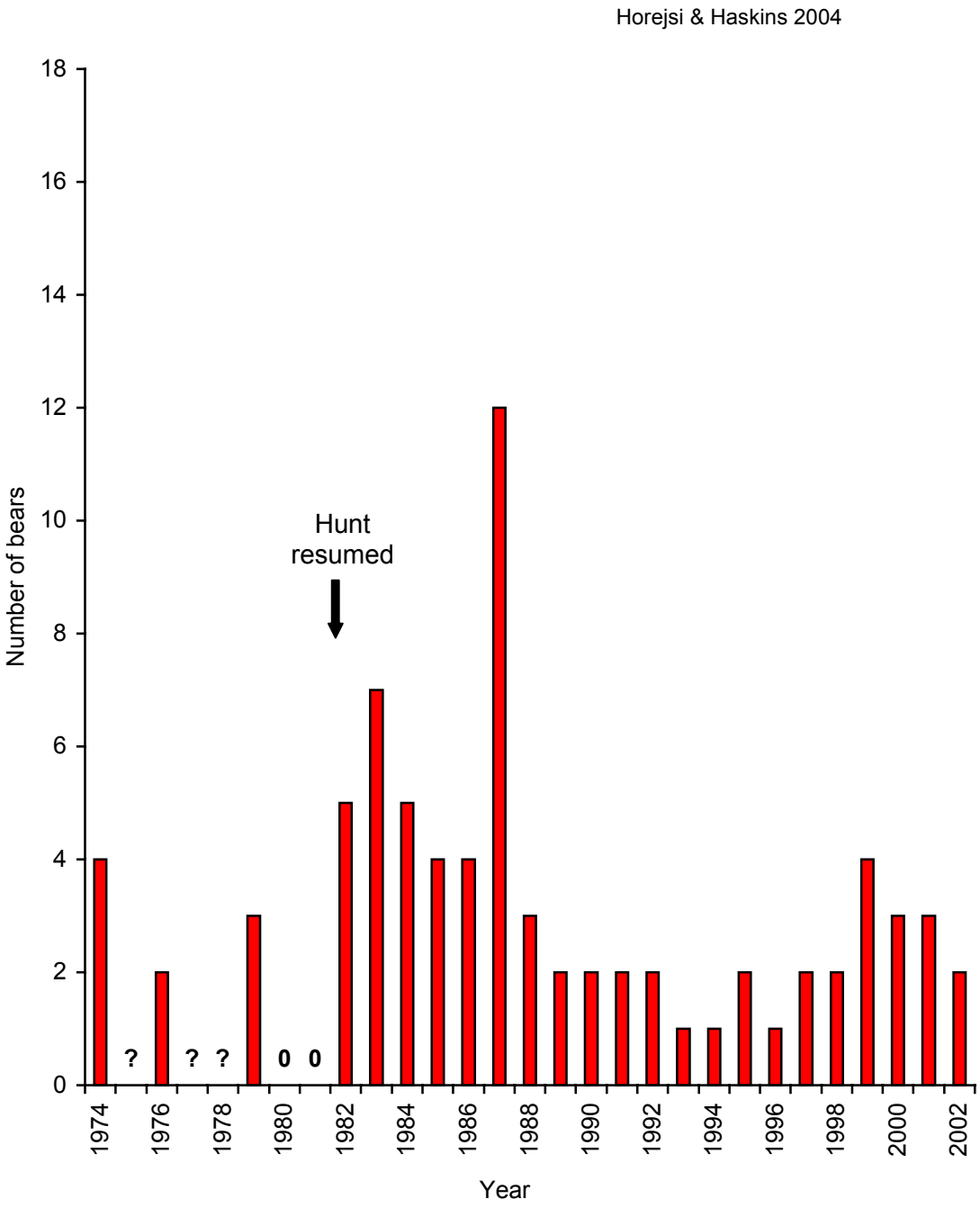

Figure 27. Grizzly bear kill (n=78) in southwest Alberta (south of Highway #3), 1974-2002. WMUs 300, 302, 303 and 400. From Alberta Sustainable Resources grizzly bear mortality database.

Table 15. Distribution of the reported grizzly bear kill by wildlife management unit,1974 - 2002. Data from: Gunson 1995; Alberta SRD 2002b.

Wildlife Mgmt Unit	Total kill	1974 - 1982	1983 - 1992	1993 - 2002
300	35	6	19	10
302	5	1	2	2
400	37	7	22	8
Total	77	14	43	21

Based on the reported kill, bears die much more frequently on public land than they do in the largely privately owned White Zone (WMU 302).

There are some important relationships revealed in these numbers and locations;

1) killing bears in the Green Zone at the reported rate has not alleviated conflicts on private land in the White Zone, and

2) a spike in bear mortalities in the 1982- 1987 period (Figure 27) has not produced a lasting depressing effect on management conflicts through the 1995 - 2002 period, indicating that the age and sex of bears in kill and relocation actions is, along with distribution and numbers, an important aspect of the dynamics of human - bear conflicts.

From 1974 to 1994 sex and age were determined for 51 dead bears; only one of 16 females and eight of 35 males were ten or more years of age indicating a preponderance of the bears (82%) killed in the ecosystem were sub adults and young adults. In the 1982 - 1987 period of high mortality, 25 of 31 bears killed (81%) and aged were under ten years of age. The death of these young bears does not appear to have influenced the period of high conflict management actions in the 1993 - 2002 period; killing this many young bears is not addressing the long term problem of human - bear conflict nor has it, based on this analysis, led to successful establishment of an adequate and stabilized population of adult grizzly bears.

The significance of bear mortality in an ecosystem is further revealed when mortality is placed in the context of population size; this is discussed in Section 4.3.4 below.

With as few as three adult females in this geographically defined population reproduction

cannot sustain the population given existing or historical levels of mortality and management removal. The presence of bears in this part of Alberta appears heavily dependent upon dispersal from adjacent jurisdictions. The skewed sex composition of the population favoring males is one indication of in-migration from Montana and British Columbia by subadult and young adult males. These kinds of bears dispersed an average of 29.9 + or - 3.5 km from maternal ranges in southeast British Columbia (McLellan and Hovey 2001); marked bears from the Flathead area of B.C. have been found in southwest Alberta. Young males are capable of moving great distances on the east side of the Rocky Mountains in Montana; sub adult male home ranges south of the Alberta study area extended well over 100 km from end to end (Aune and Kasworm 1989) and bears initially captured in Montana have also been observed in southwest Alberta (Alberta SRD 2003c).

The reported rate of grizzly bear kill and removal in southwest Alberta (about seven bears annually) would require a population of at least 175 grizzly bears to be sustainable even if human induced mortality was 4% (U.S. Fish and Wildlife Service 1993). With far fewer bears and a sustainable mortality rate that can reasonably be expected to be less than 4% (Harris 1986) southwest Alberta, although only a small segment of the Northern Continental Divide grizzly bear ecosystem, is acting as a huge drain on the greater population. A ten or 20% reporting error, certainly realistic by today's standards, would deepen the mortality sink and exacerbate the overall threat to the regional grizzly bear population.

4.3.4 POPULATION RISK ASSESSMENT (RISKMAN)

RISKMAN estimates the probability that a population will reach a user defined threshold within a select number of years. The threshold level of population persistence used in this analysis was a 50% decline from initial population size within 30 years.

Three population sizes were modeled, based on estimates from the DNA study of Mowat *et al.* (1998). These populations were defined as the Precautionary Estimate (39 bears), Middle Estimate (48 bears) and High Estimate (65 bears). There is considerable uncertainty associated with these estimates (Mowat *et al.* 1998; Sheppard 1999; Mowat and Strobeck 2000) and the grizzly bear population in southwest Alberta could be smaller than the modeled probable

population. The range in population sizes used reflects some of this uncertainty.

RISKMAN was applied to this population to provide an assessment of the impact of existing population and habitat management practices on populations of the modeled size and, indirectly, on the regional greater meta population upon which this sub-population is dependent for its existence. More directly, it answers the question "What would become of this population if it were not linked to adjacent jurisdictions with bears?"

The results of this population risk analysis reveal a bear population that, if it were dependent entirely on Alberta management, would be rushing toward extinction (Figure 29). When viewed as a population confined to Alberta's jurisdiction, and given existing mortality levels, population size, and habitat security, this population is not even remotely viable.

The analysis reveals that there is a 90% plus probability that the existing level of mortality of bears in southwest Alberta would lead to a 50% decline in six to eight years whether the population consisted of a Precautionary Estimate of 39 bears or an unexpected High estimate of 65 bears.

The risk assessment indicates that southwest Alberta is a "sink" area for the regional trans-boundary grizzly bear population and imposes a significant drain on that population. The bear population exhibits a negative growth rate and would decline sharply in the absence of bears from adjacent jurisdictions. The evidence indicates that there would be no grizzly bears in southwest Alberta if this were a "stand alone" population. Current management of the grizzly bear population and habitat in southwest Alberta is not meeting contemporary social or scientific standards for the conservation of threatened or endangered wildlife populations.

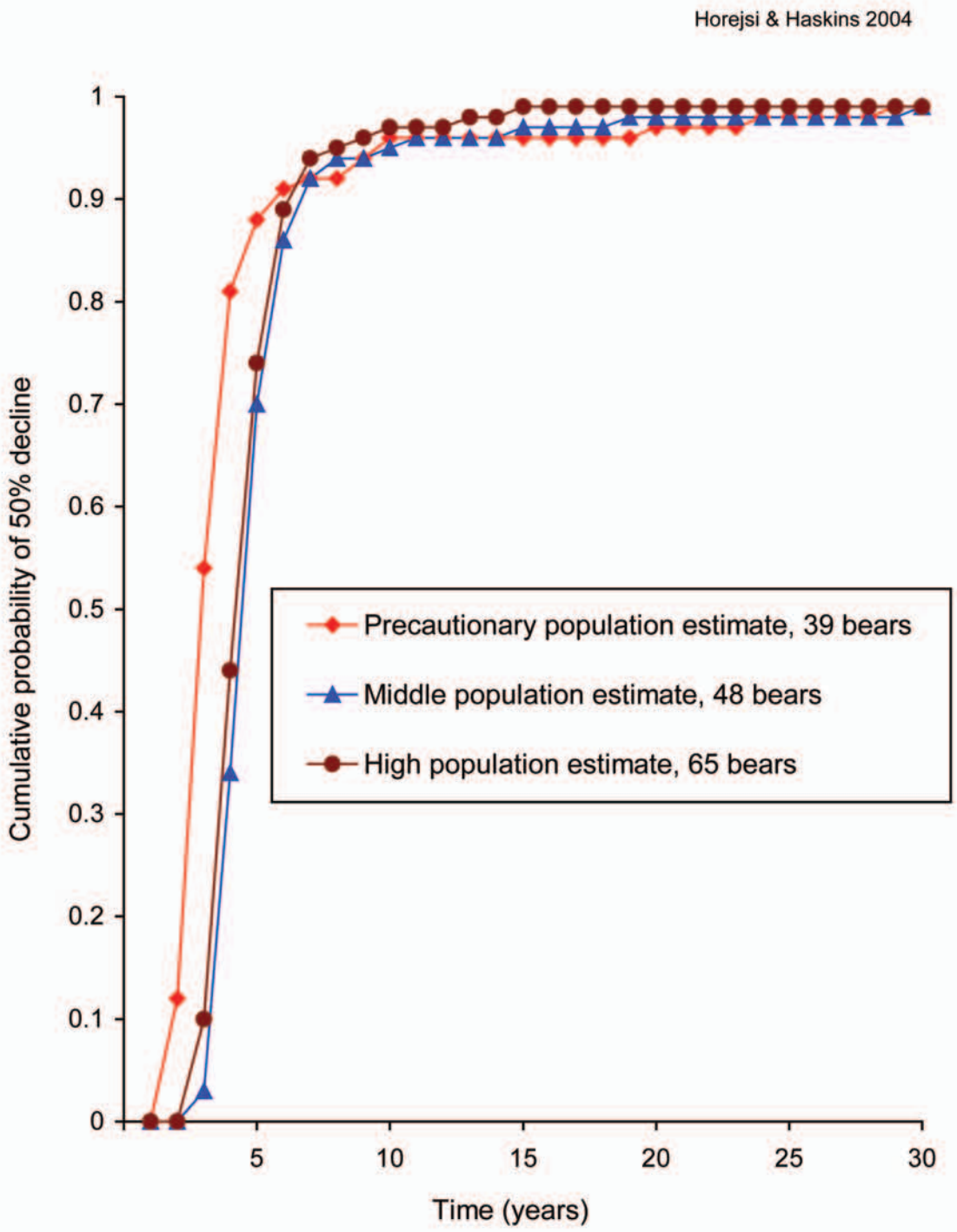

Figure 29. The probability of decline by 50% for present day grizzly bear populations in southwest Alberta as predicted by RISKMAN simulation.

5.0 THE ROAD TO RECOVERY

Needs and Recommendations

Recovery issues identified by this analysis are listed first and measures to address them are expanded upon below:

5.1. Endangered status of the population ,
5.2 Redefine bear management area
5.3. Special management skills and mandate,
5.4. Bear population goals,
5.5. Human and bear conflict management plan,
5.6 Hunting grizzly bears for sport,
5.7. Land use issues,
    5.7.1 Core Wilderness habitat,
    5.7.2 Grazing permit buy out,
    5.7.3 Acquisition of habitat,
    5.7.4 Westcastle development,
5.8.0 Numerically defined habitat protection standards,
    5.8.1 Road access management standards,
    5.8.2 Regional security habitat,
    5.8.3 Off road vehicle management,
5.9.0 C5 Forest management planning
5.10.0 The Waterton connection, and
5.11.0 Conclusions.

No one action amongst these recommendations will reverse the continuing trend toward ecosystem collapse, a process that is now well advanced, as exemplified by a grizzly bear population that is persists but is no longer viable. Just as it has taken decades of multiple management failures, and a crushing load of cumulative effects to drive this ecosystem to this state, so will it take years, systematic implementation of the multiple measures outlined, and organized and intense public involvement to reverse the trend and recover a functional ecosystem. Certain of the recovery measures can set the stage for other advances but public demand for scientific, economic and social accountability will have much to do with reestablishing a robust ecosystem.

5.1 Endangered population recognition

The grizzly bear in southwest Alberta is biologically endangered but still persists in an increasingly degraded and threatened habitat. Legal and formal recognition of this status would be a critical first step to initiating and implementing the population, habitat and management initiatives that are now necessary to allow this part of Alberta to make a functional contribution to the long term viability of the regional grizzly bear population; a population that brings together Alberta, British Columbia, Montana, two national parks and two nations. This action would compliment protection afforded these bears in Montan by the U.S. Endangered Specie Act.

With this initiative a management shift can begin; from treating bears as a source of conflict with residents and an impediment to commercial exploitation of its habitat to one where grizzlies are managed for Canadians and Americans as a national and internationally valuable asset.

5.2 Redraw bear management area boundary

The unique role that this part of southwest Alberta plays on a trans boundary and interprovincial level should be addressed with special habitat and population management measures. This role, and the important but different issues facing grizzly bear management on public (Green Zone) and private land (White Zone), can best be dealt with by designating these two areas, stretching from the international boundary north to and including the Crowsnest Pass Corridor, as distinct grizzly bear management and recovery areas. This would separate them from the management areas that presently extend north of the Crowsnest Pass Corridor and conform with designation of the bear population as endangered.

5.3 Special mandate and management skills

Southwest Alberta requires a full time grizzly bear management specialist. Constant communication and interaction with local residents are necessary to elevate their level of tolerance of bears and to reduce the availability of attractants to bears. Far more attention has to be paid to prevention of human - bear conflict and a fundamental shift to this position from

after-damage response is necessary.

Grizzly bear management in southwest Alberta has suffered from the absence of a clear statement of objectives for population and habitat conservation. My personal view is that neither government, nor its (our) public servants, can justify the systematic destruction of grizzly bears and their habitat regardless of the perceived needs of other interests. I think Albertans would endorse this view.

The point can be made that there is at least a glimmer of recognition at some levels within government that things are not going well for grizzly bears and their habitat and that change or correction in public participation and land and bear management is necessary. This view is based on the Southwest Alberta Grizzly Strategy (SWAGS). As well, for the first time in the province's long history (98 years) there is a professional biologist in the Pincher Creek office of government with responsibility for some aspects of wildlife management. *If* that biologist *could and did* "plug in" to a legislated land and wildlife regulatory framework that engages science and responds to the will of the people, progress would be made. While this is not an adequate substitute for a full time bear management specialist in the area, it is an improvement over past government commitment. This gain is, however, limited by the absence of a publically accountable legal and administrative framework within which either SWAGS or professional, scientific and public input could be meaningful (see, for example, Kennett 2003). One example of failure to capitalize on these potential gains is the current C5 Forest Management Plan review, in which the regional biologist plays not a regulatory role, but an advisory role (Alberta SRD 2003c). Necessary progress, as defined in this report, cannot be made in that organizational void.

5.4 Bear population goals

Southwest Alberta can play a crucial positive role in linking regional grizzly bear populations in the greater Rocky Mountains if, as I anticipate, private land contributions to population and habitat viability grow and public land habitat effectiveness recovery efforts outlined herein are aggressively pursued. At this late juncture in the history of grizzly bears and their habitat in southwest Alberta a population objective can best be achieved in a staged manner.

Although the area may have historically supported 20 or more adult female bears, as

opposed to the three or four that might be there now, a modest goal of ten resident [45] adult females is achievable. This assumes habitat effectiveness will improve sufficiently to support these bears primarily on public land and they would be distributed relatively evenly through the ecosystem from Highway #3 south. The objective is to establish a stabilized population of adult bears.

Security of habitat and security of life are the foundation of population viability. In this section I propose solutions, based on sound grizzly bear conservation science and lessons from grizzly bear conservation history, to the many problems facing the people of Alberta, their grizzly bears and their public lands in southwest Alberta.

The existing "throw in everything including the kitchen sink" approach to land use has led to massive proliferation of access, retreat from scientifically sound principles and practices of ecosystem conservation, and a chaotic and extensively fragmented industrialized landscape. There is little evidence that decisions have incorporated "all the perspectives at the table" (Alberta SRD; 2003b) and many options for improved land management practices, implementing the "best available science" solutions, and accommodating all the members of the public who choose to express their interest, have been foreclosed.

If the grizzly bear population and habitat recovery plan outlined in this report is implemented, it can be predicted that there will be:

> a resurgence in public involvement in public land conservation matters,
> a resurgence in all wildlife populations,
> slow recovery of native biological diversity,
> a dramatic improvement in environmental attributes associated with quality of human life,
> reestablishment of sound economic and environmental options for this and future generations, and
> use of public lands that incorporates balance between wilderness, wildlife, non motorized and motorized users, industrial use, and non industrial commercial use.
> land use that can be sustained for centuries at limited cost and will provide constant and predictable returns to society and government.

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[45] Most of their multi-season total home range and all of their home range core in Alberta.

5.5 Human - bear conflict management

It may be difficult for all parties to recognize that human grizzly bear conflict resolution in the tolerance zone will be a continuous process as long as grizzly bears survive in the region. There is never going to be a "final solution" that will put an end to conflict management. Even under ideal circumstances as defined in this report there will never be an end to active management of some members of the bear population and some members of the human population.

Active management of bears and interests of local residents need not be an indicator of mismanagement. Quite the contrary; that management can be directed towards establishing a stabilized adult female population that plays a role in connecting regional grizzly bear populations. Upon achieving that stabilized adult female population management of conflicts will represent a measure of considerable success. As this population begins to respond to improved habitat effectiveness and moves toward reaching its full biological capability [46], hands on management will be necessary and other management options will evolve.

When the southwest Alberta population has at least ten adult females, they will produce about 20 young bears every three years. [47] At least one half of these bears can be expected to die before they reach one year of age (Bunnell and Tait 1985) therefore the region will have to deal with about ten young bears every three years. Depending on the success of habitat effectiveness reclamation efforts defined in this report, some of these young bears may establish home ranges that allow those bears to integrate into the stabilized local population while others (and eventually most) will disperse to peripheral areas. Additionally, there will be those bears that disperse into this area from Montana and British Columbia. The extent to which subadults from southwest Alberta may disperse to Montana or B.C. is unknown but both of these areas are larger regions with many more bears. Part of the background rationale for the southwest Alberta recovery strategy is based on the premise that a stabilized population of adult bears in Alberta will lead to a

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[46] Given the size of the southwest Alberta jurisdictional ecosystem.

[47] One third of the females can be expected to produce a litter annually, with each female producing about two cubs per litter; 3.3 females x 2 cubs = 6.6 cubs annually x two more years until all females have produced a litter = 6.6 annually x three years = 19.8 cubs possible.

relative reduction of in-migrants.

No matter how successful this program is, there will be bears that are going to have to be dealt with in the tolerance zone but this will be done in the context of maintaining the stabilized adult sub population.

Getting the population to the level of ten adult females, i.e., to the initial stage of stabilization, will ultimately be decided by aggressive habitat directed action.

New management of human - bear conflict will require some deviation from existing convention. It is consistent with an understanding of the social behavior of a long-lived animal like the grizzly bear that a systematic and high level of trapping and relocation of sub-adults and adults, particularly those of dominant size and social stature, will create social turmoil and unnatural movement dynamics. Habitat effectiveness for grizzly bears has been chronically low in southwest Alberta and this aggravates relocation dynamics. I expect this has led to a predictable and advanced level of social and movement chaos instigated by displaced bears which suffer from lack of familiarity and predictability in habitat and home range occupation and utilization. This turmoil is compounded by displacement of resident bears and disruption of their social and ecological environment. It is reasonable to expect that this turmoil is manifesting itself in erratic movements and atypical habitat use and occupation in a temporal and spatial scale. Relocated and subsequently “destabilized” sub adult and adult male bears in a social mix with consistent in-migration of subadults and seasonal use by males from nearby jurisdictions are suspected to be the chief cause of this turmoil.

I propose that all adult male and sub adult bears that become involved in human - bear conflicts even as first time participants be removed [48]and that this practice continue until the stabilized adult female population is established. At that time the program would be re-evaluated. Adult and sub-adult females would be relocated within the ecosystem, based on an evaluation of each situation that would require that two criteria be met:

1. No female bear be destroyed or removed until at least a second chance has been granted; aversive conditioning, including the use of bear dogs, conducted by a bear management

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[48] Euthanized when necessary; there is little justification, if any, for creating similar problems in other ecosystems by relocating bears to those ecosystems.

specialist could play a complimentary role at this initial stage of conflict, and

2. Demonstrable corrective action be taken regarding the situation that provoked the conflict. Private land initiatives will be necessary. This second step is fundamental to the long term vision of stabilizing the grizzly bear population in southwest Alberta and to elevating human - bear conflict solutions to a level at which grizzly bears are dealt with as a publically owned asset of great public value.

5.6 Hunting grizzly bears for sport

Grizzly bears will continue to die in this part of Alberta but those deaths are going to have to be managed within a recovery framework. There is no evidence from any jurisdiction that hunting can be accommodated within the relatively precise envelope of management actions that are necessary. In the context of grizzly bear conservation southwest Alberta is a very small land base and, when a bear population is endangered or threatened, margin for error that could result in female mortalities is zero.

It is easily argued that the persistence of hunting grizzly bears in southwest Alberta is a throwback to the age when wildlife was the sole domain of hunters and management agencies that catered to them. Under that regime, sound wildlife conservation science fell victim to demands to continue “the right to hunt”; unfortunately, hunting organizations saw endangered and threatened populations as a threat to their traditional rights, not as a problem they could help solve. This approach no longer meets the needs or wants of today’s society. Southwest Alberta presents the hunting community with a change to “step up to the plate” and be part of the process of bear population and habitat recovery with the long term expectation that the future holds greater promise.

5.7 Land use initiatives

There are severe problems facing the recovery of the grizzly bear population and the security of its habitat in southwest Alberta but they are not insurmountable. They will require vision and commitment, jurisdictional cooperation, broad based and aggressive public involvement, regulatory reform including simplification of the chain of management control, and

financial resources. Hell, you're thinking, why not throw in a White Knight too? A legitimate observation, but southwest Alberta is no longer a naturally sustainable grizzly bear ecosystem, and the above list of necessities, and the long list of actions outlined in this section only attest to the difficulty of building this part of the world back into a functional part of the trans-boundary regional human and grizzly bear ecosystem. Local people, government, and industry dug the hole we find ourselves in, but with the help of all Albertans and our neighbors, we can climb out of that hole.

5.7.1 Core habitat - Wilderness designation

The survival of the grizzly bear in this ecosystem depends on our willingness to commit undisturbed and unimpaired low elevation habitat for secure use by bears. Limited options exist. This objective can be achieved by establishing the South Castle and Upper West Castle river valleys as core wilderness habitat (Figure 30) and creating useable and effective habitat in the Blakiston valley in Waterton Lakes National Park. Combined with designation of east slope valleys north of Waterton LNP as prime grizzly bears range when industrial and agricultural use is bought out or phased out, a secure core of habitat will be established that can provide safe shelter and a source area to maximize reproductive success.

There is every reason to establish a wilderness area in the south and upper west Castle valleys that would include all public land south of the Beaver Mines Lake road, the West Castle Road to the Old Mill Site, the middle Kootenay Pass area west of the Mill Site (upstream from the West Castle real estate and ski hill development) and extending west of the eastern boundary of the green zone south of a line extending east from Beaver Mines Lake. Time limited variances would be placed on existing oil and gas facilities but step out expansion would be confined to outside the wilderness area. Given the sharp decline in production in this field it would be provident for the provincial and federal governments to buy out existing rights just as they attempted to compensate operators for lost rights to tar sands expansion.[49]

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[49] About 1000 wells were initially shut in to allow tar sands production development to consume of the land surface to maximize synthetic oil manufacture. The cost to taxpayers is expected to be hundreds of millions of dollars, a sum likely to be far in excess of remaining commercially accessible reserves in the proposed Castle Wilderness area.

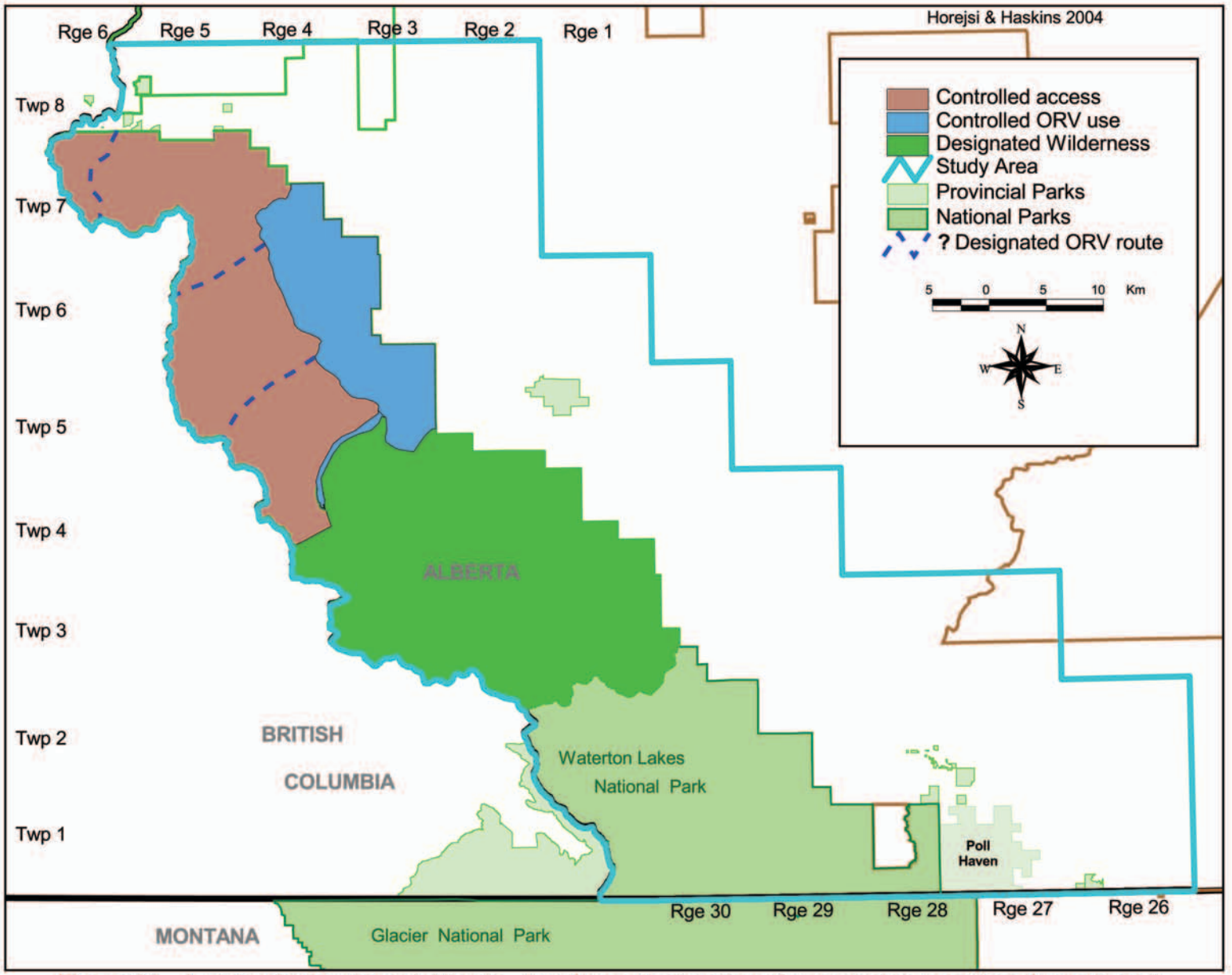

Figure 30. A vision for southwest Alberta. Land use designations for reversing resource damage and repairing the ecosystem

5.7.2 Grazing permit buy out

Part of allowing grizzly bears to use public lands effectively, and thereby both reduce their dependence on private land and increase the productivity of public landscapes, will be to allow public land to reach its ecological potential for wildlife. A major advance toward this goal could be achieved by reducing livestock impacts on a wide range of habitats, particularly riparian zones, thus eliminating conflicts between livestock owners and bears on public land, and removing a host of contentious management issues like conflicts over stocking rates, seasons of use, and adjustments for drought, all of which would ultimately reduce fear and distrust of bears and bear conservation amongst local land owners. The most reasonable way to accomplish this is to establish a voluntary grazing permit buy out program on public lands. A program similar to this has recently removed livestock from 87,500 acres (337 km^2, 3,370 ha) of grizzly bear habitat in Wyoming (Vital Ground Foundation 2003).

There are difficulties with a proposal such as this, but the voluntary participation and cash compensation aspect of it will appeal to some permittees, many of whom are often already faced with poor markets, financial difficulties, retirement, or other issues like border trade disputes. The program can only reach maximum effectiveness if permanent closure can be achieved. Buy-in to the program from the "owners" of public land - the people of Alberta - should not be difficult to achieve but government political and management resistance will be a major hurdle. While the government of Alberta might be reluctant to provide compensation to ranchers prepared to relinquish permits, there are other avenues, including third party buyout and federal government involvement. With Waterton Lakes National Park standing to be a major beneficiary, federal involvement is an issue to be explored.

A proposal similar to this has been drafted in the U.S. where grazing permits on federal public land would be relinquished permanently for a one time payment of about $US 175 per AUM (Public Land Grazing 2002). That has been equated to about $US 13.45 per acre retired by the program. In southwest Alberta some additional one time payments may be necessary to lift the sense of ownership permittees or leasees have acquired because of "improvements" for grazing.

There are other possibilities that could work to achieve the same end, which is to allow public land to be managed as productive, fully functional natural landscape, part of which would be

secure grizzly bear habitat. One such possibility is to provide tax deductions for the value of the permits that are relinquished, a strategy put to use in Great Basin National Park in Nevada (Economist 2002).

A staged approach to this program is envisioned. The establishment of a core block of secure habitat in the proposed Castle Wilderness area is a high priority, beginning with the critical east slopes canyons north of Waterton Lakes National Park. The Poll Haven is of equal importance and would be the focus of a coincident effort.

This program, once largely in place, could have consequences for human - bear conflict peripheral to these lands (in the Tolerance Zone) and would be most effectively implemented with the presence of a full time grizzly bear management specialist (see above).

5.7.3 Acquisition of habitat

Acquisition of habitat through purchase or conservation easement has and will play a significant role in determining the viability of this ecosystem. The Nature Conservancy of Canada and the Southern Alberta Land Trust lead this process but there is room for other players as well; the Rocky Mountain Elk Foundation, for example, has purchased land in the area. Given the vital position of some privately owned habitat, it is my view that government at both the provincial and federal levels should also be involved in securing this ecosystem for wildlife and the citizens of Canada and the U.S.

The tolerance zone identified in this report consists of numerous opportunities to acquire, for either public ownership or environmentally friendly private ownership, important bear habitat that could substantially improve the prospects of long term bear population viability in southwest Alberta.

Potential Tolerance Zones A, B and C (Figure 31) could be considered and managed from the bear population perspective, as Recovery Zones. Prospects for recovery of the ecosystem and permanent integration of these landscapes into areas that could be safely occupied by grizzly bears would be a monumental achievement. While we today hope that private lands remain permeable to bear movement and access, the prospects for the long term maintenance of this status are slim without coordinated land management objectives. The tolerance zones identified above have the

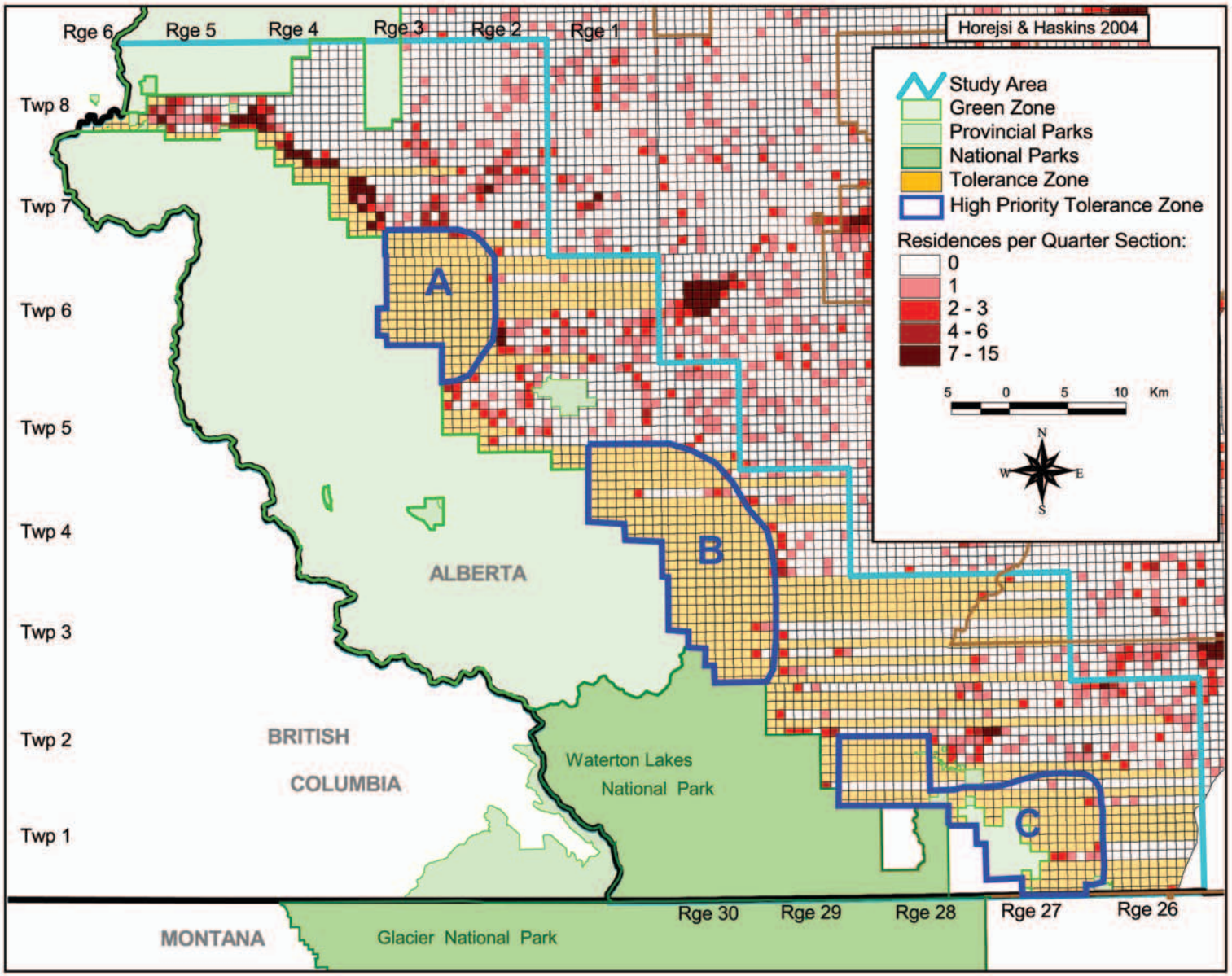

Figure 31. Potential High Priority tolerance zones represented by quarter sections with fewer than two residences (>1.5 km2).

potential to replace these tenuous habitats by becoming receptive to more predictable and secure seasonal occupation by bears. Their role as spring habitat, where intercept and redistribution of carcasses could be employed to limit depredation on adjacent private lands (as has been initiated by the southwest Alberta Grizzly Strategy), would be a crucial gain.

Concentration of acquisition or land ownership or conservation easements in target areas A, B and C would be hugely rewarding to the social, environmental and economic well being of southwest Alberta, providing for multiple wildlife and wildland opportunities, including a significant contribution to the future of grizzly bears.

5.7.4 Westcastle development

There are few ways known to humans to reduce the impact on bears of a residential - commercial development like the Westcastle real estate and ski hill development short of very high-intensity management of resident activities that are known to lead to interactions with bears, including storage and handling of garbage and other attractants. One of the other options is outright purchase of private property and removal of facilities. The establishment of the Castle Wilderness Area south of the West Castle River and incorporating the West Castle head waters and the Middle Kootenay Pass will limit the escalation of ecological damage the Westcastle Development has already caused and will continue to wreak.

Even after the Castle Wilderness Area is established it is likely bears will die in and near the Westcastle townsite, particularly if Albertans successfully recover the grizzly bear population. The best possible effort to minimize this conflict will be sanitation standards equal to or exceeding those in place in well regulated National Parks. To be effective these standards need to be legally enforceable and systematically enforced. Bear proof garbage containers and off site transport of waste are essential components of such a program, as are restrictions on street collection and open storage of garbage on individual properties.

5.8 Numerically defined habitat protection standards

Numerically established thresholds for grizzly bear habitat effectiveness and protection have been defined by research and are known to land and wildlife managers in some parts of North America. Habitat protection standards derived from them have not been calibrated with long term population viability therefore it would be wise to treat them as minimum acceptable standards. Given the absence of habitat protection standards in Canada the U.S. standards in place in the 1990s, even with their limitations, represent a sound starting baseline for application of numerically defined habitat protection standards in southwest Alberta.

5.8.1 Road access management standards

The reality of southwest Alberta is that road construction and use has escalated beyond environmentally manageable levels in terms of road density and distribution. All wildlife needs refuge; it is part and parcel of effective habitat.

While the legitimacy of U.S. standards is being challenged by the test of time and the scrutiny of science, they represent a bare bones starting point, recognizing that they may be functional only as a complimentary land use strategy in conjunction with large roadless areas and adequately sized and spaced roadless security habitat. It will be necessary to put in place in southwest Alberta a similar complement of numerically defined landscape conservation standards.

Numerical definition of standards is essential to efficient and accountable implementation, management and monitoring of landscape protection measures.

The U.S. Fish and Wildlife Service (1995) concluded that the following road densities cause harm to grizzly bears. Harm occurred when:

open motorized access density of > 0.62 km/km^2 (> 1 mi/mi^2) affects more than 13% of the landscape, and

Total motorized access density of > 1.25 km/km^2 (>2 mi/mi^2) affects over 19% of the landscape.

In the Northern Continental Divide Grizzly Bear Ecosystem radio collared adult female bears occupied home ranges that averaged 11% and 9% impact from Open Road Density of >1 km/km^2 and Total Road Density of > 2 km/km^2, respectively (NCDE Access Task Group 1998).

Female grizzly bears in the Yellowstone Ecosystem, where the population appears to be at least stable, occupy home ranges in which six (6) percent of the area was affected by an Open Road Density of >0.6 km/km^2 (> 1 mi/mi^2) and six (6) percent by TRD of > 1.2 km/km^2 (>2 mi/mi^2). Metzgar (1998) concluded long term grizzly bear population viability, for populations occupying ecosystems smaller than the Yellowstone ecosystem, could be achieved with Total Road Density standards of: > 0 - 1 km/km^2 < or = 8.3% of a home range, and

> 2 km/km^2 < or = 1.7% of a home range.

Recommended objectives for Total Road Density in southwest Alberta, set in the overall land management framework of wilderness protection and Secure Core Areas, are:

Long term (7 to 15 years): 6% or less of the managed area in TRD of >1 km/km^2, and
Less than 6% of the managed area in TRD of > 2 km/km^2.

Short term (5 to 7 years): Not more than 13% TRD of > 1 km/km^2
Not more than 11% TRD of > 2 km/km^2

5.8.2 Regional security habitat

To provide a reasonable prospect of surviving a normal life time (20 plus years) at least 68% of each female home range should be secure habitat (>500m from any motorized access route). This threshold can be viewed as a stage one objective. Using annual female with cub home range size of 162 km^2 results in Secure Habitat requirements of about 110 km^2 per home range. Ten such areas are necessary in southwest Alberta (= 1100 km^2) to “anchor” the habitat base for the stabilized adult female population. With research indicating there may be a 25% overlap in adjacent home ranges a cautious downward correction can be made, indicating for example, that if every second home range overlaps one other, core secure areas could be met with about 950 km^2.

The final location of these core areas will be a planning event but to establish continuous distribution of female bears in southwest Alberta will require that five areas be north of the West Castle Corridor (see Figure 30) and while five areas would also be necessary south of the corridor, the proposed Castle Wilderness area will assume that role and provide alternative security. Under existing management habitat effectiveness in the West Castle corridor is very low and no core areas exist.

The objective of five core areas in the Controlled Access and Controlled ORV use area (Figure 30) is to maintain population linkage along the continental divide, providing for continuous occupation of habitat from the international boundary to the CNP Corridor. These secure areas may consist of one to three units. Beyond a three unit composition the prospects increase sharply that a unit of secure habitat will be less than 26 km^2, a size representing core areas which supported over 74% of radio collared bears in the Selkirk ecosystem (Wakkinen and Kasworm 1997).

Permeability of habitat between these secure units (often referred to as matrix land) will have to be consistently high to allow movement between units and is addressed under road standards.

In summary, the numerically defined Core Habitat standards that will be necessary to direct management activities in southwest Alberta are:

> ten core areas, each

> 110 km^2 in size, and each consisting of

> not fewer than three units, with

> no one unit smaller than 24 km^2, and

> no distance greater than one km between units of a given core area.

5.8.3 Off road vehicle management

The threats posed by off road vehicle use and solutions to those threats have recently been summarized in a visionary strategy for motorized access and use (Gilbert 2003). Motorized travel plans must accommodate a large number of terrestrial and aquatic species, safeguard ecosystem function (services) at a broad scale, and realize long range protection of public lands including scientific, historical, cultural and spiritual uses. Public land access plans must be science based, adopt a conservation biology approach similar to that employed in this report, involve "identification and protection of core area and linkages" to other landscapes, and protect wildlife and its habitat for educational, economic, scientific, aesthetic, non motorized recreation, and basic democratic and freedom values (Gilbert 2003; Collar 2003).

Off road vehicle use in southwest Alberta can continue within the habitat and population recovery standards necessary to bring this ecosystem back to an ecologically functional level.

ORV use outside of main road and very select designated routes is not compatible with habitat effectiveness necessary to provide security for grizzly bears and all other wildlife populations. ORV use on main roads will still have a measurable impact on grizzly bear recovery and will add to the cumulative impact associated with traffic frequency (see Figure 8).

Core secure habitat will have to be free of designated ORV routes to meet functional objectives and access will have to be managed so as not to divide core security habitat units from one another. Fragmentation by designated routes would effectively de-link these critical areas that will be the foundation of long term grizzly bear population (and ecosystem) viability.

The proposed West Castle wilderness will represent the most secure wildlife habitat in southwest Alberta and would be free of motorized access.

The Controlled Access area (Figure 30) represents the heart of the north - south linkage that would allow wildlife populations to be connected along the continental divide; to achieve this objective it should be managed for non-motorized access with initial exceptions for limited industrial activity until the latter can be scaled down to meet road and security habitat standards. While one or two designated ORV routes may be able to be accommodated in the Controlled Access area, a more detailed Environmental Impact Assessment will be required to determine that. Until those decisions are made, ORV use could occur in the July first to September Labor Day weekend “window” in order to, 1.) allow all wildlife to maximize habitat use during the critical spring period when all wildlife have vulnerable young and require security and access to first-green-up habitats, and 2.) provide undisturbed and full access to berry producing habitats at higher elevations and seek security from seasonal concentration of activities like motorized dependent hunting.

5.9 C5 Forest management planning

Planning for renewal of the C5 forest management plan is presently underway with 2006 slated as the year for completion of the plan (Alberta SRD 2003b). The Department of Sustainable Resource Development is responsible for this plan and for the C5 plan area, which incorporates the Green Zone in the southwest Alberta grizzly bear management area.

There exist no legal, social or scientific constraints that require the Forest Service to

produce a comprehensive land management plan similar to U.S. National Forest management plans. Public land management should, however, be more than a comprehensive, albeit flexible, logging agenda. U.S. National Forest plans provide a template for forest management plans in Alberta, and the C5 plan should strive to replicate these plans and the process leading to them.

Full scale environmental impact assessment (EIA), employing the best available science, is necessary for sound forest management, and Alberta Sustainable Resource Development can best serve the public and public land by initiating this process. Public scoping must be part of the plan, and a suite of alternatives should be developed based on that scoping.

Public hearing and a publically declared comment period would be the next step, during which a draft EIA would be scrutinized. The present hand picked Public Advisory Committee is an unacceptable substitute for democratic input and scientific review.

The draft EIA would be finalized with full public input and using the best available science. An alternative would then be selected and established in law. It would bind Alberta Sustainable Resources to manage public land according to the preferred alternative.

Only with an inclusive and comprehensive land use plan can public land be sustainably managed and only with this kind of transparent process can the public be served. It is my observation that only under this kind of umbrella can biological diversity, including a viable grizzly bear population, be recovered and maintained.

The Forest Service cannot manage public lands when several other government departments impose industrial or motorized recreational activities on public lands with relative indifference. It amounts to a very substantial undertaking, but public land management in the Green Zone is in need of coordination and one-department leadership and control. Operating under legal constraints that define its social, scientific, and economic accountability, the Forest Service could be that lead party.

5.10 The Waterton Connection

The Blakiston valley can play a significant role in the recovery of the grizzly bear population in southwest Alberta but changes in land use will be necessary. This narrow but critically situated valley cannot sustain the impact of motorized use and fulfill an ecologically

productive role in local wildlife population dynamics. To meet expectations as effective grizzly bear habitat, motorized use of the valley will have to be progressively withdrawn.

The first and most easily implemented stage would be to reclaim the road upstream from Crandell Mountain campground. Stage two would be to decommission the highway east of Crandell campground to near its junction with the park highway.

Public access and enjoyment of this valley would not be denied; Crandell campground could continue to operate and the highway could remain open as a wagon trail. Access would be by foot, horseback or horse drawn wagon. If it could be reconciled with environmental standards, a motorized campsite could be relocated to the area of kilometre zero on the wagon trial.

Major benefits can be expected from these decisions and actions. Grizzly bears and other wildlife would increase their intensity and duration of use of the valley and they would reestablish ecologically driven patterns of use and all wildlife would become more readily visible and observable. Another benefit would be an escalation in human user satisfaction.

A long term vision would be the day when wagon drawn visitors travel the Red Rock wagon way for one of the most unique and rewarding wildlife experiences, grizzly bears included, in Canada.

5.11 Conclusions

Southwest Alberta is a landscape that is the product of a long history of public servants and local governments working within an uncoordinated “flexibility to manage” strategy. This strategy has proven incapable of preventing significant resource damage and cannot recover a landscape with the ecological attributes necessary to support grizzly bear population viability. The “flexibility to manage” strategy, closely guarded by alliances of traditional land users and government managers, is designed for incremental decision making and results in progressive cumulative impacts, as exemplified by southwest Alberta grizzly bear habitat.

There is a desperate need for statutory limitations on the unfettered ability of public servants and local governments to ignore science and conservation biology. In doing so these parties routinely impose changes on both private and public lands that have cumulative and significant consequences for biological diversity, including immediate and long term impacts on the

productivity and habitat effectiveness of public lands and the subsequent viability of wildlife populations.

It may seem relatively difficult to predict the evolution of this landscape particularly if the vision is one of a self-sustaining landscape that can renew itself and recover to full viability in the next decade or two, but it is not that difficult to predict that, if the landscape continues to be exploited as it has been for decades, then the future becomes even more bleak than its already impaired status would indicate. In other words, more of the same by the same managers is not good enough.

A radical shift in the direction of public land management by provincial authorities will be necessary in order that

1) the future of the grizzly bear population be secured by law,

2) a much broader Alberta public constituency be served,

3) the interests of Canadians in Waterton Lakes National Park be recognized, and

4) international obligations to contribute to the viability of the Northern Continental Divide ecosystem grizzly bear population be addressed.

The new direction should involve federal and international participation and must encompass a strong program reaching out to private lands, either complimenting or assisting the Nature Conservancy approach of acquisition and conservation easement purchase.

6.0 LITERATURE CITED

Alberta EP. 1998. DNA study pegs healthy grizzly bear population in southwestern Alberta. Alberta Game Warden, Vol. 10 (3): p16.

Alberta ESCC. 2002. Status evaluation for grizzly bear (*Ursus arctos*) in Alberta. Endangered species conservation committee, Scientific sub-committee. Alberta Department of Sustainable Resource Development, Edmonton, AB. 3p.

Alberta NRS. 1997. Grizzly trans-locations from southern mountains/foothills area. Wildlife Division, Natural Resources Service, Edmonton, AB. 2p.

Alberta NRS. 1997b. Southwest Alberta grizzly management strategy. ACA Application for project funding, Wildlife Division, Natural Resources Service, Alberta Environmental Protection, Claresholm, AB. 8p.

Alberta NRS. 1998. Southwestern Alberta grizzly strategy. Fax, 2 pages, Wildlife Branch, Natural Resource Service, Alberta Environmental Protection, Edmonton, AB.

Alberta SRD. 1996. The Castle special management area. Winter and summer trails. Map. Alberta Sustainable Resource Development, Blairmore, AB.

Alberta SRD. 1998. Range management plan for the Southend Allotment. Sustainable Resource Development, Blairmore, AB. 47p.

Alberta SRD. 2002. Grazing disposition management during drought. Public Lands Division, Sustainable Resource Development, Edmonton, AB. 2p.

Alberta SRD. 2002b. Compulsory grizzly bear kill registration, 1995-2002. Sustainable Resource Development, Edmonton, AB.

Alberta SRD. 2003b. Public consultation terms of reference. C5 Forest management plan, Crowsnest Forest area, Southwest Region, and: Terms of reference, C5 Forest Management unit, Forest management plan. Alberta Sustainable Resource Development, Blairmore, Alberta.

Alberta SRD. 2003c. Grizzly relocations in Alberta, From 1974-2003. Alberta Sustainable Resource Development unpublished data base, Edmonton, AB. 1p.

Alberta Transportation. 2003. Traffic volume history 1993-2002. Alberta Highways 1 to 986. Program Management Branch, Edmonton, AB.

Alberta Transportation. 2003b. Vehicle geographical statistics reports, 1987-2003. Transportation Safety Services Division, Edmonton, AB.

Allendorf, F.W., Harris, R.B., and L. H. Metzgar. 1991. Estimation of effective population size of grizzly bears by computer simulation. Pp. 650-654 *In:* Dudley, E.C. (*Ed.*) Proceedings of the fourth international congress of systematic and evolutionary Biology. Vol. 2. Dioscorides Press, Portland, OR.

Aune, K.E. 1994. Comparative ecology of black and grizzly bears on the Rocky Mountain front, Montana. International Conference on Bear Research and Management 9(1): 365-374.

Aune, K., and W. Kasworm. 1989. East Front grizzly studies. Final Report, Mont. Dept. Fish, Wildl. and Parks. Helena, MT. 332p.

Beecham, J.J., and J. Rohlman. 1994. A shadow in the Forest; Idaho's black bear. Univ. Idaho Press, Moscow, ID. 245p.

Benn, B. 1998. Grizzly bear mortality in the Central Rockies Ecosystem, Canada. Masters Degree thesis, Univ. of Calgary, Calgary, Alberta. 151p.

Benn, B., and S. Herrero. 2002. Grizzly bear mortality and human access in Banff and Yoho National Parks, 1971-98. Ursus13: 213-221.

Bergman, C. 2001. Draft. Relevance of 1992 West Castle Environmental Impact Assessment and final NRCB Decision report to future development in the West Castle Valley. Fish and Wildlife Service, AB Dept. of Sustainable Resource Development, Pincher Creek, AB. 7p. + Append.

Boone, R.G., and M.L. Hunter, Jr. 1996. Using diffusion models to simulate the effects of land use on grizzly bear dispersal in the Rocky Mountains. Landscape Ecology 11(1): 51-64.

Bunnell, F.L., and D.E.N.Tait. 1985. Mortality rates of north American bears. Arctic 38(4): 316-323.

Collar, N.J. 2003. Beyond value; biodiversity and the freedom of the mind. Global Ecology & Biogeography 12: 265-269.

Copps, S. 2000. Forward. Waterton Lakes National Park of Canada management plan. Parks Canada, Waterton Lakes National Park, Waterton, AB.

Cormack, R.G.H. 1956. Spruce-fir climax vegetation in southwestern Alberta. Forestry Chronicle Vol. 32 (3): 346-349.

Cowie, I. 1913. The company of adventurers; on the great buffalo plains. William Briggs, Toronto. 515p.

Craighead, J.J., Sumner, J.S., and J.A. Mitchell. 1995. The grizzly bears of Yellowstone: their ecology in the Yellowstone ecosystem, 1959-1992. Island Press, Covelo, CA. 535p.

Economist. 2002. Subsidised cow chow. The Economist, March 2, 2002. 1p.

Getty, I.A.L. 1971. The history of Waterton Lakes National Park, 1800-1937. National and Historic Parks Branch, Dept. Indian Affairs, Ottawa, ONT. 246p.

Gunson, J. 1995. Analysis of grizzly bear mortalities in Alberta during 1972-1994. Natural Resources Service, Alberta Environmental Protection. Edmonton, AB. 101p.

Gibeau, M.L. 2000. A conservation biology approach to management of grizzly bears in Banff National Park, Alberta. Ph.D. dissertation, Univ. of Calgary, Calgary, AB. 129p.

Gibeau, M.L., and S. Herrero. 1998. Roads, rails and grizzly bears in the Bow River Valley, Alberta. Pp. 104-108 *In:* Proceedings of the international conference on wildlife ecology and transportation. (*Eds.*) Evink, G., Garrett, P., Zeigler, D. and J. Berry. FL-ER-69-98. Florida Dept. Transportation, Tallahassee, FL.

Gilbert, B.K. 2003. Motorized access on Montana's Rocky Mountain Front. A synthesis of scientific literature and recommendations for use in revision of the travel plan for the Rocky Mountain Division. Utah State Univ., Logan, UT. 41p.

Gilbert, T., and J. Wooding. 1996. An overview of black bear roadkills in Florida, 1976- 1995. *In:* Proceedings of the Transportation Related Wildlife Mortality Seminar (*Eds.*) Evink, G., Garrett, P., Zeigler, D. and J. Berry. FL-ER-58-96. Florida Dept. Transportation, Tallahassee, FL. 15p.

Greenough, J.A., and W.A. Kurz. 1996. Stand tending impacts on environmental indicators. Canadian Forest Service and B.C. Ministry of Forests, Victoria, B.C. 58p.

Gunson, J. 1995. Analysis of grizzly bear mortalities in Alberta during 1972-1994. Natural Resources Service, Alberta Environmental Protection. Edmonton, AB. 101 p.

Gunther, K., Biel, M.J., and H.L. Robison. 1998. Factors influencing the frequency of road-killed wildlife in Yellowstone National Park. Pages 32-42 *In:* Proceedings of the international conference on wildlife ecology and transportation. (*Eds.*) Evink, G., Garrett, P., Zeigler, D. and J. Berry. FL-ER-69-98. Florida Dept. Transportation, Tallahassee, FL.

Hamer, D., S. Herrero, and K. Brady. 1985. Studies of the grizzly bear in Waterton Lakes National Park. Final Report. Univ. Calgary, Calgary, AB. 188 p.

Hamer, D., S. Herrero, and K. Brady. 1991. Food and habitat use by grizzly bears, *Ursus arctos*, along the continental divide in Waterton Lakes National Park, Alberta. Canadian Field Naturalist 105(3): 325-329.

Hamilton, A.N. 1996. Rationale for Intermediate biodiversity emphasis as minimum acceptable LU options in NDT1 and NDT2 for maintaining grizzly Habitat. B.C. Ministry of Environment, Lands and Parks. Victoria, B.C. 5 p.

Haroldson, M., and D. Mattson. 1985. Response of grizzly bears to backcountry human use in Yellowstone National Park. Interagency Grizzly Bear Study Team, Montana State Univ., Bozeman, MT. 38 p.

Harris, R.B. 1986. Modeling sustainable harvest rates for grizzly bears. Pp. 269-279 *In*: Dood, .R., Brannon, R.D., and R.D. Mace. 1986. Final programmatic environmental impact statement. The grizzly bear in northwestern Montana. Montana Dept. Fish, Wildlife and Parks, Helena, MT.

Hood, G.A, and K.L. Parker. 2001. Impact of human activities on grizzly bear habitat in Jasper National Park. Wildlife Society Bulletin 29(2): 624-638.

Horejsi, B.L. 1989. Uncontrolled land-use threatens an international grizzly bear population. Conservation Biology 3(3): 220-223.

Horejsi, B.L. 1990. The grizzly bear management plan for Alberta. Research Report 1-90. Speak Up For Wildlife Foundation, Calgary, Alberta. 15 p.

Horejsi, B.L. 2001. Comments on the Draft Environmental Impact Statement, Forest Plan Amendments, *for* motorized access management within the Selkirk and Cabinet-Yaak grizzly bear recovery zones. Western Wildlife Environments Consulting Ltd., Calgary, Alberta. 23 p.

Horejsi, B.L. 2002. Science and thresholds versus reality: Grizzly bear population and habitat recovery in southwest Alberta. *In* Proceedings, Ecological and earth sciences in mountain areas Conference, Banff, Alberta. (*Eds.*) Taylor, L., Martin, K., Hik., D. and A. Ryall: 215-225.

Horejsi, B.L. 2003. In Press. Science based habitat and population protection thresholds: access induced displacement and access management standards for grizzly bears (*Ursus arctos*). *In:* Access management: Policy to Practice. Proceedings of the Alberta Society of Professional biologists Conference, Calgary, Alberta. xxx:000-000.

Horejsi, B.L., and Hornbeck, G.E. 1987. Ecology of moose in West central Alberta during gas exploration and development activities. Western Wildlife Environments Consulting Ltd., Calgary, Alberta. 214 p.

IGBC. 1998. Selkirk / Cabinet-Yaak grizzly bear ecosystem interim road management strategy. Interagency grizzly bear committee. Published by U.S. Forest Service, Coeur D'Alene, ID. 9p.

IGBC. 1998b. Grizzly bear/motorized access management. Revised Task Force Report. Interagency Grizzly Bear Committee.

IHS Accumap. 2003. Well record data base, Calgary, AB.

Kehoe, N.M. 1995. Grizzly bear distribution in the North Fork of the Flathead River Valley; a test of the linkage zone prediction model. MSc. Thesis, Univ. Montana, Missoula, MT.

Kendall, K.C., and L. Waits. 2001. Monitoring grizzly and black bear populations using DNA. Northern Rocky Mountain Science Center, U.S. Geological Survey, West Glacier, MT.

Kennedy, M., Smith, T., and B.O.K. Reeves. Conservation excavations DjPq-1 - An 8000 year record of human occupation in the Crowsnest Pass, B.C. Final Report. Lifeways of Canada Limited, Calgary, AB. 10p.

Kennett, S.A. 2003. Spinning wheels in the Castle: A lost decade for sustainability in southwestern Alberta. Occasional Paper #14, Canadian Institute of Resources Law, Calgary, AB. 68p.

Kennett, S.A., and M.M. Ross. 1998. In search of public land law in Alberta. Journal of Environmental Law and Practice, Vol. 8: 131-179.

Knight, R.R., Blanchard, B.M., and L.L. Eberhardt. 1988. Mortality patterns and population sinks for Yellowstone Grizzly bears, 1973-1985. Wildl. Soc. Bull. 16: 121-125.

Laliberte, A.S. and W.J. Ripple. Wildlife encounters by Lewis and Clark; A spatial analysis of interactions between native Americans and wildlife. Bioscience 53(10): 994-1003.

Larsen, D.G., and R. L. Markel. 1989. A preliminary estimate of grizzly bear abundance in the southwest Yukon. Final Report, Yukon Fish and Wildlife Branch, Dept. Renewable Resources, Whitehorse, Yukon. 52p.

Mace, R.D., and T.L. Manley. 1993. South Fork Flathead River grizzly bear project: Prog. Rep. for 1992. Mt. Dept. Fish, Wildlife and Parks, Kalispell, MT. 32p.

Mace, R.D., and J.S. Waller. 1996. Grizzly bear distribution and human conflicts in Jewel Basin Hiking area, Swan Mountains, Montana. Wildlife Society Bulletin 24(3):461-467.

Mace, R.D., and J.S. Waller. 1997. Grizzly bear ecology in the Swan Mountains, Montana. Final Report, Montana Fish, Wildlife and Parks, Kalispell, MT.

Mace, R.D., and J.S. Waller. 1997b. Spatial and temporal interaction of male and female grizzly bears in northwestern Montana. J. Wildl. Manage. 61(1): 39-52.

Mace, R.D., J.S. Waller, T. L., Manley, L. J. Lyon and H. Zuuring. 1996. Relationships among grizzly bears, roads and habitat in the Swan Mountains, Montana. Journal of Applied Ecology 33: 1395-1404.

Mace, R.D., J.S. Waller, T. Manley, K. Ake, and W.T. Wittinger. 1999. Landscape evaluation of grizzly bear habitat in western Montana. Conservation Biology 13(2): 367-377.

Mattson, D.J. 1993. Background and proposed standards for managing Grizzly bear habitat security in the Yellowstone ecosystem. National Biological Survey, College of Forestry, Wildl. and Range Sci., Univ. Idaho, Moscow, ID. 17p.

Mattson, D.J. 1993b. An estimation of the effects of the proposed Sunshine ski area expansion on grizzly bears in Banff National Park. Cooperative Park Study Unit, Univ. Idaho, Moscow, ID.

Mattson, D.J. 1997. Use of lodgepole pine cover types by Yellowstone grizzly bears. J. Wildl. Manage. 61(2): 480-496.

Mattson, D.J. 1998. Changes in mortality of Yellowstone's grizzly bears. Ursus 10: 129-138.

Mattson, D.J., B.M. Blanchard, and R.R. Knight. 1992. Yellowstone grizzly bear mortality, human habituation, and Whitebark pine seed crops. J. Wildl. Manage. 56 (3): 432 - 442.

Mattson, D.J., Herrero, S., Wright, R.G., and C.M. Pease. 1996. Science and management of Rocky Mountain grizzly bears. Conservation Biology 10(4): 1013-1025.

Mattson, D.J., and R.R. Knight. 1991. Effects of access on human-caused mortality of Yellowstone grizzly bears. Interagency Grizzly bear study team Report. 13p.

Mattson, D.J., and R.R. Knight. 1991. Application of cumulative effects analysis to the Yellowstone grizzly bear population. Interagency Grizzly bear study team report. 8p.

Mattson, D.J., and R.R. Knight. 1991. Implications of short-rotation (70-120 years) timber management to Yellowstone grizzly bears. Interagency Grizzly bear study team report, Bozeman, MT. 19p.

Mattson, D.J., R.R. Knight, and B.M Blanchard. 1987. The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. International Conference on Bear Research and Management 7: 259-273.

Mattson, D.J., Wright, G.R., Kendall, K.C., and C.J. Martinka. 1995. Grizzly bears. Pp.103-105 *In*: Our living resources. U.S. Dept of the Interior, National Biological Service, Washington, DC.

McCarty, J. 2001. Gap dynamics of forest trees: a review with particular attention to boreal forests. Environ. Rev. 9: 1-59.

McLellan, B.N. 1991. Relationships between resource extraction industries and grizzly bear in the Flathead drainage. Grizzly bear management workshop proceedings, Revelstoke, B.C. Can. Parks Service: 49-55.

McLellan, B.N., and F.W. Hovey. 2001. Natal dispersal of grizzly bears. Can. J. Zool. 79:838-844.

McLellan, B.N., Hovey, F.W., Mace, R.D., Woods, J.G., Carney, D.W., Gibeau, M.L., Wakkinen, W.L., and W.F. Kasworm. 1999. Rates and causes of grizzly bear mortality in the interior mountains of British Columbia, Alberta, Montana, Washington, and Idaho. J. Wildl. Manage. 63(3): 911-920.

McLoughlin, P.D. 2002. Managing risks of decline for hunted populations of grizzly bears given uncertainty in population parameters. Dept. Biological Sciences, Univ. of Alberta, Edmonton, AB. 63p.

Metzgar, L.H. 1998. A review of: Rationale and choices made in the review and development of an access direction proposal for the NCDE grizzly bear ecosystem. Missoula, MT. 22p.

Metzgar, L. 2001. Comments on the Draft Environmental Impact Statement, Forest Plan Amendments for motorized access management within the Selkirk and Cabinet-Yaak grizzly bear recovery zones. Missoula, MT. 17p.

Miller, J.R., Joyce, L.A., Knight, R.L., and R.M. King. 1996. Forest roads and landscape structure in the southern Rocky Mountains. Landscape Ecology 11(2): 115-127.

Miller, S.D., White, G.C., Sellers, R.A., Reynolds, H.V., Schoen, J.W.., Titus, K., Barnes Jr., V.G., Smith, R.B., Nelson, R.R., Ballard, W.G. and C.C. Schwartz. 1997. Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark-resight techniques. The Wildlife Society, Wildlife Monographs No. 133. 55 p.

Mitchell, J.E., Knight, R.L., and R.J. Camp. 2002. Landscape attributes of subdivided ranches. Rangelands Vol. 24(1): 3-9.

Montana FWP. 2002. Grizzly bear management plan for southwestern Montana 2002 - 2012. Final Programmatic environmental impact statement. Montana Fish Wildlife and Parks, Helena, MT. 115 p.

Mowat, G., Russell, J., and C. Strobeck. 1998. Estimating population size of grizzly bears using hair capture and DNA fingerprinting in southwest Alberta. Timberland consultants Ltd., Nelson, B.C., and Dept. Biol. Sciences, Univ. Alberta, Edmonton, AB. 19 p.

Mowat, G., and C. Strobeck. 2000. Estimating population size of grizzly bears using hair capture, DNA profiling, and mark-recapture analysis. J. Wildl. Manage. 64(1): 183-193.

Nagy, J.A., and J.R. Gunson. 1990. Management plan for grizzly bears in Alberta. Wildlife Mgmt. Planning Series No. 2, Pub. No. T/232. AB. Fish and Wildlife Div., Edmonton, AB. 164 p.

NCDE Access Task Group. 1998. Draft. Rationale and choices made in the review and development of an access direction proposal for the NCDE grizzly bear ecosystem. Flathead National Forest, Kalispell, MT. 23 p.

NCDE AccessTechnical Group. 2002. NCDE access management rule set proposed direction. Northern Continental Divide Access Technical Group. Flathead National Forest, Kalisipell, MT. 8 p. + 7 Appendices.

Newmark, W.D. 1975. Legal and biotic boundaries of Western North American national parks. A problem of congruence. Biol. Conservation 33: 197-208.

Nielsen, P.L. 1975. The past and present status of the Plains and Boreal Forest Grizzly Bear in Alberta. Canadian Wildlife Service, Edmonton, AB. 61 p. + append.

NRCB. 1993. Decision report, Application to construct recreational and tourism facilities in the Westcastle valley. Application 9201. Natural Resources Conservation Board, Edmonton, AB.

Olliff, T., Legg, K., and B. Kaeding, Editors. 1999. Effects of winter recreation on wildlife of the Greater Yellowstone Areas; a literature review and assessment. Report to the Greater Yellowstone Coordinating Committee. Yellowstone National Park, Wyoming. 315 p.

Parks Canada. 2000. Waterton Lakes National Park of Canada management plan. Waterton Lakes National Park, Waterton Park, Alberta. 63 p.

Pease, C.M., and D.J. Mattson. 1999. Demography of the Yellowstone grizzly bears. Ecology 80(3): 957-975.

Pielou, E. C. 1991. After the ice age; the return of life to glaciated North America. Univ. Chicago Press. 366 p.

Powell, R.A., Zimmerman, J.W. and D.E. Seaman. 1997. Ecology and behavior of North American Black bears; Home ranges, habitat and social organization. Chapman and Hall, London, UK. 201 p.

Proctor, M.F., McLellan, B.N., and C. Strobeck. 2002. Population fragmentation of grizzly bears in southeastern British Columbia, Canada.. Ursus 13: 153-160.

Public Land Grazing. 2002. Voluntary federal grazing permit buyout proposal. National Public Lands Grazing Campaign, Ashland, OR.

Reed, R.A. , Johnson-Barnard, J., and W.L. Baker. 1996. Contribution of roads to forest fragmentation in the Rocky Mountains. Conservation Biology 10(4): 1098-1106.

Reid, W.V., and G.M. Mace. 2003. Taking conservation biology to new levels in environmental decision-making. Conservation Biology 17 (4): 943-945.

Rogers, L.L. 1976. Effects of mast and berry crop failures on survival, growth and reproductive success for black bears. Proc. North American Wildl. and Natural Resources Conf. 41:431-438.

Russell, A. 1972. Grizzly country. Alfred A. Knopf, New York. 302 p.

Schleyer, B.O., Jonkel, J.J., Rhoades, K.G., and D.M. Dunbar. 1984. The effects of nonmotorized recreation on grizzly bear behavior and habitat use. Inter. Grizzly Bear study team, MSU, Bozeman, MT. 83 p.

Schullery, P. 2002. Lewis and Clark: Among the Grizzlies: Legend and legacy in the American west. Falcon, Helena, MT. 247 p.

Schwartz, C.C., and M.A. Haroldson. 2000. (*Eds.*)Yellowstone grizzly bear investigations. Annual report of the Interagency grizzly bear study. U.S. Dept. Interior, U.S. Geological Survey, Bozeman, MT.

Schwartz, C.C., Haroldson, M.A., Gunther, K.A., and D. Moody. 2002. Distribution of grizzly bears in the Greater Yellowstone Ecosystem, 1990-2000. Ursus 13: 203-212.

Sheppard, D.H. 1999. Southwest Alberta grizzly bear DNA census: What it tells us and what it doesn't. A review. Crown Castle Wilderness Coalition, Pincher Creek, AB.

Sheppard, D.H., Parkstrom, G., and J.C. Taylor. 2002. Bringing it back: A restoration framework for the Castle Wilderness. Castle Crown Wilderness Coalition, Pincher Creek, AB. 176p.

Stenhouse, G., Boyce, M., and J. Boulanger. 2003. Report on Alberta grizzly bear assessment of allocation. Alberta Sustainable Resource Development, Fish and Wildlife Division, Edmonton, AB. 41 p.

Suring, L.H., Barber, K.R., Schwartz, C.C., Bailey, T.N., Shuster, W.C., and M. D. Tetreau. 1998. Analysis of cumulative effects on brown bears on the Kenai Peninsula, southcentral Alaska. Ursus 10: 107-117.

Taylor, M., Obbard, M., Pond, B., Kuc., M., and D. Abraham. 2002. Riskman. Version 1.8. Stochastic and deterministic population modelling RISK MANagement decision tool for harvested and unharvested populations. Wildlife Division, Dept. Sustainable Development, Govt. of Nunavut, and Wildlife and Natural Heritage Section, Ministry of Natural Resources, Ontario. 37 p.

U.S. Fish and Wildlife Service. 1993. Grizzly bear recovery plan. U.S. Dept. Interior, Grizzly Bear recovery coordinator, Missoula, MT.

U.S. Fish and Wildlife Service. 1993b. Final biological opinion on the Lost Silver Timber Sale on the Hungry Horse Ranger District, Flathead National Forest. Helena, Montana. 31 p.

U.S. Fish and Wildlife Service. 1994. Plum Creek Timber Company cost-share roads agreement. Biological Opinion. Regional Director, Spokane, WA. 29 p.

U.S. Fish and Wildlife Service. 1995. Biological opinion on Amendment 19 to the Flathead National Forest Plan. Montana Field Office, Helena, MT. (January 6). 61 p.

U.S. Fish and Wildlife Service. 2000. Biological opinion for the effects to grizzly bear and bull trout from the implementation of proposed actions associated with plans of operation for: Sterling Corporation Rock Creek Silver/Copper Mine. Helena, MT. 132 p. + append.

U.S. Forest Service. 1995. Allowable sale quantity and objectives and standards for grizzly bear habitat management. Forest Plan Amendment #19, Amended Environmental Assessment, Flathead National Forest, Kalispell, MT. 135 p. + append.

U.S. Forest Service. 1995b. Allowable sale quantity and objectives and standards for grizzly bear habitat management. Forest Plan Amendment #19, Decision Notice. Flathead National Forest, Kalispell, MT. 30 p. + append.

U.S. Forest Service. 1999. Final environmental impact statement. Open road and open motorized trail analysis. U.S. Forest Service, Targhee National Forest, St. Anthony, ID.

U.S. Forest Service. 2000. Forest Service roadless area conservation. Final Environmental Impact Statement, Volume 1. USDA Forest Service, Washington, D.C.

U.S. Forest Service. 2001. Draft. Forest plan amendments for motorized access management within the Selkirk and Cabinet-Yaak grizzly bear recovery zones. Draft Environmental Impact Statement, Kootenai, Lolo and Idaho Panhandle national Forests, Libby, MT.

U.S. Forest Service. 2002. Protocol Paper, NCDE grizzly bear motorized access management and Flathead National Forest, Amendment 19, Moving window motorized access density analysis & security core area analylsis for grizzly bear. Flathead National Forest, Kalispell, MT. 19 p.

Vital Ground Foundation. 2003. Bear market. E-mail, September 10, 2003. Park City, Utah.

Wakkinen, W.L., and W.F. Kasworm. 1997. Grizzly bear and road density relationships in the Selkirk and Cabinet-Yaak recovery zones. Idaho Dept. Fish and Game and U.S. Fish & Wildlife Service, Bonners Ferry, ID. 28 p.

Waller, J.S. 1992. Grizzly bear use of habitats modified by timber management. M.Sc. Thesis, Montana State Univ., Bozeman, MT. 64 p.

Waller, J.S., and R.D. Mace. 1997. Grizzly bear habitat selection in the Swan Mountains, Montana. J. Wildl. Manage. 61(4): 1032-1039.

Waller, J.S., and C. Servheen. 1999. Documenting grizzly bear highway crossing patterns using GPS technology. Pp. 21-23 *In*: Proceedings of the 3rd Inter. Conf. On Wildlife ecology and transportation. (*Eds.*) Evink, G.L., Garrett, P., and D. Zeigler. FL-ER-73-99. Florida Dept. of Transportation, Tallahassee, Florida.

Waterton LNP. 1979. Traffic reports, 1970 and 1979. Parks Canada, Waterton Lakes National Park, Waterton Park, AB.

Waterton LNP. 2002. Monthly traffic reports, 2001 and 2002. Parks Canada, Waterton Lakes National Park, Waterton Park, AB.

Waterton LNP. 2003. Campsite occupancy data file. Visitor Services. Parks Canada, Waterton Lakes National Park, Waterton Park, AB.

Weilgus, R.B. 2002. Minimum viable population and reserve sizes for naturally regulated grizzly bears in British Columbia. Biological Conservation 106: 381-388.

White, D., Kendall, K.C., and H.D. Picton. 1999. Potential energetic effects of mountain climbers on foraging grizzly bears. Wildlife Society Bulletin 27(1): 146-151.

Willoughby, M.G. 1997. Castle River; range condition and trend from 1953-1995. Rangeland Reference Areas, Environmental Protection, Land and Forest Service, Alberta Sustainable Resource Development, Edmonton, AB. 22 p.

Willoughby, M.G. 1997b. Carbondale River; range condition and trend from1953-1995. Rangeland Reference Areas, Environmental Protection, Land and Forest Service, Alberta Sustainable Resource Development, Edmonton, AB. 15 p.+ Append.

Willoughby, M.G., and M.A. Alexander. 1998. Dutch Creek; range condition, forage production and fire effects from 1953-1998. Rangeland Reference Areas, Environmental Protection, Land and Forest Service, Alberta Sustainable Resource Development, Edmonton, AB. No pg. Nos.

APPENDIX A. FIGURES.

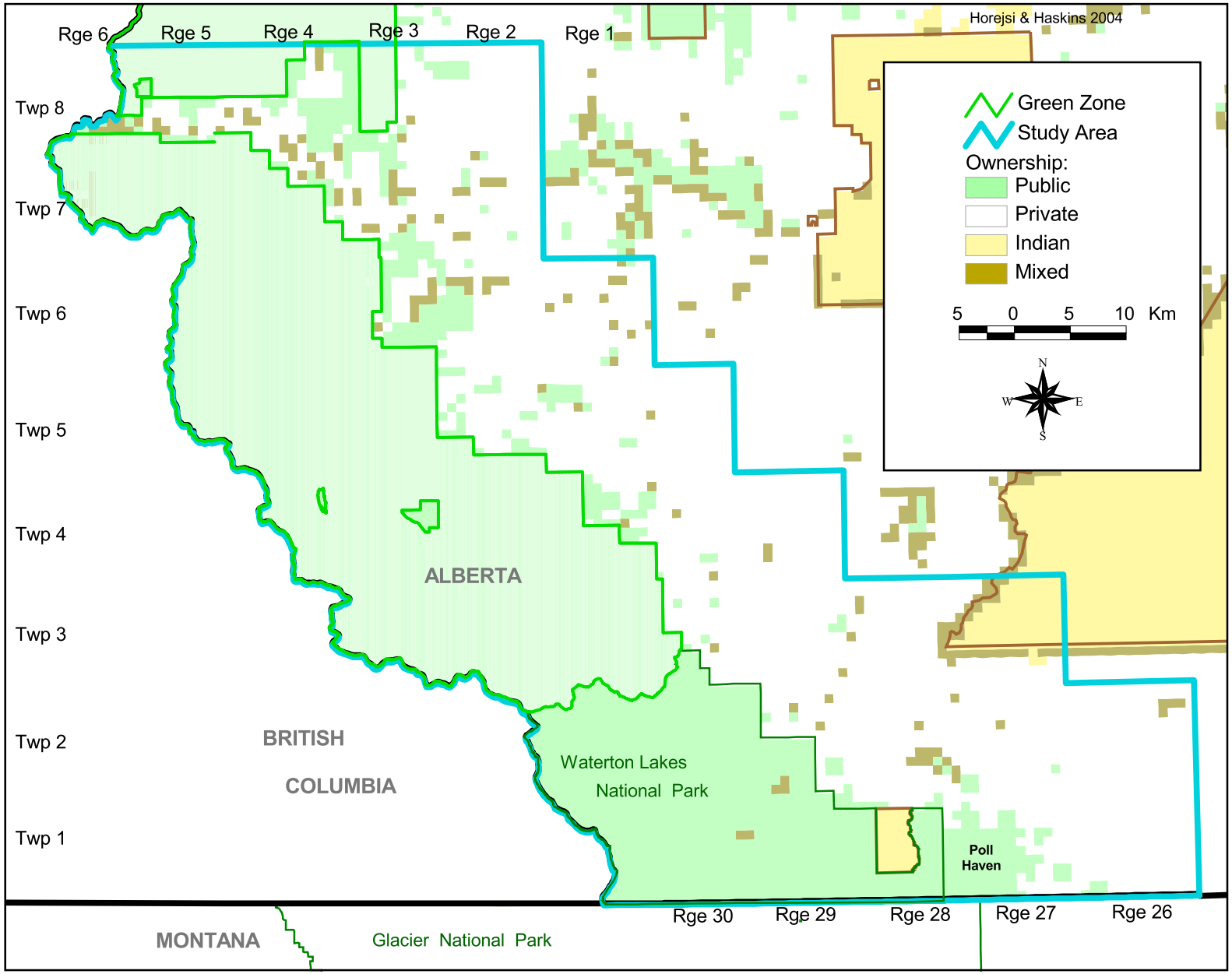

Figure 2. The distribution of public land in the study area.

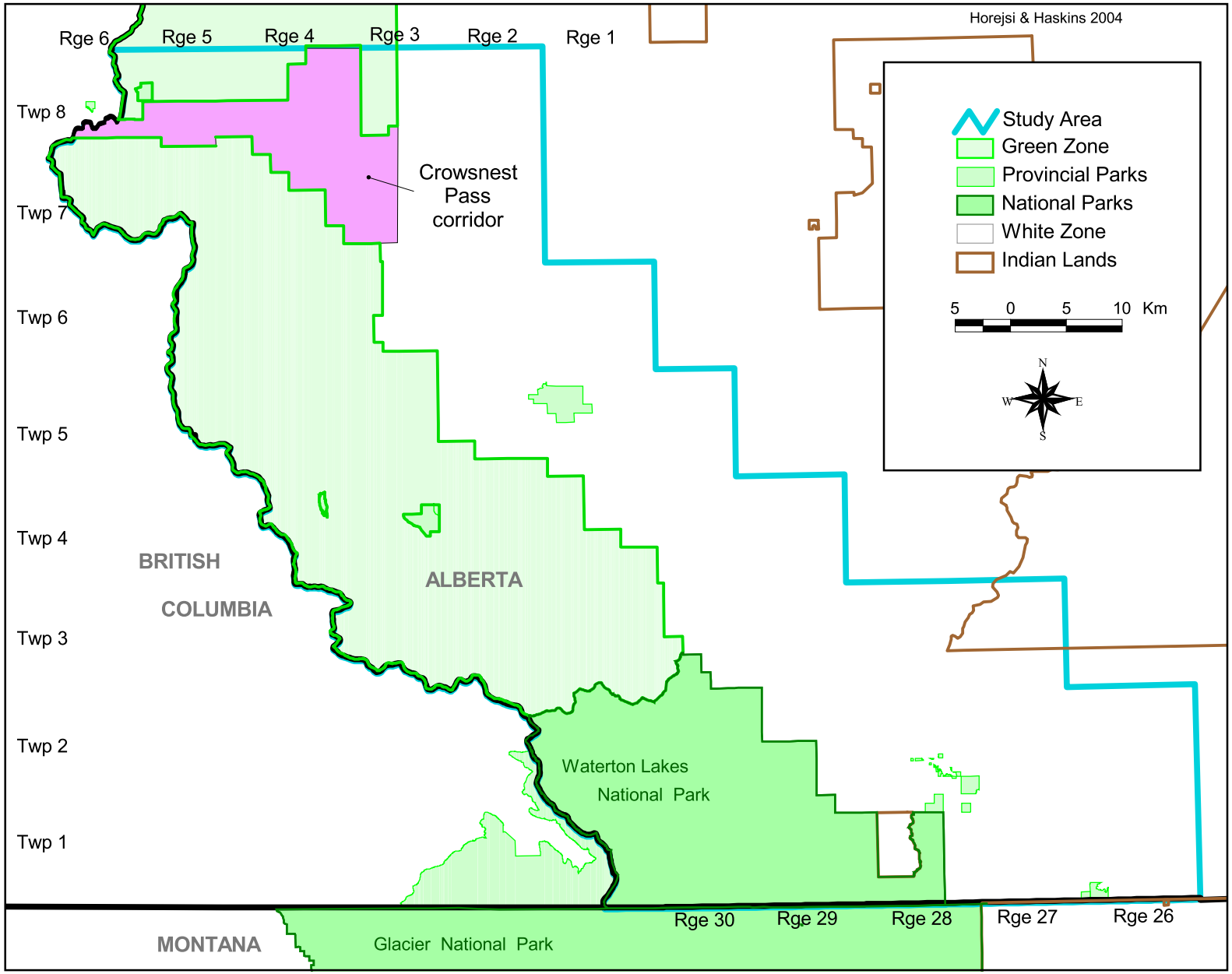

Figure 3. Location of the Crowsnest Pass corridor.

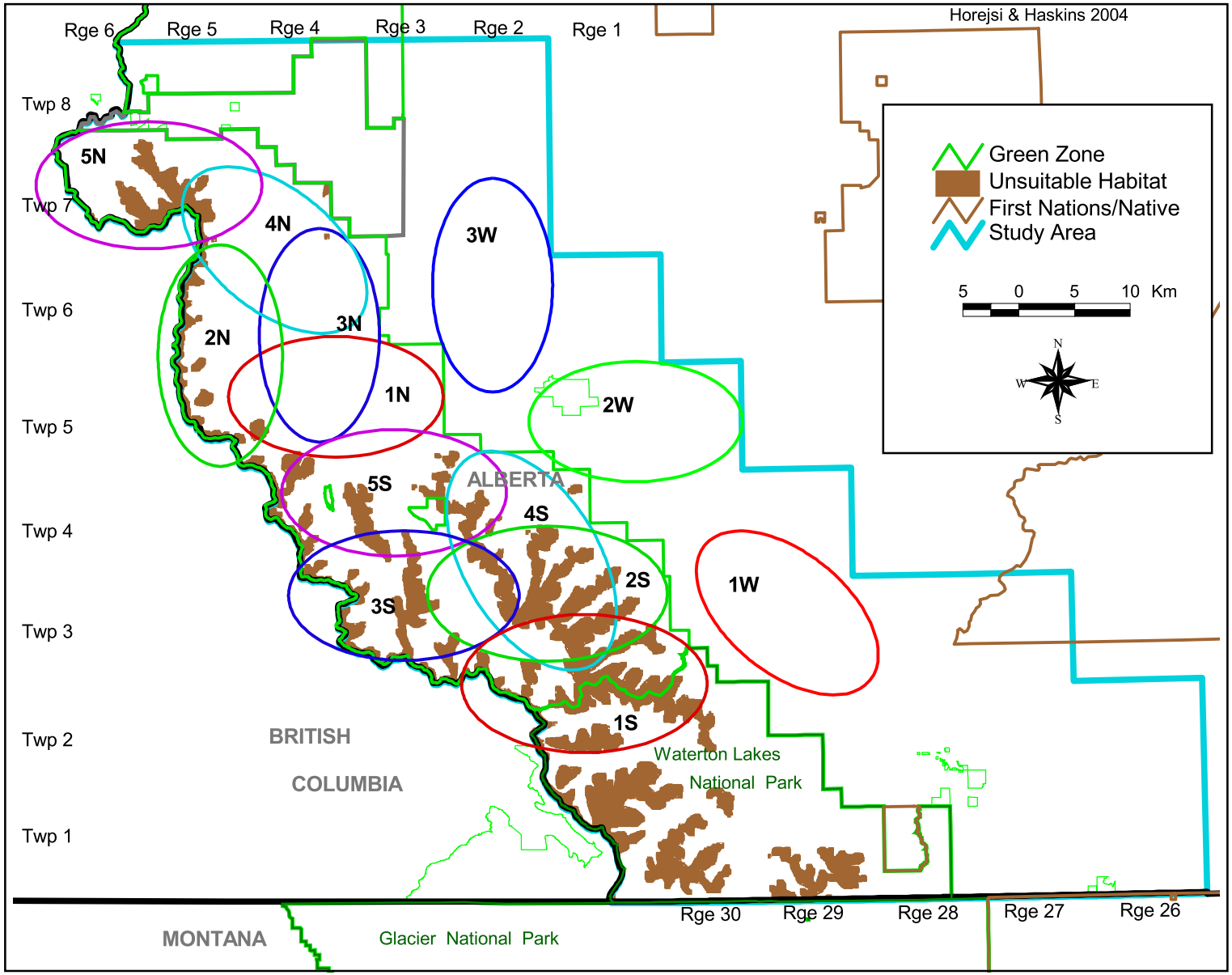

Figure 4. Home range ellipses used to determine random walk road-related risk. W = White Zone; N = north Green Zone; S = south Green Zone.

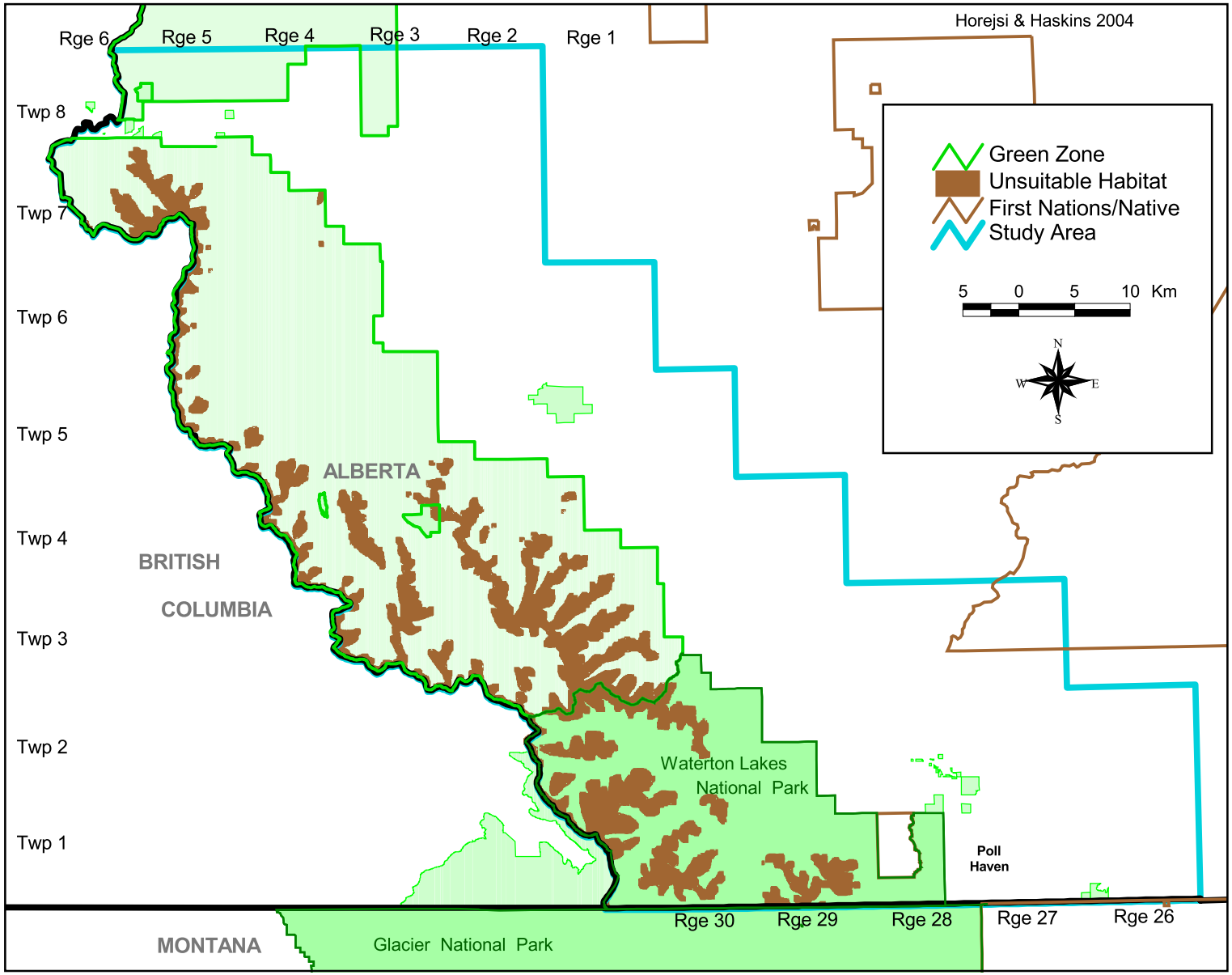

Figure 5. Unsuitable grizzly bear habitat in southwest Alberta (> 2133 m elevation).

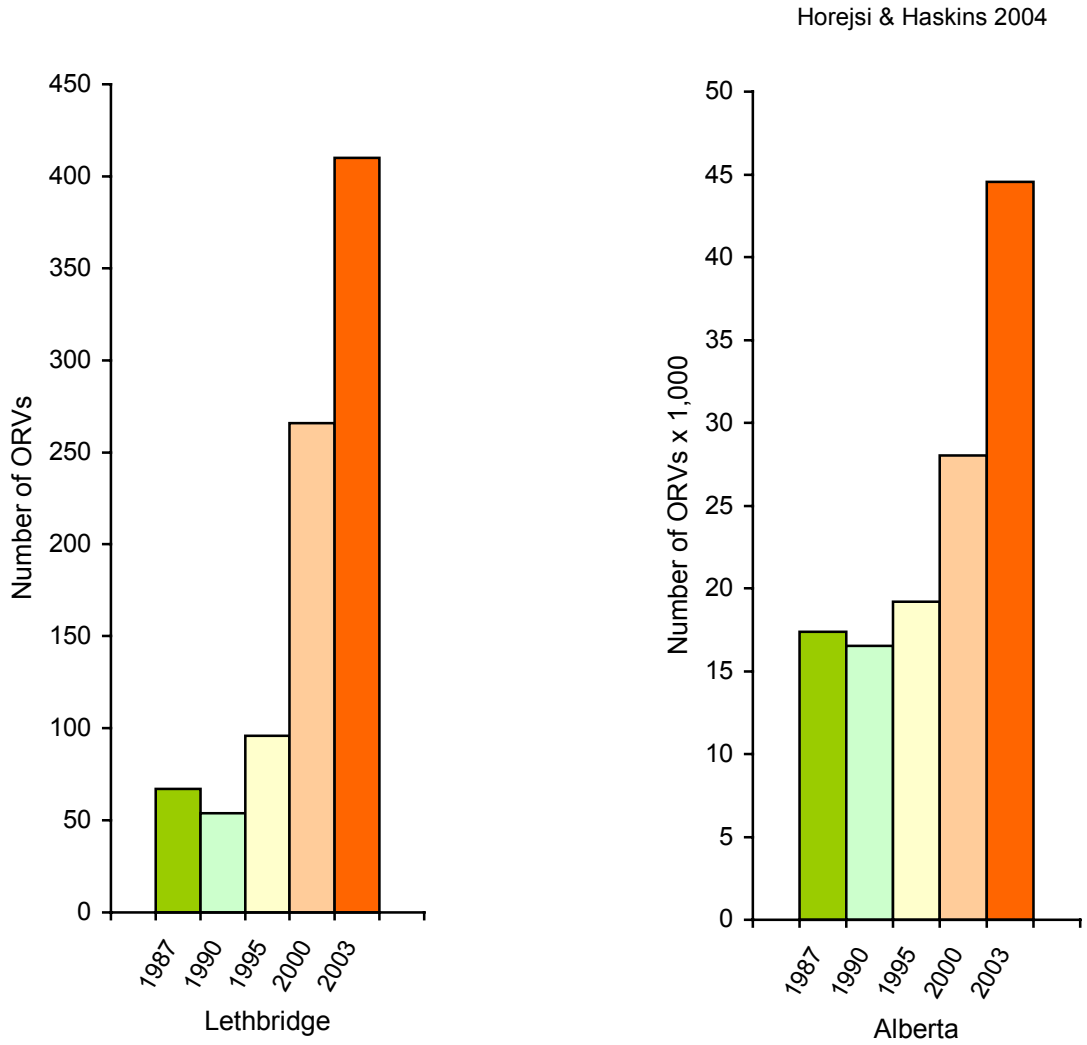

Figure 12. Registered off road vehicles (ORVs) in Lethbridge and the province of Alberta, 1987 to 2003.

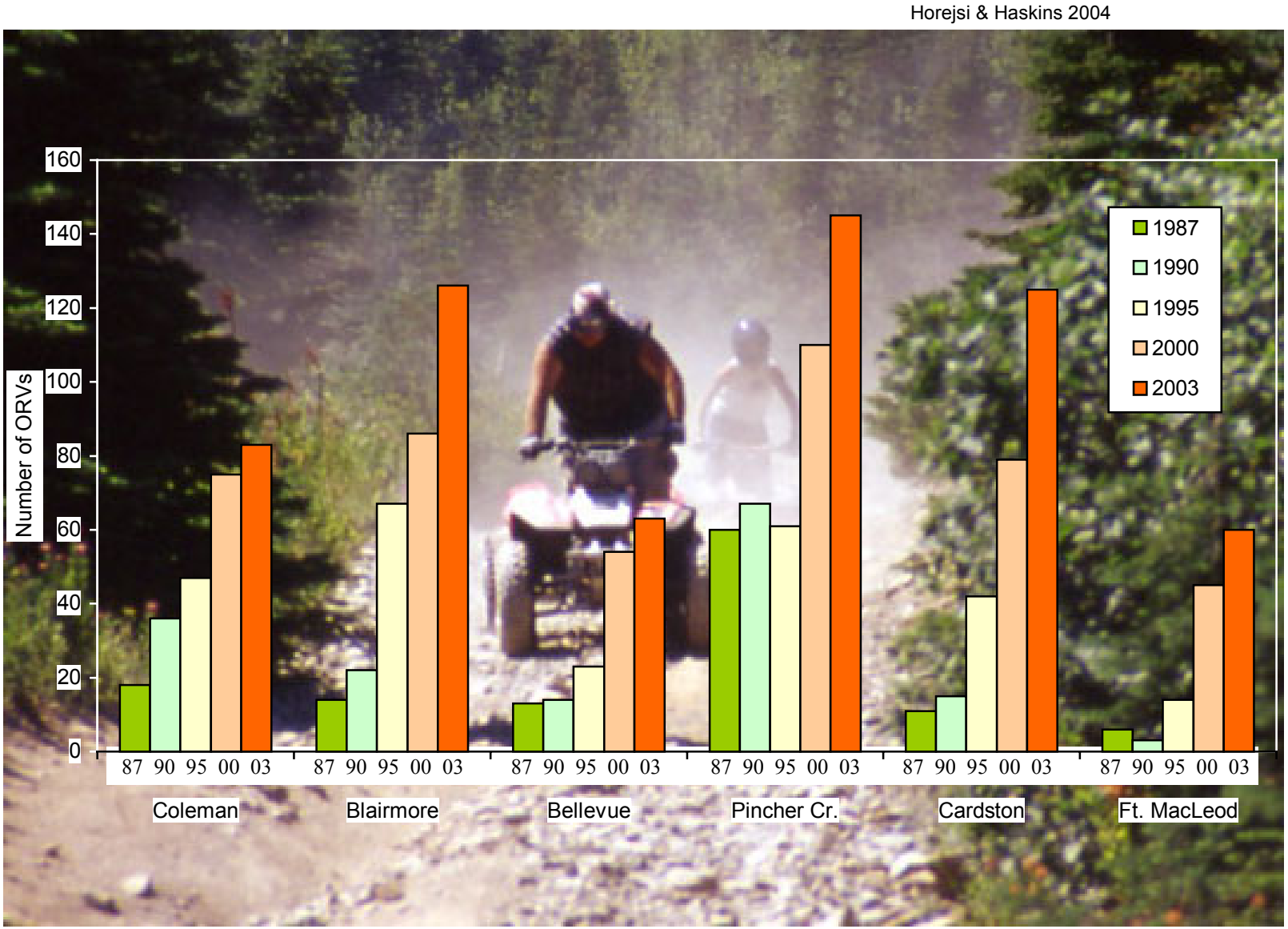

Figure 13. Registered off road vehicles (ORVs) in southwest Alberta communities, 1987 to 2003.

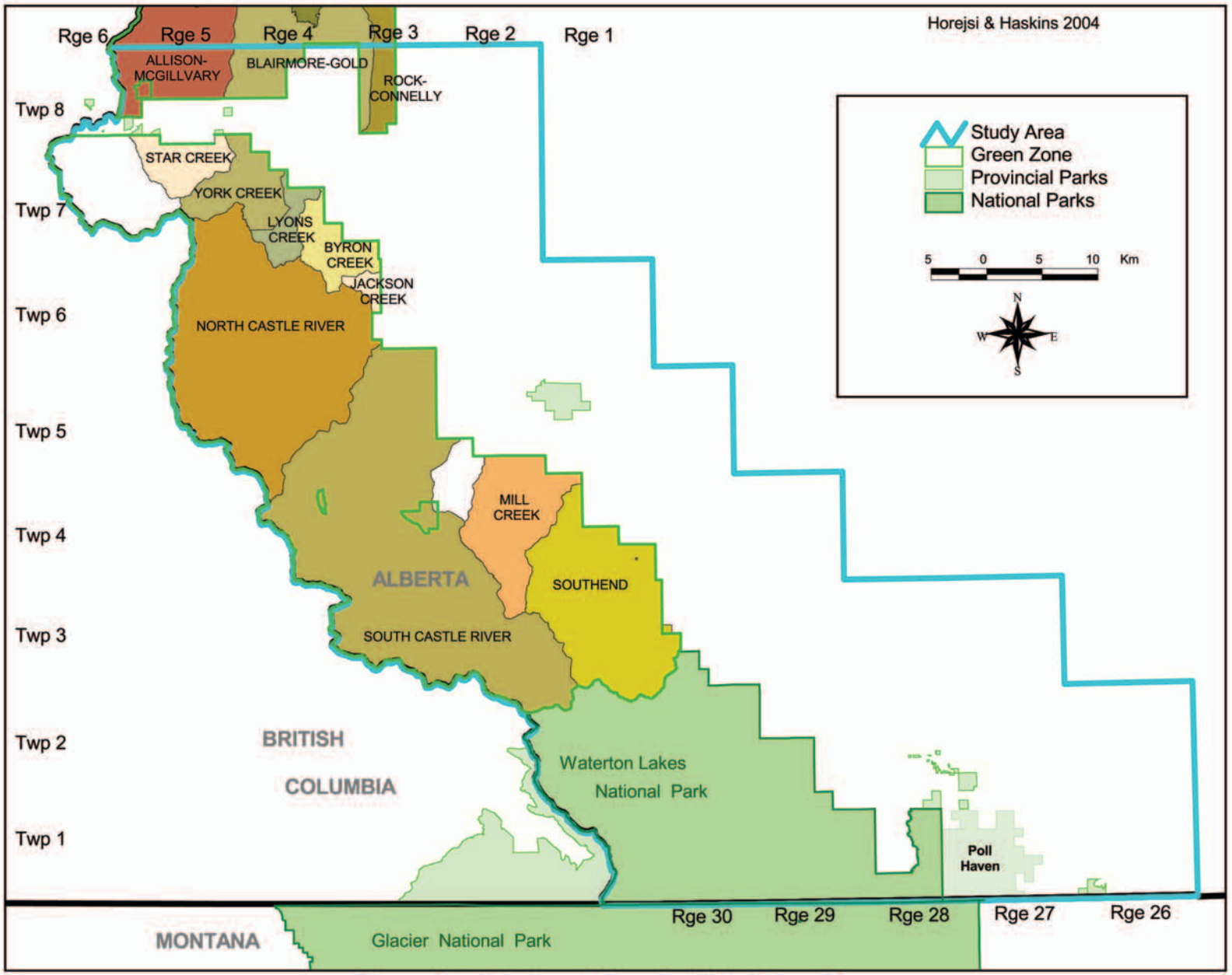

Figure 19. Grazing allotments in the Green Zone.

Horejsi & Haskins 2004

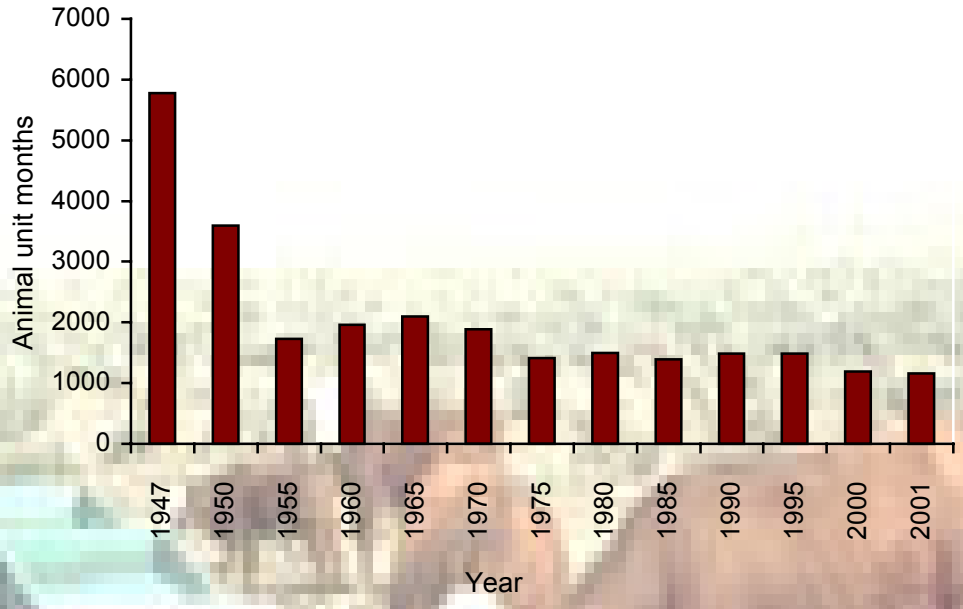

Figure 20. Grazing pressure (animal unit months actual use) in the Southend grazing allotment, southwest Alberta, 1947 to 2001.

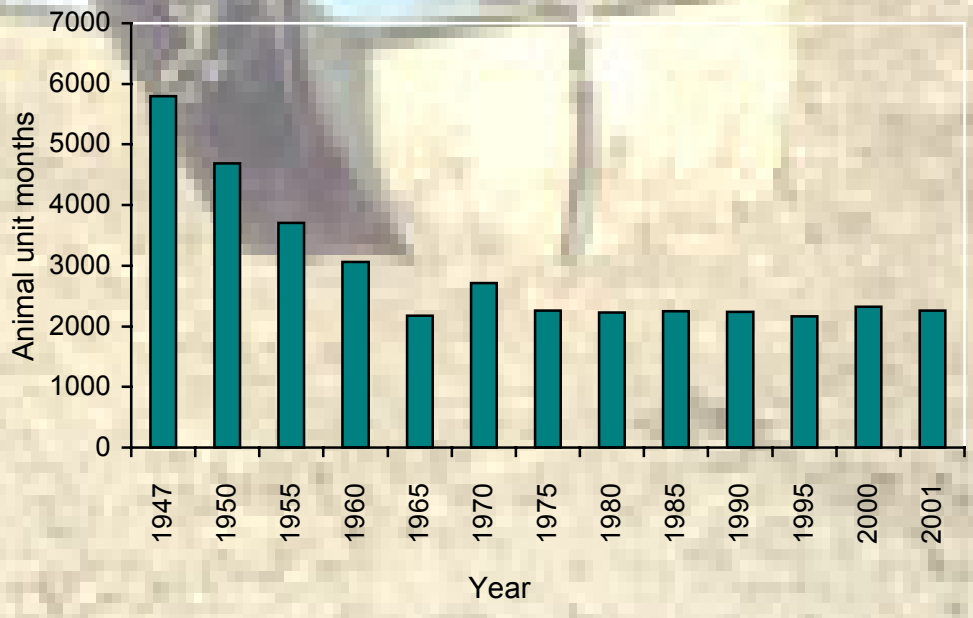

Figure 21. Grazing pressure (animal unit months actual use) in the Castle grazing allotment, southwest Alberta, 1947 to 2001.

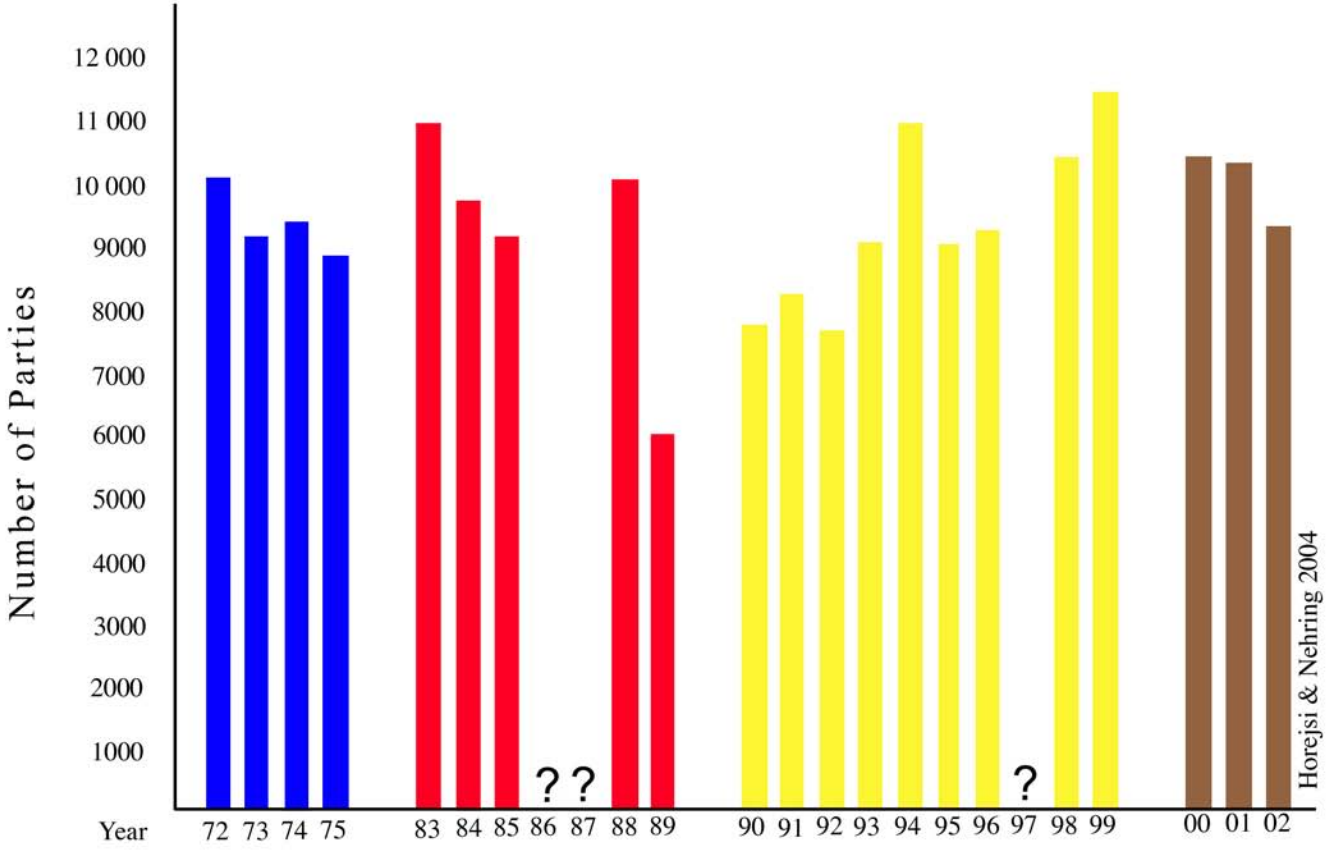

Figure 24. Crandell Mountain campsite utilization (numbers of parties),Waterton Lakes National Park,1972 2002.

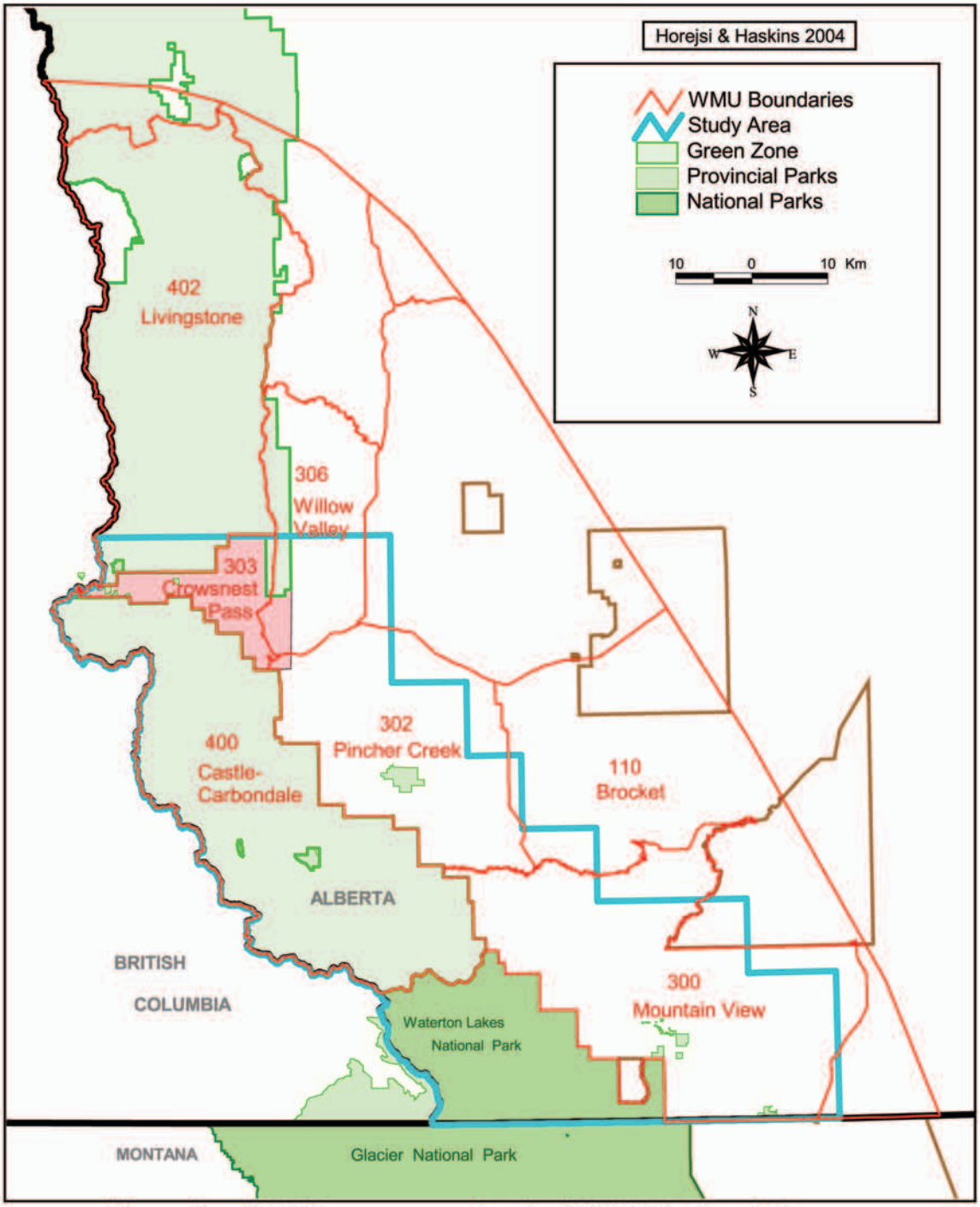

Figure 28. Wildlife management units (WMUs) in the study area.

APPENDIX B. TABLES.

Table 2. Home range metrics for random walk and road encounter risk home ranges.

Home range	Length(km)	Width (km)	Gross Area (km2)	Unsuitable(km2)	Suitable(km2)	% Unsuitable	% in B.C.	% in Waterton LNP
1N	19.2	10.8	163.4	1.2	162.2	0.8	0.0	0.0
2N	19.8	11.2	173.8	10.9	162.9	6.3	20.4	0.0
3N	19.2	10.8	161.8	0.0	161.8	0.0	0.0	0.0
4N	19.4	10.9	166.9	5.3	161.6	3.2	2.1	0.0
5N	20.3	11.4	181.2	18.9	162.4	10.4	24.4	0.0
Total	97.9	55.1	847.2	36.3	810.9	20.6	46.8	0.0
Average	19.6	11.0	169.4	7.3	162.2	4.1	9.4	0.0
1S	22.0	12.4	214.0	52.5	161.5	24.5	14.6	32.8
2S	21.5	12.1	204.3	41.8	162.4	20.5	0.0	0.0
3S	20.7	11.6	188.7	27.6	161.1	14.6	14.8	0.0
4S	21.7	12.2	207.2	44.5	162.7	21.5	0.0	0.0
5S	20.2	11.3	179.2	18.1	161.1	10.1	0.0	0.0
Total	106.0	59.6	993.3	184.5	808.8	91.2	29.4	32.8
Average	21.2	11.9	198.7	36.9	161.8	18.2	5.9	6.6
1W	19.2	10.8	161.8	0.0	161.8	0.0	0.0	0.0
2W	19.2	10.8	161.8	0.0	161.8	0.0	0.0	0.0
3W	19.2	10.8	161.8	0.0	161.8	0.0	0.0	0.0
Total	57.5	32.3	485.5	0.0	485.5	0.0	0.0	0.0
Average	19.2	10.8	161.8	0.0	161.8	0.0	0.0	0.0

Table 3. Demographic parameters used to run RISKMAN. Data are from theYellowstone Grizzly Bear Ecosystem and have been reproduced from McLoughlin (2002).

	Mean	Standard Error
Survival of cubs	0.841	0.064
yearlings	0.874	0.064
subadult[1] females	0.886	0.064
subadult[1] males	0.888	0.064
Adult females	0.951	0.064
Adult males	0.949	0.064
Litter size	2.385	0.100
Proportion of females able to mate in previous year that are successful in producing cubs in the next year	0.595	0.067
Mean age, first cubs	6	-
Mean age, last reproduction[2]	20	-
Maximum age of survival[2]	20	-

[1] Ages 2 - 5

[2] Based on absence of bears 20+ years of age in capture and kill records from southwest Alberta.

Table 4. Ecosystem size (km^2), International boundary and U.S. threatened and endangered grizzly bear populations.

U.S. Recovery areas	
Yellowstone Ecosystem	24,101 km^2
Northern Continental	23,157
International Populations	
Selkirk Ecosystem	9,478
Cabinet Yaak	6,254
Southwest Alberta	
Study area	3,733
Green Zone + Waterton	1,690
White Zone with CNP	2,043

Table 5. Road load calculations for each of the random walk and road encounter risk home ranges.

Home range	Suitable habitat (km2)	Linear feature length (km)	Linear feature density (km/km2)	500m zone of influence (km2)	Percent in 500m zone of influence
1N	162.2	385.8	2.38	142.7	88.0
2N	162.9	268.7	1.65	118.2	72.5
3N	161.8	348.6	2.15	135.1	83.5
4N	161.6	283.9	1.76	125.8	77.9
5N	162.4	249.2	1.54	108.8	67.0
Total	810.90	1536.15	9.48	630.43	388.77
Average	**162.18**	**307.23**	**1.90**	**126.09**	**77.75**
1S	161.5	105.9	0.66	68.5	42.4
2S	162.4	133.4	0.82	76.5	47
3S	161.1	97.6	0.61	65.2	40.4
4S	162.7	84.2	0.52	58.3	35.8
5S	161.1	181.5	1.13	81.7	50.7
Total	808.80	602.67	3.73	350.06	216.46
Average	**161.76**	**120.53**	**0.75**	**70.01**	**43.29**
1W	161.8	290.8	1.80	141.2	87.3
2W	161.8	306.4	1.89	144.2	89.1
3W	161.8	258.3	1.60	133.7	82.6
Total	485.49	855.49	5.28	419.12	258.99
Average	**161.83**	**285.16**	**1.76**	**139.71**	**86.33**

N = north; S = south; W = white

Table 6. Waterton Lakes National Park road density calculations. Unsuitable habitat and Waterton Lake excluded.

	Road buffer			Moving window road density, mi/mi2				Moving window road density, km/km2			
	Total	Within 500 m road/trail buffer	Outside of 500 m road/trail buffer	0 mi/mi2	>0 - 1	>1 - 2	>2	0 km/km2	>0 - 1	>1 - 2	>2
hectares	40725	16026	24698	16472	6967	9632	7654	16472	14211	7027	3014
percent	1.00	0.39	0.61	0.40	0.17	0.24	0.19	0.40	0.35	0.17	0.07

Table 10. Grizzly bears (all ages) relocated from and to southwest Alberta, by wildlife management unit, 1974 to 2002 annually. Subscript(+) = number of bears placed in WMU. Data from: Alberta NRS 1997 and Alberta SRD 2003c.

Year	Wildlife Management Unit									
	South of Highway #3				North of Highway #3					
	300	302	400	110	303	402	306	304, 305, 308		
1974	-	-	-	-	-	-	-	-	-	-
1975	-	-	-	-	-	-	-	-	-	-
1976	-	-	-	-	-	-	-	-	-	-
1977	1	-	-	-	-	$-_{+1}$	-	-	-	-
1978	-	1	-	-	-	$-_{+1}$	-	-	-	-
1979	1	-	1[1]	-	-	-	-	-	-	-
1980	1	3	-	-	-	-	-	-	-	-
1981	1	2	-	-	-	-	-	-	-	-
1982	-	2	-	-	-	-	-	-	-	-
1983	-	1	-	-	-	-	-	-	-	-
1984	2	2	$-_{+1}$	-	-	$-_{+1}$	-	-	-	-
1985	-	1	-	-	-	-	-	-	-	-
1986	9	-	$-_{+2}$	-	-	-	-	-	-	-
1987	5	-	-	-	-	-	-	-	-	-
1988	-	-	-	-	-	-	-	-	-	-
1989	-	-	$-_{+1}$[2]	-	-	1	-	-	-	-
1990	-	1	-	-	-	$-_{+1}$	-	-	-	-
1991	3	-	-	-	-	1	-	-	-	-
1992	2	1	-	-	-	4_{+1}[3]	-	-	-	-
1993	1	1	-	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-	-	-	-
1995	4	-	-	-	-	-	-	-	-	-
1996	6	2	-	-	-	$-_{+4}$[4]	-	-	-	-
1997	16	1	-	-	1	$-_{+3}$[5,6]	-	-	-	-
1998	9	3	$-_{+6}$[7]	-	-	$-_{+1}$[8]	-	-	-	-
1999	4	-	$-_{+4}$[9]	-	-	-	-	-	-	-
2000	1_{+1}[10]	2	$-_{+2}$[11]	-	2	1_{+3}	-	-	-	-
2001	2	1	$-_{+1}$[12]	-	1	-	-	-	-	-
2002	3	2	$-_{+5}$[13]	4	1_{+1}[14]	$-_{+1}$[15]	-	-	-	-

[1] To Flathead R. in B.C. [2] From WMU 402 [3] Relocate within WMU 402 [4] From WMU 300
[5] Both from WMU 300 [6] One from WMU 303 [7] From WMU 300 [8] From WMU 300
[9] From WMU 300 [10] From WMU 300 [11] Both from WMU 110 to the east
[12] From WMU 302 [13] Female + 3 SuAd (2M, F) from WMU 110 [14] From same WMU
[15] From WMU 300

Table 14. Grizzly bear mortality in southwest Alberta, as reported annually, by wildlife management unit, 1972 to 2002. Data from: Alberta SRD 2002b and Gunson 1995.

Year	Wildlife Management Unit							
	South of Highway #3				North of Highway #3			
	300	302	400	303[1]	402	306	304, 305, 308	
	Closed to legal hunt 1970 to 1981							
1972	-	-	-	-	-	-	-	- -
1973	-	-	-	-	-	-	-	- -
1974	-	-	4	-	-	-	-	- -
1975	-	-	-	-	-	-	-	- -
1976	2	-	-	-	-	-	-	- -
1977	-	-	-	-	-	-	-	- -
1978	-	-	-	-	-	-	-	- -
1979	1	1	1	-	-	-	-	- -
1980	-	-	-	-	-	-	-	- -
1981	-	-	-	-	1	-	-	- -
			Hunt reintroduced					
1982	3	-	2	-	-	-	-	- -
1983	4	-	3	-	-	-	-	- -
1984	2	-	3	-	3	-	1	- -
1985	2	1	1	-	1	-	-	- -
1986	1	1	2	-	3	-	-	- -
1987	7	-	5	-	2	-	-	- -
1988	-	-	3	-	-	-	-	- -
1989	1	-	1	-	-	-	-	- -
1990	1	-	1	-	1	-	-	- -
1991	-	-	2	-	-	-	-	- -
1992	1	-	1	-	1	-	1	- -
1993	-	-	1	-	3	1	-	- -
1994	-	-	1	-	-	1	-	- -
1995	-	-	2	-	3	-	-	- -
1996	1	-	-	-	-	-	-	- -
1997	2[2]	-	-	-	1	-	-	- -
1998	1	-	1	-	-	-	-	- -
1999	2	1	1[3]	-	-	-	-	- -
2000	1	-	1	-	-	-	-	- -
2001	2	1	-	-	1	-	-	- -
2002	2	-	-	-	-	-	-	- -

[1] Established in 1996; formerly part of WMU 402 [2] Killed by another bear [3] Killed by another bear