SUMMARY: EASTERN SLOPES GRIZZLY BEAR PROJECT FINAL REPORT

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DEMOGRAPHY OVERVIEW

Long term survival of independent female grizzly bears (*Ursus arctos*) was the primary factor influencing whether grizzly bear numbers were increasing or decreasing. The reproductive output of the bears we studied in the Bow River watershed was exceptionally low and not likely to increase in the short run. Since most of the independent female bear mortality was caused by people, managing human-caused mortality to attain high survival rates is essential for population persistence or increase.

THE RAPIDLY DEVELOPING REGIONAL LANDSCAPE

Grizzly bear habitat in Banff National Park (BNP), Kananaskis Country (KC), and surround can be reached after a 1–2 hour drive from Calgary, an affluent city of 900,000 in Alberta, Canada. Calgary's human population grew by 16%, 1996–2000, the fastest rate of urban growth in Canada. Nearby smaller cities and towns such as Canmore, Cochrane and Bragg Creek also had rapid growth. The oil and gas driven economy will continue to fuel rapid growth and development in Calgary and surround and will encourage more people to be in grizzly bear habitat. Grizzly bear conservation will depend upon managing the cumulative effects of humans. Grizzly bears in this area live in one of the most developed and rapidly developing landscapes where they still survive.

THE ESGBP AND AREAS WHERE WE CONDUCTED RESEARCH

The Eastern Slopes Grizzly Bear Project (ESGBP) began in 1994 in response to regional development pressures and their potential adverse effects on the vulnerable grizzly bear. The primary research area was the Bow River watershed (BRW) from its headwaters in the Rocky Mountains near Bow Lake to approximately where it meets the prairie. This 11,400 km^2 area included roughly half of BNP and all of the adjacent Alberta Provincial land known as KC plus other Alberta provincial land. A larger research area, approximately 40,000 km^2, called the Central Rockies Ecosystem (CRE), was also a focus of research in recognition of probable genetic connectivity throughout this area and the large movements of, especially male, grizzly bears. The CRE included Alberta provincial lands as far north as Highway 11, south to and including the Highwood River drainage, and east as far as grizzly bears were found. In British Columbia provincial lands adjacent to the Alberta portion of the CRE and extending to the Columbia Trench were included, as well as Yoho and Kootenay National Parks.

The ESGBP is an independent research group based at the University of Calgary. It has been partly funded and advised by a steering committee made up of representatives from governments (Alberta, BC, and Canada), business and industry, conservation groups and other regional stakeholders. The ESGBP has no formal decision, management or policy role.

THE ESGBP'S 9 YEAR STUDY OF BIOLOGY, DEMOGRAPHY AND ECOLOGY USING RADIOTELEMETRY

During 1994–2002, in cooperation with government agencies, we captured, radiomarked, and monitored 37 female and 34 male grizzly bears in the BRW. Based on this sample we estimated rates of survival and reproduction with a focus on estimating demographic vigor (i.e. the rate of population growth, lambda [λ]) and understanding spatial, temporal and environmental covariates of human-caused mortality. For the radiomarked sample of grizzly bears we also studied morphology, genetic structure (relevant to genetic and demographic fragmentation), nutrition and stress, movements and home range characteristics, resource selection, response to human use, habitat effectiveness and security, and denning. In the CRE we also investigated human-caused mortality, regional growth, and the science and policy of grizzly bear management.

DEMOGRAPHIC RESEARCH RESULTS

Annual survival rates of radiomarked grizzly bears, 1994–2002, other than dependent young averaged 95% for females and 81–85% for males. Although grizzly bears were mostly unhunted in the BRW, humans caused 75% of female mortality and 86% of male mortality. Females produced their first surviving litter at 6–12 years of age ($\bar{x}$ = 8.4 years). Litters averaged 1.84 cubs spaced at 4.4-year intervals. Adult (6+ year-old) females produced 0.24 female cubs per year and were expected to produce an average of 1.7 female cubs in their lifetime, based on rates of reproduction and survival. Summed elasticities for female survival (0.92) far exceeded elasticities for reproduction (0.08) documenting the dominant role of female survival on reproductive output. Although this is the slowest reproducing grizzly bear population yet studied in North America, high rates of survival seem to have enabled positive population growth (λ=1.04, 95% CI = 0.99–1.09), based on analyses using Leslie matrices. We caution, however, that we are <95% certain that the population is not actually declining. Given the biological nature of grizzly bears and the cost of such research, it is unlikely we will ever know the population status with more certainty. Current management practices, instituted in the late 1980s, focus on alleviating human-caused bear mortality. This emphasis on controlling human-caused mortality is critical to the continued health of this population. If the 1970–80s style of management, with resulting higher human-caused mortality rates, had continued, we estimate that an average of 1 more radiomarked female would have been killed each year, reducing female survival to the point that the population would have declined. Maintaining high survival rates in a landscape as developed as the BRW requires substantial planning and management efforts, public support and adequate budget.

We believe our results regarding grizzly bears radiomarked in the BRW are acceptably precise regarding the probable positive growth rate, 1994–2002. However, our knowledge regarding the status of grizzly bears in the remaining, approximately 30,000 km^2 of the CRE in Alberta and British Columbia, is relatively poor. Over most of this area grizzly bears and ungulates are hunted, with resulting increases in grizzly mortality risk. Extensive resource-related development associated with forestry, mining, and recreation occurs. Demographic research on grizzly bears has not been done. However, within the CRE north of the Bow River (Bear Management Area 4C, Alberta), government research concluded that there was a trend of declining age structure for dead female bears. Females formed a major component of total mortalities. This was identified as being of potentially serious management concern and steps to reduce the mortality rate were seen as necessary (Stenhouse, G., M. Boyce, and J. Boulanger. 2003. Report on Alberta grizzly bear assessment of allocation. Report to Alberta Sustainable Resource Development, Edmonton, Alberta, Canada).

Postscript to Demographic research results

Following 9 years of intensive study (1994–2002) of grizzly bears, mortality monitoring was continued for another 2 years. A sample of 18 radiocollared females and 9 males were tracked from the ground during 2003–2004. Two females and 3 males died in 2003 and 4 females and 2 males died in 2004. Four (36%) of these (2 males, 2 females) were natural mortalities, 3 were caused by other bears and 1 by wolves. The 7 human-related loses (4 females, 3 males) were the result of collisions with a vehicle on the highway (n=2), translocations due to nuisance activity (n=3) or being shot (n=2).

Estimated survival for females (all ages pooled) based on these data was 88% (95%CI 72–100%) in 2003 and 71% (CI 45–96%) in 2004. These rates were well below the mean and confidence intervals of the previous 9 years (95% CI 91–99%, yearly range 93–100%). They were also below the minimal rate of survival (91%) necessary to sustain this population (i.e., to achieve λ = 1), given previous reproductive output. The sample, however, was small and potentially biased.

Results from these last 2 years of monitoring reemphasize two important points discussed in our previous paper: (1) the effects of stochastic events (and possibly increased density-dependent effects) on grizzly bear demographics, and (2) the importance of continued monitoring for a population like this, where slight changes in bear or human behavior that influence grizzly bear mortality can tilt population trend from positive to negative.

POPULATION AND HABITAT VIABILITY WORKSHOP

In 1999 the ESGBP, in conjunction with the IUCN's Conservation Breeding Specialist Group and 87 participants, conducted a Population and Habitat Viability Assessment (PHVA) using the *Vortex* model. The PHVA report is the only attempt by the ESGBP to project future conditions for grizzly bears at the scale of the entire CRE. Habitat quality and degree of human use and development were incorporated into the model. The model was not assumed to have precise population parameters as input. Best estimates based on available research were used and sensitivity to parameter increase or decrease was documented. Assumptions were explicit so future improvement is possible with additional research.

Vortex was programmed to predict the probability of population decline or increase in the future. Risk assessment projections depended most heavily on 2 demographic parameters: the percentage of adult females breeding, and rate of adult female mortality. Percentage of adult females breeding is influenced primarily by nutrition and is not likely to change much in the short term. The rate of adult female mortality depends primarily on people's actions. This can be influenced strongly by policy and management. PHVA modeling showed that a predicted, significant increase in human population and related development would likely further decrease habitat security. Without changes in management, this was predicted to increase contact between humans and female grizzly bears, increase female grizzly bear mortality rate, and cause a population decline. The PHVA workshop concluded that impacts of humans on grizzly bear habitat and mortality need to be reduced even while numbers of humans in the region increase. To accomplish this, the workshop recommended grizzly bear habitat restoration (primarily by access management) approaching 2% annually in order to decrease probabilities for female grizzly bear mortality. Habitat restoration would proceed until it was scientifically demonstrated that grizzly bear mortality rates were sustainable throughout a given management unit.

POPULATION DENSITY

While estimating grizzly bear population density was not a major objective of our research we used radiomarked bears, DNA from hairsnagging, and a capture/recapture design to estimate density in a 4000 km^2 portion of the BRW. Our estimate was too imprecise to be used for population management but it was convergent with estimates from 2 previous studies. However, neither of these had estimates with acceptable precision. Nonetheless, the 3 studies had convergent results that suggested a population density estimate of 1.2–1.6/100 km^2 (no acceptable CIs) for the areas studied. In the northwestern portion of the CRE in BC densities were probably higher, 2.2 (95% CI 1.5 – 4.3)/100km^2 [Apps, C.D., B.N. McLellan, J.G. Woods, and M.F. Proctor. 2004. Estimating grizzly bear distribution and abundance relative to habitat and human influence. Journal of Wildlife Management 68: 138–152], reflecting the greater moisture and productivity of this portion of the CRE. The low density estimates for the BRW are consistent with the low reproductive output and further suggest population vulnerability.

MORTALITY IN THE BOW RIVER WATERSHED

Based on research previously conducted on other grizzly bear populations we knew, before the ESGBP began, that mortality in the independent female cohort would be the primary factor influencing demographic vigor. Therefore, we researched circumstantial, spatial, temporal and environmental correlates of mortality with the objective of identifying management actions that could lessen female grizzly bear mortality. We analyzed mortality for the radiomarked sample in the BRW. We also analyzed all known mortalities (radiomarked and not radiomarked) that occurred in the BRW 1993–2002. Of 39 known mortalities, 87% (34 of 39) were human-caused. Treaty Indians, who can legally kill grizzly bears anytime outside of national parks, accounted for 20% (8 of 39) of all, known mortalities; government action 18% (7 of 39); citizen action 15% (6 of 39); accidental 15% (6 of 39); natural 10% (4 of 39); research 8% (3 of 39), illegal 5% (2 of 39), misidentification 3% (1 of 39), unknown cause 3% (1 of 39) and legal harvest 3% (1 of 39). These multiple sources of mortality demonstrate the complexity of management response needed. Legal harvest, the single largest contributor in the Alberta and BC Provincial mortality databases, and the easiest to manage, is a minor factor in the BRW. There is currently no effective dialogue by federal or provincial governments with First Nations, the largest mortality source.

Sex specific data revealed that 41% of all known, human-caused mortalities in the BRW were female bears (n=14). Additionally 3 adult female bears were translocated out of the ecosystem (essentially lost) over the 10 year period. The loss of this many females in the BRW during our study is a potentially serious management concern that was not identified in the analysis of the radiomarked sample. Possibly, the female grizzly bear mortality rate in the BRW may have been higher than we calculated for our radiomarked sample. If this were true our estimate of lambda would have been high.

GRIZZLY BEAR MORTALITY IN BANFF AND YOHO NATIONAL PARKS

For Banff and Yoho National Parks we conducted univariate spatial and temporal analyses to examine the relationship between access, changing grizzly bear management strategies, and grizzly bear mortality, 1971–98. Concurrent with improved management of people's food and garbage, and management effort aimed at not removing "problem" independent female grizzly bears, the annual number of grizzly bear deaths declined significantly between 1971–84 ($\bar{x}$ = 7.07) to 1985–98 ($\bar{x}$ = 1.43) However, the female portion of this mortality was 80% from 1985–98 compared to 50% during the earlier period. Human-related causes were the primary sources of recorded grizzly bear mortality in the study area with 91% (119 of 131) of known mortalities. Control of problem bears accounted for 71% (85 of 119) of known human-caused mortalities, followed by highway and railway mortalities 19% (23 of 119), unknown cause of death 9% (11 of 119), and research 1% (1 of 119). All 95 human-caused mortalities with known accurate locations were within 500m of roads or 200m of trails whereas only 40% of the study area fell within road or trail buffers. Eighty percent of these mortalities occurred below 2000m and near human settlements and access. Mortalities were concentrated at Banff townsite, Lake Louise, and along the Trans Canada Highway. Management of development, road and trail access, and human food and garbage are critical for managing grizzly bear mortality in these national parks.

GRIZZLY BEAR MORTALITY AND HUMAN ACCESS IN THE CRE

We acquired grizzly bear mortality data from 1972-2002 and 1976-2002 for the Alberta and British Columbia (BC) study areas of the Central Rockies Ecosystem (CRE). We conducted spatial and temporal analyses to examine the relationship between access and changing grizzly bear and land use management practices on grizzly bear mortality. We summarized mortalities by cause of death, sex, age, and cohort. Human-related causes were the primary sources of grizzly bear mortality in both study areas. In Alberta, legally harvested grizzly bears accounted for 48% of 229 known human-caused mortalities, followed by management control (18%), illegal kills (16%), self defense kills (11%), and other causes of death (7%). In BC, 81% of all known mortalities were legally hunted bears followed by management control (16%) and illegal kills (3%). Total human-caused and harvest mortality and percent females in the kill were within management guidelines for population sustainability in both jurisdictions. The total number of grizzly bears and the proportion of females killed both dropped following the implementation of limited entry hunting. Grizzly bears spend much of the year at lower elevations in both study areas, and roads and trails usually follow valley bottoms, potentially fragmenting riparian habitats. Eighty-six percent of 549 mortality locations in Alberta and BC fell below 2000m. Ninety percent of 185 known human-caused mortalities with accurate locations in Alberta and 56% of 369 in BC fell within 500m of roads and 200m of trails. Buffered roads and trails occupied 54% and 41% of the area of suitable habitat (<2400m) in each study area. Area-concentrated kills occurred along many drainages accessible by road or trail and around townsites and First Nations Reserves. Management of access, in particular of open roads, and human food and garbage, and educating hunters are critical issues with respect to managing grizzly bear mortality in the CRE. We present recommendations for reducing grizzly bear mortality.

SPATIAL PATTERNS OF GRIZZLY BEAR MORTALITY IN THE CRE

For the Alberta portion of the CRE (including Banff National Park) we examined the spatial patterns of 297 human-caused grizzly bear mortalities from 1971 to 2002. We explored relationships between mortalities and variables reflecting human development, terrain, and vegetation. Using logistic regression, we modelled the distribution of grizzly bear mortalities based on local landscape attributes as well as examining variation among demographic status, seasons, and mortality type. Grizzly bear mortalities were concentrated in 3 main regions of the Alberta portion of the CRE: (1) Lake Louise; (2) Banff town site; and (3) Alberta Provincial lands near the Red Deer River. Models describing the relative risk of mortality were positively associated with human access, water, and edge features, while negatively associated with terrain ruggedness and greenness indices. Model predictions fit well with a portion of the data withheld for model verification. Overall, relatively little of the landscape was secure from human-caused mortality for grizzly bears. This would be most directly remedied by controlling motorized access. We suggest that risk models be integrated with habitat models for identifying key habitat-related mortality sinks where mortality control should be enhanced, and secure areas where continued maintenance of security should be continued. Management and mitigation of potential habitat-related sinks may be necessary during essential grizzly bear activities such as the hyperphagic berry feeding period (August to October), or during the spring, limited-entry bear hunt, when grizzly bears are at high risk of being killed by humans.

We also did finer scale analysis of spatial and temporal aspects of female grizzly bear mortalities in Alberta and British Columbia, 1972–2002. We analyzed 106 human-caused female mortalities with acceptably accurate locations in Alberta, and 129 in British Columbia. Using a geographical information system (GIS) we analyzed the human-caused, female grizzly bear mortality densities for 2 time periods for each province: 1972–1989 and 1990–2002 for Alberta, and 1978–1989 and 1990–2002 for British Columbia. We present detailed geographic descriptions of areas having identifiable concentrations of human-caused female mortalities for each time period. We suggest that area specific mortality information and its changes over time should be a consideration in management decisions related to human-caused grizzly bear mortality and habitat. Four of the areas that had concentrated human-caused female mortalities over some of their extent were shown in another ESGBP study to also have a high probability of selection by females. These areas were: 1) around the hamlet of Lake Louise, 2) from the Red Deer River/Ya Ha Tinda area and south to and including the Burnt Timber drainage, 3) around Banff townsite and, 4) along the Canmore/Bow River corridor as far east as the Kananaskis River drainage and the Old Fort Creek drainage, and extending south to include the Wind Valley and the Evan-Thomas Recreation Area. These areas that are attractive to female grizzly bears also have significant risk of death for them. They are candidates for management action aimed at grizzly bear conservation. Using GIS generated maps we also illustrated the geographic distribution of a number of variables known to be associated with grizzly bear mortality. These variables were: access, the location of grizzly bear and ungulate hunting, the location of protected areas, and land ownership. Understanding the relationship between these variables and human-caused grizzly bear mortality could help to geographically and jurisdictionally focus grizzly bear conservation efforts.

GENETIC AND POPULATION FRAGMENTATION

Population fragmentation has been associated with the extirpation of many grizzly bear populations in the contiguous United States. To explore potential fragmentation of grizzly bears, Proctor gathered genetic samples in southwestern Canada between 1996 and 2001 (Proctor, M.F. 2003. Genetic analysis of movement, dispersal and population fragmentation of grizzly bears in southwestern Canada. Dissertation, University of Calgary, Alberta, Canada). The ESGBP collected similar samples within the BRW. Using genetic tools Proctor explored bear movement across Highway 1 and between the BRW and adjacent geographic areas. The movement trends he found in the eastern slopes area across Highway 1 were consistent with those found in his regional study area. He found little evidence for female movement across human transportation and settlement corridors that had significant amounts of human use. He also found consistent evidence of male movement. The amount of genetic differentiation found across Highway 1 was low relative to other areas within his larger study area. He found evidence of male and female movement and/or dispersal across the continental divide to the south across Elk Pass between Alberta and British Columbia. He found less evidence of movement across the continental divide north of Highway 1 into British Columbia. These results indicate that genetic connectivity across Highway 1 is being mediated by male movement while demographic connectivity is fractured (i.e. females' movement is limited). Considering the peninsular shape of the remaining distribution of grizzly bears in southwestern Canada, Proctor recommends that the long-term population fragmentation potential from the major east-west highways (1, 3, 11, and 16) should be considered for management attention.

BODY CONDITION INDEX, REPRODUCTIVE HORMONE LEVELS AND REPRODUCTION

Seeking potential explanations for low cub production by ESGBP bears trapped in the BRW, a comparison of select health parameters was made between ESGBP and Foothills Model Forest Grizzly Bear Project (FMF) bears (grizzly bears living further north but still on the eastern slopes). The parameters considered were body condition as a reflection of nutrition (indicated by a Body Condition Index [BCI]) and reproductive hormone levels as a reflection of reproductive function. The working hypothesis was that reduced reproductive output in ESGBP grizzly bears was a result of low energy intake causing diminished reproductive function. Results were preliminary due to small samples.

ESGBP bears tended to be in poorer body condition (lower BCIs) than FMF bears captured at the same time of year, a difference that was most notable among adult males. In both sexes, luteinizing hormone (LH) concentrations were significantly lower in ESGBP bears than in FMF bears. Results from a comparison of body condition and reproductive hormone concentrations between Eastern Slopes and FMF bears cannot be used to disprove the hypothesis that reduced reproductive output (late age of first successful reproduction, long interval between litters, and low reproductive rate) in ESGBP bears is a result of low energy uptake intake (especially in males) causing diminished reproductive function.

DIET AS INDICATED BY STABLE ISOTOPE ANALYSIS

Isotopic analysis of ESGBP grizzly bear hair was conducted to further comment on the hypothesis that low reproductive output might be due to low energy intake. Analysis of stable isotopes of carbon and nitrogen present in hair indicate the dietary contribution of plant versus animal tissue. Since hair is replaced each year in bears the values reflect the diet consumed during growth of the hair. While the isotope values suggested that males ate more meat than females, this grizzly bear population probably depended on plant matter for the bulk of its nourishment. The low reproductive output of the population probably reflects this relatively low-energy diet. The small number of grizzly bears sampled suggests caution with the results.

HOME RANGES

We documented use of space by ESGBP bears trapped in the BRW and compared this to spatial use by bears trapped and monitored in the Upper Columbia River basin (west slope) portion of the CRE (data provided by John Woods, Research Biologist, Glacier and Mt. Revelstoke National Parks, Revelstoke, BC). Eastern slope bears had large mean home ranges (95% Fixed Kernel), males 1405 km^2, and females 520 km^2. Western slope bears had much smaller mean home ranges (100% Minimum Convex Polygon), males 507 km^2, and females 103 km^2. These differences in home range size most likely primarily reflect the lesser productivity of the eastern versus western slopes. They may also reflect different methods for home range calculation. They also show that because of their larger home ranges, grizzly bears living in the eastern slopes have greater exposure to interaction with humans. Consistent with results of DNA studies a larger percentage of male versus female grizzly bears crossed the Trans Canada Highway. For nearby Highway 40, a lower volume, paved highway in the Kananaskis, both males and females frequently crossed.

LANDSCAPE SELECTION BY ADULT FEMALE GRIZZLY BEARS

Two ESGBP projects developed resource selection functions to model use versus availability of landscape units by wary, adult female grizzly bears. Research was conducted at different scales and used somewhat different approaches to understanding landscape selection by bears.

Stevens analyzed second order selection for landscapes and associated variables within and between female home ranges. She found that density of high greenness, and distance to high greenness, were the most important predictors of female grizzly bear occurrence at this relatively coarse scale. Stevens also used GIS mapping to overlay areas of high landscape selection probability with areas where habitat was classified as secure. These results are summarized under the topic of "security area analysis" in this summary.

Theberge analyzed finer-scale, third-order selection for landscapes and associated variables. She concluded that locations of female grizzly bears were correlated with environmental conditions and heterogeneous landscape patterns at different scales. Landscape selection appeared to be taking place simultaneously, at multiple scales. Selected areas had the following characteristics: within 60 metres of vegetation edges, high levels of vegetation diversity within 300-m and 1.5-km windows, rugged terrain within broad 3.0-km areas, graminoid meadows, avalanche paths, or riparian areas.

In applying Theberge's seasonal resource selection functions to the eastern slopes of Alberta landscape, we identified 4 geographic areas containing a concentration of high probabilities of adult female occurrence. These areas are described in this summary under the topic of "Spatial patterns of grizzly bear mortality in the CRE," paragraph 2). We also identified numerous smaller pockets where there was a high probability of female grizzly occurrence. These areas were distributed throughout the study area but especially south of the Trans Canada Highway. We comment on the management implications of these concentration areas.

HABITAT USE AND THE INFLUENCE OF HUMANS AND DEVELOPMENT

There was an influence on grizzly bears radiomarked in the BRW from proximity to people and development beyond directly increasing mortality probabilities. Both wary and habituated adult female grizzly bears were affected by human presence. In the relative absence of humans, these bears made more efficient use of higher quality habitats by moving shorter distances while foraging. Increased human presence eroded this habitat optimization. In the extreme, habituated female bears traveled further in utilizing sub-optimal habitats. This would likely decrease the net energy available for growth and reproduction.

Of 4 types of developments studied, the Trans Canada Highway (TCH) was avoided most by grizzly bears. Female bears avoided the busy freeway regardless of the habitat quality or time of day. Males, and especially subadult males, were found closer to the TCH when within or adjacent to high quality habitat and during the human inactive period. These observed responses, in areas without fencing and associated crossing structures, may not be solely due to the TCH, but to the higher overall density of humans associated with the valley that includes the highway. Grizzly bears crossed roads in areas where habitat quality was high. However, when grizzly bears crossed high-volume roads they moved into areas of higher quality habitat. This pattern did not occur on low-volume roads, suggesting that there is a trade off between the risks of crossing roads and benefits in terms of access to higher quality habitat.

Unlike paved roads that were located in valley bottoms and good quality habitats, high use trails were widely distributed throughout all types of habitats within the study area. When human activity was low, we found bears were closer to trails when in high quality habitat and further from trails when distant from high quality habitat.

We conclude that the cumulative effects of human use and developments such as railways, highways, and trails within the Bow Valley can limit access to important habitats, thereby negatively impacting grizzly bears.

SECURITY AREA ANALYSIS

In the past, habitat effectiveness modeling was the primary tool used to predict the impact of human activities on bears and their habitat. The model fell short, however, in not estimating the human encounter rate and associated mortality risk. For each jurisdiction in the CRE we calculated the percentage of the productive landscape that had undisturbed and connected minimum size units of 9.0 km^2, the mean size of an adult female's daily foraging area. The percent of productive land base where adult female grizzly bears have a low probability of encounters with people (secure) depends on the amount of productive land available to a bear and the extent of human influence on that land. British Columbia provincial lands had the largest percentage of secure habitat (50%), followed by Alberta provincial lands and national parks with 43% secure habitat in both, and Kananaskis Country with 36%. None of these areas met the current target level of 68% considered to be adequate security set by the USDA Forest Service in the Northern Continental Divide grizzly bear ecosystem in northwest Montana. Results suggest management intervention regarding secure habitat will be necessary to attain acceptable mortality rates for independent female bears. Results also underline the importance of a cooperative, coordinated inter-jurisdictional management approach.

Habitat quality can also be included in evaluation of grizzly bear security areas. High quality habitat is in short supply in mountainous environments, and only a small proportion of each jurisdiction encompasses secure high quality habitat. British Columbia provincial lands have the largest percentage (13%) of their available land base in secure high quality habitat. In national parks there is the least amount of available land base in secure high quality habitat (5%). In Banff National Park, an average of 4% of Bear Management Units are secure high quality habitat, 6% in Yoho, 7% in Kananaskis Country and 12% in Kootenay National Park. It is important to identify areas of high quality secure habitat. Based on this managers can work to prevent further loss of what we have shown is selected and probably important grizzly bear habitat.

Security at the level of an adult female grizzly bears' home range determined by radio telemetry revealed that for 30 female grizzly bears in the Eastern Slopes, an average of 39% of the home range was secure, with only 7% secure high habitat quality. For 10 adult female grizzly bears in the Western Slopes, an average of 62% of the home range was secure and 22% secure high quality habitat. Secure high quality habitat for the Eastern Slopes bears ranged between 0 and 34% of the home range. Secure high quality habitat for the Western slopes bears ranged between 7 and 47% of the home range. The results raise the question whether this level of security is sufficient for a long term viable grizzly bear population. This is particularly important since the Bow River watershed grizzly bear population's positive growth rate, 1994–2002, was possible because of 95-96% survival from year to year by adult females.

CUMULATIVE EFFECTS OF DEVELOPMENT IN ALBERTA'S EASTERN SLOPES

In Alberta a progression of landuses during the 20th century were responsible for significant economic growth and human population expansion, but also lead to the loss of grizzly bear habitat and numbers throughout much of the province. These landuses have included cropland agriculture, livestock grazing, and urban, suburban, and acreage expansions. Other landuses, most notably forestry, the hydrocarbon industry, and the recreational sector, have left their anthropogenic footprint extensively across historic and current grizzly habitat. Their influences on grizzly bears have been expressed in terms of grizzly bear mortality and compromised habitat. Collectively, these landuses require a large network of linear features (major roads, minor roads, hiking/biking trails, transmission lines, seismic, pipelines, etc.), now in excess of 1 million km in Alberta.

Grizzly bear/human encounters in the CRE will very likely intensify given the access infrastructure and the almost certain expansion of mountain and foothill commuting towns such as Canmore, Cochrane and Bragg Creek, and the mobility and increase of a Calgary population approaching 1 million. Whereas Calgary has grown by an average annual rate of 4% in area and 2.5% in population, during the past several decades, the growth of some of its satellite communities and acreage complexes has been even higher. If these growth rates persist in the coming decades, the City of Calgary will contain ~1.5 million people by 2030 and the central eastern slopes commuting towns will be home to greater than 100,000 foothill and mountain residents. As this young, prosperous human population satisfies its increasing appetite for front-country and back-country recreational pursuits, the attendant bear mortality may overwhelm the conservative reproductive rates exhibited by grizzly bear females in this region. The current number of 3.1 million visitors and 7.7 million visitor days for Banff National Park is projected to grow to 10 million annual visitors by 2030, and growth is likely to be accompanied by increased levels of both front-country and back-country recreational activities. Unless managed effectively, the combined mortality rate in the region will threaten the future of grizzly bears.

As the area, length and intensity of linear features in Alberta continues to grow, it is becoming increasingly clear that access management has been neglected across large tracts of remaining grizzly bear habitat. Maintaining the current range and populations of grizzly bears in the CRE will demand bold thinking by contemporary landscape managers, for their decisions today will largely define the future of grizzly bears in the next several decades. Ultimately, resource managers must help society recognize that there are clear trade-offs between the level and intensity of our landuse footprint and the viability of grizzly bear populations. Recognition of these trade-offs can lead to productive discussions about acceptable thresholds for such landscape variables as road density and use, back-country visitation, and habitat area and connectivity. Clear recognition of trade-offs between social, economic, and ecological indicators, such as grizzly bear populations, is key to exploring best practice options.

DENNING

The ESGBP observed the nature and distribution of grizzly bear dens since the initiation of the project in 1994. Following a sample of approximately 25 radio-collared bears to their dens each year complemented earlier research and eliminated possible bias for dens visible from the air. Field researchers surveyed den sites of radio-collared bears opportunistically while in the field for other research purposes. Therefore, of 173 den locations obtained by aerial telemetry (1994-2001), only 30 of those sites were characterized from the ground.

Over the course of ESGBP research, we documented grizzly bears entering their dens between mid-October through to the end of November. In the spring, the earliest emergence documented was mid-March and the latest was mid-May. Radio-collared females with cubs in our study had a mean emergence date of May 12 compared to April 16 for adult males.

All dens we surveyed were found in the upper sub-alpine at elevations between 2012m (6700ft) and 2432m (8100ft) with a mean elevation of 2253m (7500ft). All of our grizzly bear dens surveyed were located at altitudes where preliminary data suggests that thermal inversion is a prevalent phenomenon.

Grizzly bears were specific about the slope angle where dens were dug. The mean slope angle for dens we investigated was 33 degrees (range 26–39 degrees).

SUMMARY OF ESGBP MANAGEMENT RECOMMENDATIONS

(See chapter 15, pps. 228—242 for detailed version. Priority 1 (P1) implement within 2 years, Priority 2 (P2) implement within 5 years)**:**

1. DEMOGRAPHY AND MONITORING

Goal: To achieve a sustainable human-caused grizzly bear mortality rate throughout the Central Rockies Ecosystem (CRE) that is scientifically documented by collecting adequate data, with an established level of acceptable risk, which supports a high probability for the long-term survival of grizzly bears in the CRE.

1a. Establish science-based survival (mortality) rate targets for adult female bears that would have a high probability of supporting population growth or maintenance (lambda ≥ 1) for each grizzly bear population management unit in the CRE. P1
1b. Monitor survival/mortality rate and reproduction in the Bow River Watershed. P1
1c. Develop and apply non-invasive DNA “capture-recapture” designs to calculate and monitor relative abundance, derive population estimates against which to evaluate human-caused mortality, and as one means of documenting distribution changes. P1
1d. Use annual counts of females with cubs as a coarse index of population trend. P2
1e. Have periodic scientific peer review and inform the public regarding the scientific basis for grizzly bear population estimates. P1

1f. Given the extremely low reproductive output of grizzly bears studied in the Bow River watershed, use research to better understand the reasons. P2
1g. Continue research regarding body condition and reproductive hormones. P2

2. MORTALITY: RECORDING, UNDERSTANDING AND MANAGING

*Goal: To document, evaluate, understand and sustainably manage grizzly bear mortality***.**

2a. Document, analyze and report annually on grizzly bear mortality in the Central Rockies Ecosystem. P1
2b. Develop programs to be able to manage each significant source of grizzly bear mortality in a responsive way with annual reports and annual review of mortality management programs and their success related to cause-specific mortality. P1
2c. Use understanding of spatial aspects of grizzly bear mortality in the CRE for input into planning human activities that have a significant grizzly bear mortality probability so as not to exceed the established human-caused, mortality rate limit for each management unit. P2

3. HABITAT: DISTRIBUTION, SELECTION, SECURITY, CONNECTIVITY

Goal: To define and implement habitat standards that would support grizzly bear persistence.

3a. Using the best available data on landscape selection, by especially female grizzly bears, work toward CRE-wide identification and protection of grizzly bear habitat. P2
3b. Using the best available science establish habitat security targets that would support human-caused mortality rate goals. P2
3c. Maintain, restore or mimic ecological processes in order to recreate plant and animal communities that are more similar to those grizzly bears experienced in the CRE when First Nation peoples were the only humans. P2
3d. Apply both coarse and fine scale selection models to landscape management to ensure that habitat important to female grizzly bears is conserved. Also, support the Integrated Decision Tree Approach for habitat mapping. P2
3e. Begin to systematically restore grizzly bear habitat in the CRE. P2
3f. Establish and apply targets for grizzly bear distribution, habitat connectivity and fragmentation. P2

4. BEAR-HUMAN CONFLICT: AVOIDING AND MANAGING

Goal: To work toward minimizing human-grizzly bear conflict and to provide for safety for grizzly bears and humans.

4a. Develop and enforce regulations related to human food and garbage attractants throughout the CRE. Encourage public involvement using the bear smart community model and other community involvement approaches. P2
4b. Maintain and evaluate aversive conditioning programs, especially for female grizzly bears. Consider alternatives that may be more cost effective**.** P1
4c. Develop integrated CRE-wide monitoring of grizzly bear-human conflict to serve as a basis for corrective management actions. Report results yearly. Analyze every 5 years. P1

4d. Inform the public regarding grizzly bear activity in high human use areas. Continue with periodic use restrictions related to human safety or grizzly bear needs. Continue to experiment with removing natural attractants such as wild berries from high human use areas. P1
4e. Continue to monitor human land use and to document its relationship with grizzly bear landscape use and mortality probability. P2

5. INTERAGENCY COORDINATION AND COOPERATION

Goal: To support agencies working together toward coordinated, integrated data collection related to grizzly bear research and management. At the same time to recognize agency jurisdictional autonomy.

5a. Work toward coordinated, integrated data collection and grizzly bear management, yet retain jurisdictional autonomy. P1
5b. The CRE should remain one geographic area for interagency coordination related to grizzly bear management. P1

6. PLANNING, MANAGEMENT, STRATEGIES AND PROCESSES

Goal: To continue to develop research, planning and management structures and products that will support and guide actions to achieve a non-declining grizzly bear population in the CRE.

6a. Continue to develop and detail agency specific and CRE-wide conservation strategies for grizzly bears. P2
6b. Encourage peer-reviewed publication of research regarding grizzly bear management and its scientific basis. Consider periodic program review by highly qualified scientists regarding the scientific basis for management. Provide opportunities for public comment and information exchange. P2
6c. Design access and facility management and planning to support grizzly bear persistence. P2
6d. Target research to address threats that have critical knowledge gaps. P1

7. PUBLIC, BUSINESS AND FIRST NATION INVOLVEMENT AND INFORMATION EXCHANGE

Goal: To continue to refine processes for informing and involving various societal sectors in grizzly bear management.

7a. Refine and expand societal understanding and involvement in grizzly bear management. P2
7b. Establish a mechanism to maintain some of the public involvement and information that were part of the Eastern Slopes Grizzly Bear Project. P2
7c. Develop further communication with First Nations regarding grizzly bear ecology and management. P1

8. FUNDING TO MAINTAIN GRIZZLY BEARS

Goal: To adequately fund research that will inform and support maintaining a non-declining grizzly bear population in the CRE.

8a. Adequately fund research, management and planning directed toward long-term maintenance of grizzly bear populations. Use multi-stakeholder funding approaches developed by the ESGBP to do this. P1

9. IMPLEMENTATION OF ESGBP MANAGEMENT RECOMMENDATIONS

Goal: To achieve the goals and implement the management recommendations of the ESGBP.

9a. Form an ESGBP implementation committee. P1