Grizzly Bear (*Ursus arctos*) Harvest Management in British Columbia

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Introduction

This report provides the technical background for British Columbia's process of determining the allowable harvest of Grizzly Bears (Ursus arctos). The process was revised in 2003 based on the recommendations made by an independent Grizzly Bear Scientific Panel appointed by the Minister of Water, Land and Air Protection (Peek et al. 2003) and applied to the three year allocation period that began in 2004 and will end in 2006. The population estimates and allowable mortality levels used for harvest management purposes will remain in effect throughout that period unless new information becomes available that identifies a significant conservation concern.

Legal Context

The national Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated Grizzly Bears as a "Species of Special Concern," and the provincial Conservation Data Centre (CDC) has placed Grizzly Bears in BC on the equivalent "Blue List." International export of Grizzly Bears or their parts from BC requires a permit because the species is listed in Appendix II of the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES). Grizzly Bears are listed in Appendix II, not because they are endangered but because their parts resemble parts of Appendix I bear species and populations. Under the federal *Species at Risk Act* (SARA), Grizzly Bears are listed as a "Species of Special Concern".

Grizzly Bears are designated "Big Game" under the provincial *Wildlife Act*. All Grizzly Bear hunting in British Columbia is limited by the number of hunting authorizations issued to resident hunters through a random draw, known as Limited Entry Hunting (LEH), and by quotas issued to guide outfitters for either resident or non-resident hunters. LEH authorizations are valid only within specified areas. This system allows wildlife biologists to carefully regulate harvest levels in each area where Grizzly Bear hunting is allowed.

The number of LEH authorizations available for each area is determined by the Director of the BC Fish and Wildlife Recreation Allocation Branch, based on technical input of provincial wildlife biologists. Non-resident hunters must be accompanied by a licensed Guide Outfitter or assistant guide in order to hunt Grizzly Bears. Quotas set the maximum number of Grizzly Bears a Guide Outfitter's clients may take within their Guide Outfitter Area. Quotas are determined by the BC Regional Environmental Stewardship Manager or the Director of the BC Fish and Wildlife Recreation Allocation Branch, again, based in part on the technical input of provincial wildlife biologists.

The bag limit for Grizzly Bears is one bear per year. In British Columbia it is illegal to kill a bear < 2 years old, or any bear in its company (usually its mother). It is also illegal to possess bear gall bladders or to possess bear genitalia separated from the carcass or hide or to traffic in, import or export bear paws separated from the carcass or hide. It is illegal for a hunter to kill a Grizzly Bear and fail to remove the hide. It is also illegal to hunt a Grizzly Bear by placing bait or using a dead animal or a part of it as bait. The maximum fine for illegally killing a Grizzly Bear is $100,000 and six months in jail for a first offence.

Any Grizzly Bear killed by a hunter must be submitted for a compulsory inspection within 15 days of the kill for unguided hunters (extensions of this time limit are available based on prior requests for a written approval) or the end of the hunting season for guided hunters. This inspection includes confirmation of sex, extraction of a tooth for ageing and recording the date and location of the kill, as well as the hunter's name. These data are recorded and tracked in a relational database. The compulsory inspection system also allows for the collection of additional biological samples under specific circumstances (e.g., tissue samples for DNA analysis).

Harvest Management

Grizzly Bear harvest management in British Columbia is directed by the Grizzly Bear Harvest Management Procedure (Appendix 1). Grizzly Bear Population Units (GBPUs), where the population estimate is < 50% of the area's habitat capability (the number of animals that could be supported under optimal conditions) will be designated as "Threatened;" and will be closed to Grizzly Bear hunting where they are below the GBPU's population objective. The selection of 50% of minimum habitat capability as the threshold below which a population is considered "Threatened" should not be considered an absolute indication of population status, but rather a subjectively chosen criterion in the context of considerable uncertainty about what constitutes a "viable" Grizzly Bear population. In some cases, a population may be viable at less than 50% of habitat capability. In others, populations that exceed 50% may still not be viable over the long-term. GBPUs with < 100 animals are also closed to Grizzly Bear hunting (Figure 1; Hamilton *et al*. 2004) because the conservation risk of hunting such small populations is deemed unacceptably high.

The best population estimate is used for harvest calculations and includes animals of all ages. For the purpose of harvest management, the population contribution of areas > 100 km^2 that are indefinitely closed to Grizzly Bear hunting (defined as areas closed for reasons not due to the application of the harvest procedure but instead to achieve unrelated objectives) is not included in harvest calculations. Similarly, Grizzly Bear mortalities in these areas are not deducted from allowable mortality levels.

Mortalities of Grizzly Bears < 2 years (24 months) old are not included in calculations of allowable mortality levels because these mortalities are more compensatory than those of older animals given their lower survival rates. These losses therefore have less influence on population sustainability than mortalities of older animals (Bunnell and Tait 1981; Harris 1986; Miller 1990; McLellan 1994; Hovey and McLellan 1996). Reported mortalities of animals of unknown sex are assumed to be split 50:50 between males and females (< 2% of the mortalities reported from 1978-2003 do not have sex recorded).

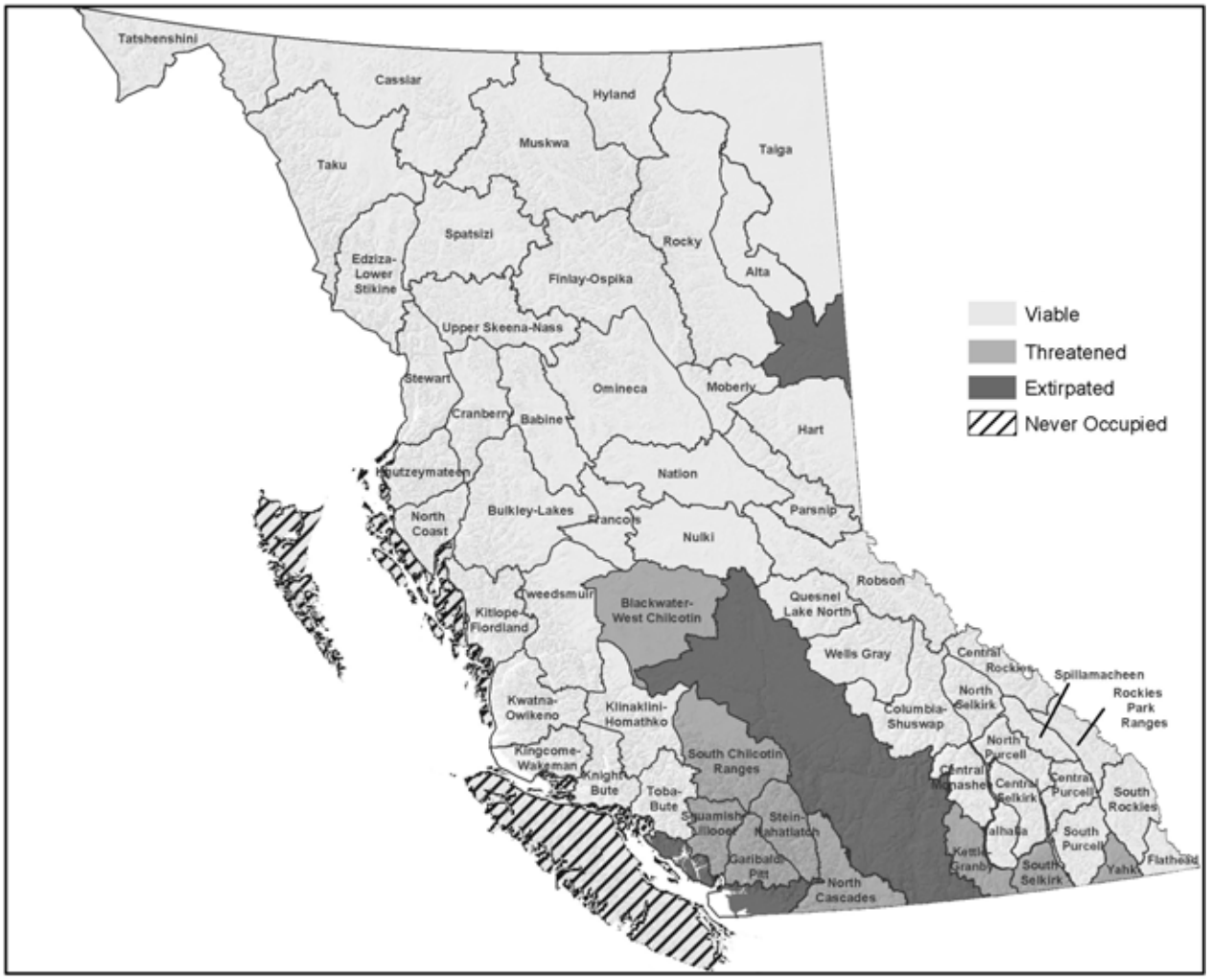

Figure 1. Conservation status of Grizzly Bear Population Units in British Columbia.

The maximum annual allowable human-caused mortality rate ranges from 3-5%. The “sliding scale” for determining the maximum annual allowable human-caused mortality rate in each GBPU is based on the GBPU’s habitat effectiveness density as a percentage of the highest habitat capability density in the province (Table 1; Hamilton and Austin 2004).

The maximum end of the sliding scale for maximum allowable human-caused mortality rate (5%) is consistent with the available literature on sustainable levels of human-caused mortality (Bunnell and Tait 1981; Harris 1986; Miller 1990; Hovey and McLellan 1996). The scale is based on the principle that the lower the average habitat effectiveness, the lower the productivity of the area and therefore the lower the rate of human-caused mortality that the population is capable of sustaining (Eberhardt 1990; McLellan 1994; McLoughlin 2003).

Table 1. Maximum allowable human-caused mortality rate relative to habitat effectiveness density.

Average Habitat Effectiveness Class*	Habitat Effectiveness Density (bears/1,000 sq km)	Percentage of the Highest Habitat Capability Density	Maximum Allowable Total Human-Caused Mortality Rate
1-3	>15.7	>25%	5%
4	15.7 - >3.1	>5-25%	4%
5	3.1 - >0	>0-5%	3%

* Calculated as the average habitat effectiveness for the GBPU.

The next step in the calculation of allowable harvest levels is to deduct an estimate for the unreported human-caused mortality rate from the maximum allowable human-caused mortality rate. The process of calculating these estimates begins with the development of a "benchmark" rate for the Flathead GBPU – the only GBPU for which sufficient data is available to calculate an unreported human-caused mortality rate. This was done by first taking the British Columbia Grizzly Bear mortality data from Table 2 in McLellan *et al*. (1999) and calculating the assumed relative level of the unreported human-caused mortality as compared to reported human-caused mortality (i.e., based on 8 known or suspected human-caused mortalities that would not have been known of by managers if the animals had not been instrumented, plus 20 human-caused mortalities that would have been known of by managers, thus the unreported mortality rate is 40% of the known mortality rate).

An average population estimate of 126 animals for the Flathead GBPU during the period from 1980-1997 was calculated based on the population reconstruction model described in Hamilton and Austin (2004). The reported mortality rate for the Flathead GBPU was then calculated as 5.1%, by applying the reported mortalities that occurred during the 1980-1997 period against the average population estimate. The unreported mortality rate for the Flathead was then calculated as 2.0%, based on the calculated relationship between the unreported and reported human-caused mortality rates.

Once the 2.0% "benchmark" rate of unreported human-caused mortalities was calculated for the Flathead GBPU, it was then extrapolated to the other GBPUs in the province, using four indices that were believed to be positively correlated with the rate of unreported human-caused mortality. These indices were: (1) the density of hunters (measured by hunter days / 1,000 km^2, using the highest hunter-day value among the big game species that are hunted in the fall for each Management Unit); (2) the density of large ungulate harvest (elk, moose and caribou harvest combined / 1,000 km^2 by Management Unit); (3) the proportion of habitat capability (from the expert-based model) in areas where road density is > 0 km / km^2; and (4) the proportion of habitat capability in areas with > 5,000 people within 50 km (Appendix 2).

Each index value for a GBPU was divided by the Flathead GBPU value for that index to arrive at a proportion of the index value represented of the "benchmark". The proportions for all four indices were then averaged, and the results multiplied by the "benchmark" rate of 2.0%. The range of resulting unreported human-caused mortality rates was limited to a minimum of 0.3% and maximum of 3.0% for application to harvest management due to concerns about extrapolating to values that differed too greatly from the "benchmark." Only two GBPUs (Yahk

and Nulki) had unreported mortality rates calculated at > 3.0% and both are closed to Grizzly Bear hunting.

After the unreported human-caused mortality rate (0.3-3.0%) is deducted from the maximum allowable human-caused mortality rate (3.0-5.0%), the result is the uncorrected allowable known human-caused mortality rate. In order to account for uncertainty in population estimates, these rates are corrected based on the uncertainty in each GBPU's population estimate and an acceptable level of risk. The acceptable level of risk is defined as the percentage of times that, if the calculated maximum mortality levels were achieved, they would exceed the intended rates due to population size being smaller than estimated (Table 2). The consequence of this approach is that the corrected maximum allowable known human-caused mortality rate is positively correlated with the status of the population measured as the population estimate as a proportion of habitat capability, and negatively correlated with the level of uncertainty in the population estimate (which generally increases with lower densities) (Figure 2).

Table 2. Allowable risk in Grizzly Bear harvest management based on uncertainty in population size.

Population Estimate as a Percentage of the GBPU's Habitat Capability	Acceptable Risk of Overestimating Allowable Mortality Rate	Confidence Interval that Lower Limit is Taken From
>90-100%	30%	40%
>80-90%	25%	50%
>70-80%	20%	60%
>60-70%	15%	70%
>50-60%	10%	80%

The calculation for the rate correction involves determining the proportion of the density based on the best population estimate that the appropriate (based on the acceptable level of risk) lower confidence limit of that density represents. For this purpose the relationship between uncertainty and population density derived for the multiple regression model was also applied to the expert-based model, as it does not have a measure of uncertainty directly associated with it (Table 3; Mowat *et al*. 2004; Hamilton and Austin 2004). For the two GBPUs where population inventories were used, the uncertainty from those estimates was applied (Boulanger 2001; Poole *et al*. 2001).

Table 3. The density reduction from the best estimate to calculate the lower confidence interval associated with the acceptable level of risk for GBPUs, where either multiple regression or the expert-based model are used.

Acceptable Risk of Overestimating Allowable Mortality Rate	Confidence Interval that Lower Limit is Taken From	Population Density Reduction (bears/ 1,000 sq km)
30%	40%	5.1
25%	50%	6.2
20%	60%	7.7
15%	70%	9.6
10%	80%	11.9

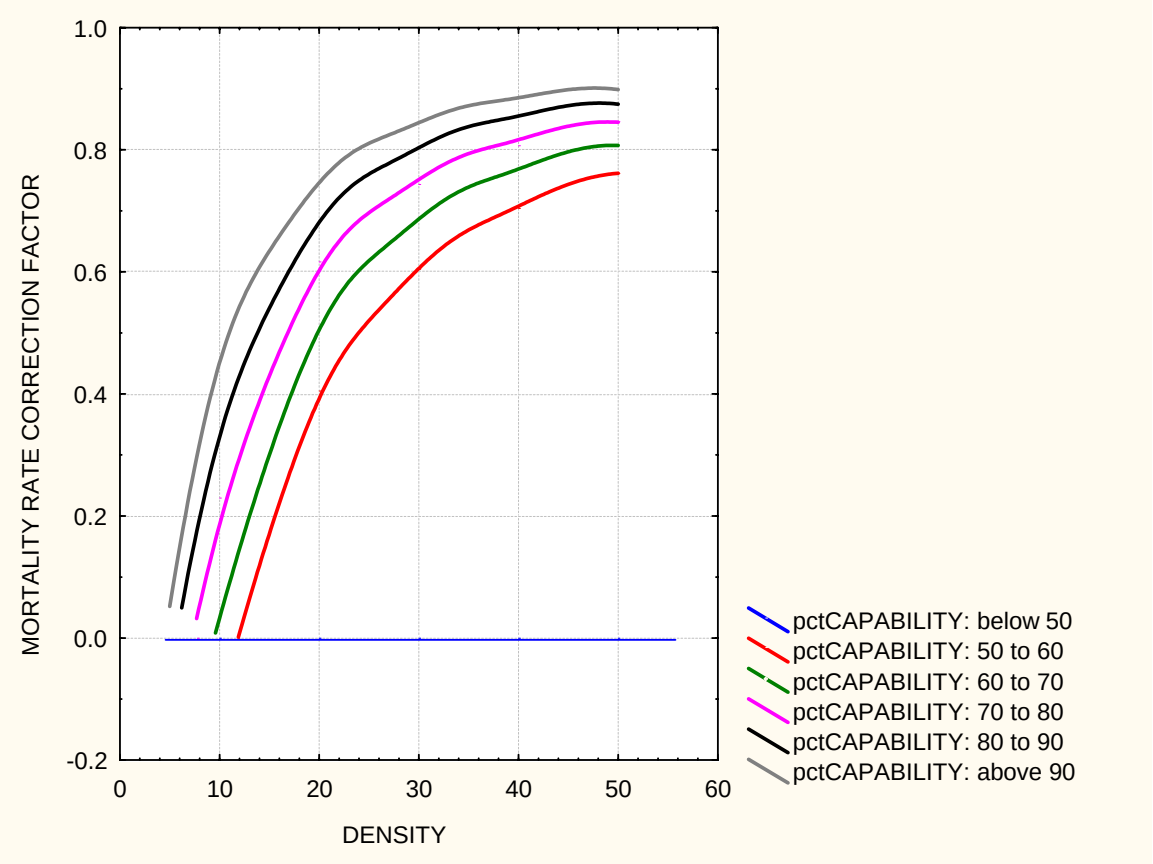

Figure 2. Mortality rate correction factor based on the population estimate as a percentage of the Grizzly Bear Population Unit's estimated habitat capability.

For example, for a population between 80 and 90 % of the area's habitat capability estimate, the lower end of a 50% prediction limit is prescribed, which is 6.2 bears / 1,000 km^2 below the predicted estimate (see Table 3), so the mortality rate correction factor for a population estimated at 30 bears / 1,000 km^2 is 0.793 ((30-6.2) / 30).

The corrected maximum known human-caused mortality level for each GBPU is calculated by multiplying the corrected maximum known human-caused mortality rate by the population estimate, excluding areas > 100 km^2 that are indefinitely closed to Grizzly Bear hunting. The known female Grizzly Bear human-caused mortality limit is 30% of the corrected maximum known human-caused mortality level. Both total and female mortality levels are managed over fixed, provincially consistent, three-year allocation periods over the entire GBPU. If either the total or female limit is exceeded during an allocation period, the hunting seasons will be closed for the remainder of the allocation period. Any mortality in excess of either the total or female limit at the end of an allocation period is deducted from the limit available in the following allocation period. Positive mortality balances are not carried forward between allocation periods.

Once the known total mortality limit over an allocation period is established for each GBPU, a deduction is made to account for the non-hunting losses that are expected to be reported (e.g., animal control kills, road and train kills) based on previous records for the area. The balance is the allowable harvest over the allocation period. This allowable harvest is then divided between

First Nations entitlements, non-residents and resident hunters. The non-resident allocation may be adjusted based on the proportion of the Guide Outfitter Quotas in the GBPU that have been used in the past. These quotas dictate the maximum number of Grizzly Bears that each Guide Outfitter's clients may harvest in a year.

For resident hunters, the allocated harvest is partitioned to each hunting season (i.e., spring and fall, where both seasons occur) and then divided by the average success rate for resident hunters in that area over the previous six years to determine the calculated number of LEH authorizations that will be made available through a lottery system. The minimum success rate used for calculating the number of LEH authorizations is 5%. The calculated number can be deviated from where necessary, for example, to address concerns over female Grizzly Bear mortality levels.

Grizzly Bear translocations outside of a GBPU are counted as if they were known mortalities in the source GBPU. Translocated bears are not added to the population estimate used for harvest purposes in the area of relocation; however, if translocated bears die as a result of human causes they are not counted as mortalities in the new area.

The calculation of allowable mortality levels for the 2004-2006 allocation period is summarized for each GBPU in Appendix 3.

South Rockies

In the South Rockies GBPU the combined effect of applying the population estimate calculated through the application of the multiple regression model and the harvest management process described below resulted in a maximum allowable harvest of < 1 Grizzly Bear over three years (Heard *et al*. 2004). Given that an average harvest level of 10 Grizzly Bears per year has been sustained from 1978-2003 in the South Rockies GBPU, a decision was made to retain the previous habitat-based estimate and allowable harvest level in the South Rockies GBPU for the 2004-2006 allocation period while further reviews are conducted.

Population Objectives and Grizzly Bear Management Areas

GBPU boundaries, population estimates and the conservation status of GBPUs is reviewed prior to each allocation period. Prior to the commencement of the next allocation period (2007-2009), population objectives will be approved for all GBPUs. The consultation process for population objectives may also address the establishment of Grizzly Bear Management Areas (GBMAs) that are closed to Grizzly Bear hunting.

Three types of GBMAs have been proposed: Benchmarks, Cores and Linkages. Benchmark GBMAs are intended to be large areas – of similar scale to GBPUs but necessarily following GBPU boundaries – that fulfill a long-term conservation role at the ecoprovince scale, as representative populations with minimal levels of human impact (Demarchi 1996). Core GBMAs are intended to be of intermediate size and to serve as refugia that contribute to conservation at the GBPU scale. Linkage GBMAs are intended to be small areas that address mortality risk across current or potential future barriers to Grizzly Bear movement, often associated with the boundary between GBPUs (Apps 1997).

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Appendix 1. Grizzly Bear Harvest Management Procedure (**PDF 79KB**)
Worksheet for calculating Allowable Grizzly Bear Harvest (**.xls 40KB**)

Appendix 2. Calculation of Unreported Human-caused Mortality Rates by Grizzly Bear Population Unit. (**PDF 31KB**)

Appendix 3. Calculation of Allowable Known human-caused Mortality Levels by Grizzly Bear Population Unit (**PDF 32KB**)