A Review of Grizzly Bear Harvest Management in British Columbia

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Introduction

This review builds on the information presented in Hamilton and Austin (2002). The purposes are: 1) to identify and present information on the outstanding scientific and management issues involved in assuring that hunting does not represent a conservation threat to grizzly bear populations and, 2) to outline potential future directions that are under consideration for grizzly bear harvest management in the province. It is based on the experience and professional opinions of provincial wildlife biologists within the British Columbia Ministry of Water, Land and Air Protection.

It is well recognized that grizzly bear populations are more sensitive to human-caused mortality than almost any other hunted species in North America due to their relatively slow intrinsic rate of increase (Weaver et al. 1996). Similarly, there are inherent problems associated with counting or estimating the size or trend of grizzly bear populations (Miller et al. 1997). When these limitations are combined with non-hunting related human-caused mortality, the fact that grizzly bear hunting can not be restricted by sex despite the particular sensitivity of populations to adult female mortality, and the demands for hunting opportunities, this presents wildlife managers with significant challenges in managing harvests to avoid exceeding sustainable mortality levels.

This document is divided into two major sections. The first is a critique of British Columbia's Grizzly Bear Harvest Management Procedure (Ministry of Environment, Lands and Parks 1999). Comments in italics have been inserted into the text of the procedure. The second section identifies potential future directions in the continued development of grizzly bear harvest management in the province including possible responses to the issues identified in the critique.

The information and perspectives provided in this document are intended to assist the Grizzly Bear Scientific Panel in its examination of current practices and future opportunities for improvement. They represent the views of the professionals engaged in grizzly bear harvest management on behalf of the Ministry of Water, Land and Air Protection. They are not, however, formal proposals from the ministry and should instead be viewed as scientifically-based ideas for possible further consideration by the panel.

Critique

The following is an excerpt from British Columbia's Grizzly Bear Harvest Management Procedure (Ministry of Environment, Lands and Parks 1999) with comments added in italics.

Procedures:

1 Principles

1.1 Total human caused mortality of grizzly bear populations will be sustainable, and will not reduce the viability or distribution of populations.

While this principle is supported, it should be noted that the procedure allows for harvests that are not sustainable in specific circumstances where an approved population objective is lower than the current population level (see Section 6.4 and 6.5). To date population objectives have not been established for any grizzly bear population to date.

1.2 Population estimates, maximum allowable total human caused mortality, and harvests will be consistent with available scientifically supportable information, and will be conservative in recognition of uncertainty.

This principle is supported, however, the phrases "scientifically supportable information" and "conservative in recognition of uncertainty" are open to considerable variations in interpretation.

1.3 Harvests will be planned with the intent that total human caused mortality will not exceed the maximum allowable.

See comment on Section 1.1 above.

1.4 GBPUs *(sic – Grizzly Bear Population Units)* designated as "Threatened" will be closed to grizzly bear hunting until they have recovered. Measures for recovery will be determined through Recovery Plans prepared for each Threatened GBPU.

The procedure does not include a definition for a "Threatened" population. The definition that is used by the ministry is any GBPU in which the current population estimate is less than 50% of the estimated current habitat capability.

The selection of this threshold is recognized to be somewhat arbitrary although it was reviewed and supported by the Grizzly Bear Scientific Advisory Committee. In some cases the ministry has been slow to recognize populations as being "Threatened" and to close grizzly bear hunting in these areas. Examples include the South Selkirks, Kettle-Granby, Stein-Nahatlatch, South Chilcotin, Valhalla and Central Monashees GBPUs which are all currently closed to grizzly bear hunting.

While it can be argued that hunting in these areas has been very limited and therefore has had little impact on these populations, the fact remains that the response to changes in population status was slow in the absence of monitoring data. There has often been a resistance to closing hunting seasons even when populations have been recognized to be at risk or in need of recovery due to the belief that this represents the loss of a management "tool".

1.5 GBPUs that are not connected to other GBPUs, and that have population estimates of less than 100 grizzly bears, will not be harvested due to their inherent vulnerability.

The principle of not harvesting small, isolated populations is supported by some, however, this has not been applied to date as there are few populations with fewer than 100 animals that are not designated as "Threatened" and these populations are considered to be connected to other surrounding populations. The degree to which populations are connected to others is open to considerable variation in interpretation. One possibility is to simply restrict harvest to populations of 100 or more animals. Note that in one region Management Units with fewer than 50 grizzly bears are closed to grizzly bear hunting, regardless of the status of the GBPU.

Others do not believe that the restriction on the harvest of isolated populations of less than 100 animals is necessary.

2 Process

2.1 Wildlife Branch staff coordinate development of policy, procedure and standards with regions; remain current with and communicate advances in science; provide technical advice to regions; ensure that methods used for items such as population estimates and harvests are applied consistently across regions; and ensure that regulations are within the bounds of provincial legislation, policy and standards prior to recommending these to the Minister.

Some have suggested that regional staff are better able to make harvest management decisions based on local knowledge of populations and stakeholder interests. Others believe that headquarters staff have an important role to play in ensuring that the best available science is incorporated into the decision-making process and to help ensure consistency both among regions and with provincial standards and policy direction.

The current system divides the responsibility for managing grizzly bear harvest between the Director of the Wildlife Branch (Director of Fish & Wildlife Allocation and Recreation) in headquarters for resident hunting opportunities through Limited Entry Hunting and Regional Fish & Wildlife Managers (Regional Managers of Environmental Stewardship) for non-resident hunting opportunities. This presents significant challenges to the coordination of overall harvest levels.

The current system ensures that potential conflicts with this procedure are identified and addressed, however, the effort expended could potentially be reduced if regional staff had responsibility for setting both resident and non-resident hunting opportunities based on the *harvest management procedure. This could then be complemented by annual reviews by headquarters staff to identify any potential problems and, if necessary, to recommend the closure or adjustment of hunting seasons and harvest levels.*

2.2 Regional Wildlife Section Heads (RWSHs) determine Grizzly Bear Population Units (GBPUs), population estimates consistent with the provincial model, maximum allowable human caused mortality, and allowable harvests. RWSHs will consult with the Large Carnivore Specialist (LCS) and Large Carnivore Research Biologist (LCRB).

In practice the development of GBPU boundaries and population estimates has involved both regional and headquarters staff with varying levels of cooperation.

The lack of a fully documented, formally peer-reviewed population estimation procedure with supporting literature and research has been a continuing issue (see comment on Section 3.3 below).

2.3 RWSHs must forward recommendations for items in 2.2 above, along with the comments of the LCS and LCRB, to the Regional Fish and Wildlife Manager, for approval and submission to Victoria.

See comment on Section 2.1 above.

2.4 Due dates for all steps in the grizzly bear management and hunting regulations processes will be set annually by the Director or Deputy Director.

See comment on Section 2.1 above.

2.5 The Regional Fish & Wildlife Manager and the Chief of Wildlife will resolve issues forwarded by the biologists. Where appropriate, some regulation issues may go to the Deputy Director instead of the Chief of Wildlife. Unresolved issues will be referred to the Director of Wildlife for resolution with the Regional Director.

Many of the issues that have been raised through this process have resulted from a lack of familiarity with the harvest procedure, concerns that the procedure as currently applied is overly complicated and/or conservative and disagreements with the results of applying the procedure based on local knowledge or perceptions about populations. Some concerns have been raised about the need to more effectively communicate the results of the final decision reached to all relevant regional staff in some cases.

3 Population Estimates

The current grizzly bear harvest management system is based on the calculation of allowable mortality levels from minimum population estimates. Limited information is available, however, on population trend. Where such information is available the procedure does not address how it *should be applied in setting allowable harvest levels. In practice trend information has been considered when available but no standards exist for what is acceptable information to infer trends from or for how to respond in terms of adjusting harvest levels from what would otherwise be indicated by the application of the procedure.*

An example of the problems that can occur in the absence of information on population trend is the situation that recently occurred in the Kwatna-Owikeno GBPU. In 1997 a Department of Fisheries and Oceans technician who had conducted salmon surveys in the Owikeno Lake area for over 20 years contacted the Wildlife Branch to report a dramatic drop in the number of grizzly bear sightings he had had over the previous three years (Steve Bachen, Senior Salmon Technician, Department of Fisheries and Oceans, Campbell River, British Columbia, personal communication). After consulting with other individuals familiar with the area and reviewing the technician's field notes, a decision was made to reduce hunting opportunities while the situation was investigated. Reconnaissance grizzly bear work in the area began in the fall of 1998 and has been continued in subsequent years of intensive monitoring. This work involves flying rivers in the area to count grizzly bears during the peak of the major salmon runs as well as some DNA sampling through hair collection.

The results of this fieldwork indicated that the current population size of the area was well below the population estimate for Management Unit 5-07 of 285 grizzly bears. It is now estimated that a minimum of 113 grizzly bears occupied the area (Hamilton and Austin 2002). During this time the sockeye salmon returns to the Owikeno Lake watershed were collapsing from an estimated 1,500,000 in the 1960s to approximately 3,600 in 1999 (Rutherford and Wood 2000). It is important to note that the 1990 population estimate of 285 grizzly bears was not developed through the use of the Fuhr/Demarchi method alone which would have resulted in a population estimate of 213 grizzly bears at that time.

Using the Fuhr/Demarchi estimate as a starting point, the estimate was increased to account for the effect of salmon and included an assumption of seasonal movements to the area in the fall as bears travelled from interior areas to access salmon (John Youds, Regional Wildlife Section Head, Cariboo Region, B.C. Ministry of Water, Land and Air Protection, Williams Lake, British Columbia, personal communication). This estimate was also used to calculate spring harvest rates and it is not known whether the adjustment to the population estimate that was based on the assumed seasonal movement of bears resulted in a reduction of the population estimates for the source areas.

The reason for this adustment is that the Fuhr/Demarchi method has often been considered to underestimate grizzly bear populations in coastal ecosystems. This is due to the limitations of the approach of assigning densities to terrestrial habitats that adequately incorporate the contribution to carrying capacity represented by salmon. In some cases the availability of salmon to bears may be poorly correlated with the terrestrial habitats rated through the Fuhr/Demarchi method.

In the fall of 1999 with salmon returns at a historic low there was a dramatic increase in grizzly bear activity at the Rivers Inlet village near Owikeno Lake resulting in significant public safety concerns and bear/human conflicts (the major attractant is a landfill). There were 10 grizzly *bears destroyed and one family group of three was translocated. The animals destroyed and translocated were noted to be in poor condition with little body fat. Immediately following these events the grizzly bear hunting season in Management Unit 5-07 was closed and currently remains closed.*

In the absence of the report of declining grizzly bear sightings from the Department of Fisheries and Oceans technician, the provincial government would likely not have had any indication of a problem until the conflicts occurred at Rivers Inlet in the fall of 1999. While it could be argued that grizzly bear hunting exceeded sustainable levels prior to the closure of the hunting season, the more significant issue is the apparent dramatic reduction of the carrying capacity of the area resulting from the collapse of the salmon stocks. In fact, it is possible that any excessive mortality was at least partially compensatory given that the area's carrying capacity for grizzly bears was declining.

There is no direct inventory information available to indicate whether the 1990 population estimate was accurate or not at the time it was developed or whether the Fuhr/Demarchi based estimate of 213 was more accurate. However, it is highly likely that a grizzly bear population decline occurred in this GBPU from 1990 to 2000 as the salmon returns collapsed. Some believe that this is a good example of the importance of local knowledge. Further, they believe that while this information was used in this case when a downward trend was indicated, similar information that indicates increased population levels is ignored under the current system.

3.1 Population estimates will be prepared for each GBPU. GBPUs will normally be composed of adjacent Management Units (MUs) that collectively make up a reasonably distinct population. It is recommended that partial MUs not be used, except where required for an ecologically valid GBPU. It is recommended that Limited Entry Hunt (LEH) zones be created where an MU is split between two or more GBPUs. GBPUs may be revised as needed to incorporate new information or changing distribution of adult female bears.

The current GBPU and LEH Zone boundaries in some areas are not consistent with this direction. In some cases where GBPUs cross regional boundaries the portion of the GBPU in each region has effectively been managed independently.

GBPUs are relatively large areas, and therefore harvest mortality may at times be concentrated in individual MUs or LEH Zones (see comment on Section 4.6 below).

3.2 Grizzly bear habitat in areas >100 km^2 that are permanently closed to hunting, and that are intended to approximate natural ecosystems or populations, will not be used to determine population estimates for harvest management purposes. Examples of such areas include those Provincial Protected Areas that are permanently closed to hunting, and National Parks.

The size limit selected is intended to reduce the effort involved in excluding small areas from the population estimate. The Grizzly Bear Conservation Strategy included a commitment to establish a network of Grizzly Bear Management Areas (GBMAs) across the province that would *be closed to grizzly bear hunting. There have been three categories of GBMAs identified – Benchmarks, Cores and Linkages – however, none have been designated to date.*

Benchmark GBMAs would be the largest, approximately the size of GBPUs, and one would be established for each of the terrestrial Ecoprovinces with significant grizzly bear populations (there are six: Coast and Mountains, Southern Interior, Southern Interior Mountains, Central Interior, Sub-Boreal Interior and Northern Boreal Mountains). Benchmarks are intended to serve as relatively unimpacted populations for comparative purposes over the long-term as well as a potential source populations for the future.

Core GBMAs would be smaller than Benchmarks and would represent refugia within GBPUs. Linkage GBMAs would, for the most part, be the smallest and would span current or potential human-caused fractures or barriers to grizzly bear movement and dispersal. Often Linkage GBMAs would cross GBPU boundaries.

The only habitat conservation measures currently attached to GBMAs is direction in the Identified Wildlife Management Strategy under the Forest Practices Code Act that Wildlife Habitat Areas for grizzly bears will normally only be created within "Threatened" GBPUs and/or GBMAs. To date no GBMAs have been designated due to opposition from hunting stakeholders and lack of internal support in the absence of more substantial habitat conservation measures that would be implemented when a GBMA is established.

3.3 The LCRB is responsible for preparing provincial habitat capability estimates in cooperation with RWSHs and Resource Inventory staff. Habitat capability estimates will normally be revised every three years, except when revisions are needed to incorporate new scientifically valid information.

The Ecoregion Classification and Biogeoclimatic Ecosystem Classification (BEC) systems are combined to create the combinations used for rating grizzly bear habitat capability (Meidinger and Pojar 1991, Demarchi 1996 and Hamilton and Austin 2002). There is a lack of formal documentation of the current potential or capability assignments to each of the unique combinations and their direct links to bear density. The rationale for these assignments, although logical and defendable, is not transparent. As a consequence, some believe that the approach is overly subjective and is not adequately based on appropriate scientific information.

Some also suggest that it is simply not appropriate to extrapolate grizzly bear densities from known areas to other areas, or at least not to the degree that it has been done in British Columbia. Others believe that extrapolation based on an ecological stratification combined with an assessment of human impacts is a reasonable approach, provided that a conservative approach is taken and contend that recent inventory work (Boulanger and Hamilton 2002) has supported this view.

3.4 RWSHs will use provincial habitat capability estimates in combination with the provincial step-down process to determine population estimates for each GBPU. It is recommended that the step-down be done by variant within MU where possible. It is recognized that this may not be practical everywhere.

Some consider the process used to develop population estimates to be overly complex and highly subjective without clear documentation of the assumptions used. For example, applying the step-down process at the variant level within an MU as opposed to the MU as a whole.

3.5 Population estimates will include all ages of grizzly bears. Population estimates will normally be updated every three years, but may be updated more often if needed to incorporate new scientifically valid information.

The procedure does not address the retroactive application of revised population estimates or whether or not new populations estimates can or should result in any negative mortality balance being eliminated. In one circumstance (the Kootenay Region) the implementation of new population estimates that were considered to have incorporated past excess human-caused mortality resulted in all negative harvest balances being eliminated for the beginning of a new three year allocation period.

In another case (the Cariboo Region) population estimates for some coastal populations were reduced, in some cases substantially, however, these estimates were not applied retroactively to re-calculate the allowable harvest for the previous allocation period (see Section 3 above) and negative harvest balances from the previous allocation period were not eliminated. Finally, in the Peace Subregion population estimates increased in many areas and were applied retroactively to the calculation of the allowable harvest.

Another issue that is not addressed directly in the procedure involves the impact of exceeding the allowable mortality levels on the population estimate.

Some have questioned whether it is appropriate to include cubs in population estimates used to set harvest levels given that it is illegal to kill a bear <2 years old. Others believe that the allowable mortality levels used are based on studies and modelling that includes bears of all sex and age classes (Bunnell and Tait 1981, Harris 1986, Miller 1990a, Hovey and McLellan 1996).

3.6 Population estimates based on habitat capability will be conservative, which will be defined as the low value of the density range within each provincial standard habitat capability class.

Some believe that the procedure is overly conservative due to the use of minimum population estimates, (especially for the lower density classes where the minimum/maximum range is very large), as opposed to the best estimate of the actual number. Others believe that this element of conservatism is appropriate given the sensitivity of the species to excessive mortality (Taylor et al. 2000, Taylor and Wade 2000).

This issue has confounded the comparison of inventory results with the Fuhr/Demarchi estimates for the same areas. Boulanger and Hamilton (2002) compared the mean estimate from inventory projects to the minimum and midpoint Fuhr/Demarchi estimates and found that the midpoint estimates were significantly larger than the inventory means, while the minimums were not significantly different. Other work, however, has shown greater consistency between inventory *means and the midpoint of Fuhr/Demarchi estimates and is critical of the use of minimum estimates (Mowat et al. 2002a, b).*

An issue with the current use of the Fuhr/Demarchi method is the availability of information that can be used to identify when populations have been overestimated. An example of where this type of problem has occurred is the Kitlope River drainage where controversy surrounding grizzly bear hunting and an independent investigation (McCrory 1994) led to reconnaissance work being undertaken. The results of this work indicated that the Fuhr/Demarchi method based population estimate for the area was too high and may have been resulting in unsustainably high harvest levels (Fuhr et al. 1994, Marshall and Sharpe 1995).

The reason that the Fuhr/Demarchi method resulted in an overestimate of the size of the grizzly bear population is believed to be related to problems with habitat mapping that categorized habitats as being of higher productivity than they were assessed to be following the reconnaissance work. The habitats in question – which were known to be high value habitats in other areas – were steeper with a higher incidence of bare rock than in those other areas. The end result was that grizzly bear hunting was closed in the Kitlope River drainage (which has subsequently been designated as a protected area).

Some ministry wildlife biologists are confident based on past harvest, their personal experience and/or anecdotal reports from hunters and other people active in grizzly bear habitat that the population estimates produced through the Fuhr/Demarchi method for some areas are too conservative. For example, the Kingcome DNA mark-recapture inventory resulted in a population estimate the was substantially higher the estimate prepared for the same area using the Fuhr/Demarchi method. The population estimate derived through the inventory project was also very similar to an estimate prepared prior to the inventory based on local knowledge and expert opinion.

Another issue with the Fuhr/Demarchi method is its inherent subjectivity. It relies on a consistent approach that is based on a thorough understanding of grizzly bear ecology and sensitivity to human impacts as well as local knowledge of the area in question. The system is vulnerable to variations in individual interpretations, particularly when the focus is on the result of the process (i.e. the final population estimate to be used for harvest calculations). Due to the fact that there are a series of assumptions involved in calculating a population estimate using the Fuhr/Demarchi method, one of the challenges is that even if the true population size for an area was known and varied from the Fuhr/Demarchi estimate for that area, it would be impossible to determine with certainty which assumption(s) were incorrect.

Given the subjectivity of the Fuhr/Demarchi method, it can be difficult to separate the assessment of the appropriate level of risk sensitivity that should be applied in calculating population estimates for harvest purposes from the process of setting the assumptions to be used. These variations in the degree to which the principle of "erring on the side of caution" is applied or in interpretations about where the need for caution arises, may influence the inputs applied and, as a direct result, the final population estimates derived.

3.7 RWSH may use densities above the low value of the habitat capability class when justified by written rationale. LCRB must be consulted to ensure that densities are within the provincial model. Population densities within a habitat class will always be within the density range assigned to that class.

3.8 Habitats can be reclassified to a different class where justified by scientific information by agreement of the RWSHs with the LCRB.

3.9 Where scientifically valid inventory information specific to an area is available, that information may be used to refine or replace the habitat based estimate. For the purpose of harvest calculations the population estimate derived from direct inventories will normally be the population estimate minus the standard deviation of the estimate. Population estimates based on techniques that do not allow for the calculation of precision will be evaluated on a case by case basis. Estimates from population inventories will not be used when ministry inventory standards or assumptions of the inventory have been violated. The results from inventories may also not be used where the precision of the estimate derived is unreasonably low.

Inventories have generally had low precision and the boundaries have often not corresponded directly to MUs or LEH Zones used for harvest management. As a result this section of the procedure has not been applied. Instead inventory results have been used to refine Fuhr/Demarchi based estimates. One of the challenges in doing this however, is that it is not possible to definitively identify which portion of the habitat estimate needs to be adjusted. For example, if a reliable inventory indicates that the population in an area is higher than predicted using the Fuhr/Demarchi technique, it will be difficult for a manager to know whether the habitat capability estimate for the area is too low, the step-down for human impacts is too great or both.

Some believe that the mean estimate derived from inventories should be used for harvest management purposes as opposed to the population estimate minus the standard deviation of the estimate (see comment on Section 3.6 above) .

3.10 Regional Fish & Wildlife Managers may implement new population estimates at the time they consider most appropriate in relation to current allocation periods. Where new information shows that past total human caused mortalities are above the maximums allowable, these will be handled following the provisions for excess mortality in this procedure.

See comment on Section 3.5 above.

3.11 Valid inventory data will be used to improve the accuracy of the provincial habitat based model of estimating population size.

See comment on Section 3.9 above.

4 Harvest

4.1 RWSHs will provide the proposed allowable harvest, including quotas for information purposes, and the recommended LEH authorizations, for each GBPU, to the LCS. Regions having both fall and spring grizzly seasons may combine the proposed LEH and quotas for each season into one submission.

4.2 Harvests will be determined as follows:
allowable harvest = (maximum allowable total human caused mortality) - (estimate of unknown human caused mortality) - (the estimated known non-hunting human caused mortalities that are predicted to occur based on past experience).

In practice, an estimate for known non-hunting mortality estimates has not normally been applied. This results in hunting opportunities being negatively impacted when such mortalities do occur. The procedure does not address potential liberalization of harvest levels (i.e. in the final year of a three year allocation period) if known non-hunting mortality is lower than estimated.

4.3 All grizzly bear harvest submissions must use the standard provincial spreadsheet.

Some believe that the standard provincial spreadsheet is unnecessarily complicated.

4.4 Total human-caused mortality for all GBPUs will be reviewed annually, and adjustments made in allowable harvests where required to stay within the maximum allowable total human caused mortality over the whole allocation period.

One of the foundations of the procedure is the close tracking of grizzly bear mortality. As in any large system of this nature, however, some known mortalities are not reported or are reported but are not accurately reflected in the database. Some hunters may fail to have the grizzly bear they have harvested inspected, in some cases staff have not submitted Compulsory Inspection forms for animals that have been reported dead but that they have not been able to inspect, forms may be lost or copies not sent to headquarters and errors have been identified at times in the Compulsory Inspection Database (most notably kills being entered more than once).

One area of particular concern is that of reporting the sex of Compulsory Inspected animals. Given the importance of female mortality limits and the potential for female mortality to significantly impact hunting opportunities there may be an incentive for some to falsely report female grizzly bears as males. A recent review of harvested polar bears documented a substantial proportion of females being reported as males (Schliebe et al. 1999). There have been reports of known female grizzly bears taken by hunters being falsely reported as males (F. Hovey, Wildlife Habitat Analyst, B.C. Ministry of Forests, Revelstoke, British Columbia, personal communication).

While the regulations governing Compulsory Inspection do require that evidence of sex be retained there may be circumstances such as hides that are rolled up and frozen where the sex of the animal is recorded based on the report of the hunter as opposed to direct inspection by staff. In some cases Compulsory Inspections are conducted by non-technical staff (Mark Hayden, Director, Enforcement and Emergencies Branch, B.C. Ministry of Water, Land and Air Protection, Victoria, British Columbia, personal communication).

Errors in kill locations have been detected (others, no doubt have not), locations are known to be falsely reported at times and some mortalities – particularly some non-hunting mortalities – are of an undetermined sex (treated as females). In some cases animal control mortalities have not be reported in the past due to a perception by some that an inspection of the animals was required. Some biologists are concerned that the procedure treats cubs of the year as equivalent to adult animals in terms of tracking acceptable mortality levels. In an extreme circumstance an adult female with three cubs of unknown sex that are destroyed as a result of a conflict will be treated as four female grizzly bear mortalities for the GBPU in question.

Mortality from closed areas is not always accounted for under the procedure. These areas also do not contribute to allowable mortality (see Section 3.2 above), however, in some cases mortality in closed areas may exceed sustainable levels and therefore may need to be accounted for within the GBPU.

4.5 Normally, hunting seasons will be closed only where more than two years of '0' harvest would be needed to bring total mortality within the maximum allowable. Where two or less years of closure would be needed, seasons will normally be left open with the minimum legal harvest for either one or two years.

This approach allows hunting seasons to continue, albeit at minimal levels, when allowable thresholds have been exceeded. If the two year period straddles a multi-year allocation period this could effectively allow hunting seasons to remain open even if the mortality deficit exceeded twice the annual allowable total or female mortality (i.e. upon commencing a new allocation period, usually three years, the allowable mortality is combined for the entire period).

In the past there has been great reluctance the close hunting seasons due to concerns that they would not be re-opened. In these situations compromises have often been made in which hunting opportunities have been reduced to the low levels (i.e. 1 LEH authorization and 0 guide-outfitter quotas). While the concern over the ability to re-open temporarily closed hunting seasons has diminished as a result of seasons being re-opened as intended, it still remains a substantial issue. There is potential for a "backlash" in response to hunting closures in some circumstances.

In 1999 following the temporary closure of the South Rockies GBPU due to excessive mortality (some associated with electro-fencing of landfills in the Elk Valley) there were 10 grizzly bears killed in "self-defence" in the Kootenay Region. In the same year only one person was injured by a grizzly bear (Richard Daloise, Regional Enforcement Manager, Kootenay Region, B.C. Ministry of Water, Land and Air Protection, Nelson, British Columbia, personal communication). Many proponents of grizzly bear hunting believe that hunting reduces the *likelihood of grizzly bear attacks and have predicted that more bears would be killed as a result of conflicts if hunting seasons are closed.*

4.6 It is essential to avoid excess concentration of harvest, and therefore mortality (total and of females) will be monitored by LEH Zone. Harvests may be re-distributed between zones, possibly including closure of zones, to avoid excess concentration of either total or female harvest.

In practice the major focus for harvest management is at the GBPU level with mortality balances in individual Management Units or LEH Zones being a minor consideration. Concerns have been raised about the local concentrations of grizzly bear mortalities or "sinks" (Doak 1995). Some suggest that the occurrence of highly concentrated adult female mortality may ultimately lead to local extirpation if mortality exceeds the rate at which vacant home ranges can be reoccupied. McLellan and Hovey (2001) have recently found that dispersal of subadult females was very limited in a rapidly growing population.

A review of the literature has not found any examples – including theoretical models – of situations where the location of mortalities has been shown to have an impact on whether a given level of mortality is sustainable or not. While locating "sinks" may be useful for guiding management activities in the event that mortality levels exceed what is desired; there is no evidence that the geographic location of mortalities, (independent of the level of mortality relative to the population's size and productivity), has any measurable impact on sustainable mortality levels. In fact, some believe that concentrating mortality in areas of predictable, high hunter success is desirable and reduces potential fluctuations in harvest levels resulting from variable hunter success.

4.7 First Nations may be allocated grizzly bear harvest. All grizzly bears harvested by First Nations under their allocation are considered as part of the harvest. Any bears taken outside of a formal allocation will be considered as part of the known non-hunting human caused mortality.

Allocations to First Nations have only be developed for the Skeena Region. It is believed that some First Nations harvest is not reported, however, the intent of the procedure is that this issue will be considered when developing estimates of unreported human-caused mortality. In addition, efforts continue to be made to improve harvest information through agreements with local First Nations. In general the level of grizzly bear harvest by First Nations is believed to be relatively low.

5 Total Human-Caused Mortality

5.1 Total human caused mortality will be managed by GBPU.

5.2 The predicted total human caused mortality will not exceed the following maximums based on average habitat capability.

Average Habitat Capability*	Maximum Allowable Total Human-Caused Mortality
1	6%
2	6%
3	5%
4	4%
5	3%

* Calculated as the average habitat capability for contributing grizzly bear habitat within an MU.

The upper end of the allowable mortality rates (6%) is consistent with the available literature on sustainable mortality rates for grizzly bears (Bunnell and Tait 1981, Harris 1986, Miller 1990a, Hovey and McLellan 1996), however, the sliding scale that reduces this rate based on the average habitat capability of each Management Unit has been developed without empirical data on the relationship between habitat capability and population dynamics. The sustainable mortality rates for moderate to low density grizzly bear populations in British Columbia are unknown, however, it is believed that the mortality rates used in the procedure err on the side of being conservative.

Some have argued that grizzly bear hunting selectively removes older, dominant males and results in reduced cub survival due to increased levels of cannibalism on cubs as new males move into the home ranges of harvested animals and females with young select poorer quality habitats in order to reduce the risk of infanticide (Weilgus and Bunnell 1994a,b, 1995, 2000, Weilgus et al. 2001). Alternatively it has been suggested that the removal of adult males increases or does not affect female reproduction and cub survival (Bunnell and Tait 1981, Stringham 1983, Miller 1990b, Reynolds 1997).

Although the impact of removing adult males on female grizzly bear reproduction as well as the nature of any density-dependent response in grizzly bear populations are both unresolved, the larger issue is the ability a grizzly bear population to sustain human-caused mortality including harvest. Harvested grizzly bear populations have demonstrated population growth rates combined with mortality rates that are equal to, or exceed, the human-caused mortality rates used in the Grizzly Bear Harvest Management Procedure (Bunnell and Tait 1981, Harris 1986, Miller 1990, Hovey and McLellan 1996).

Concerns are often raised about potential cumulative impacts to grizzly bear populations resulting from habitat impacts and human-caused mortality. It is believed that the population estimates that are developed using the Fuhr/Demarchi method account for habitat impacts on population size and that the harvest levels allowed under this procedure are sustainable and do not exacerbate the effect of habitat impacts.

5.3 Regions will estimate an unknown mortality rate, which will be included as part of the maximum allowable total human caused mortality for each GBPU.

Unknown rates will normally be 2% in areas having high human grizzly interactions. Rates will be lower in areas having fewer such interactions, but will not be below 1% unless supported by a written rationale.

The proportion of unreported human-caused mortality that is comprised of females is not considered in the harvest procedure, however, McLellan et al. (1999) found that of 31 grizzly bears suspected or known human-caused mortalities that would not have been known to managers without the aid of radio-telemetry, 13 or 42% were females. Given that Harris (1986) found that female mortality should not exceed 30% of the allowable total human-caused mortality (including unreported mortality) this suggests that the unreported human-caused mortality estimate should include an estimate of the proportion that are females. This estimate should then be incorporated into the process of setting the allowable known human-caused female mortality level. The result would be an even greater need than already exists to reduce female mortality through hunting.

While the procedure requires that an estimate of unreported human-caused mortality be included in the calculation of allowable harvest this is a relatively new requirement. Previous to the procedure the known allowable mortality rate used was 4% with no explicit estimate for unreported human-caused mortality, however, this implied an estimate of 2% from a total allowable human-caused mortality rate of 6%. Currently the estimates for unreported human-caused mortality are set at 1% for most areas, the lowest level allowed under the harvest procedure in the absence of a written rationale.

5.4 Total human caused mortality of grizzly bears (both total bears and females) will be managed over fixed multi-year periods corresponding to harvest allocation periods. The preference is for three year allocation periods. Periods up to 5 years may be used where warranted.

5.5 Wherever total human caused mortality exceeds the maximum for a given allocation period, the overkill (either total or of females) will be carried forward to the next allocation period and deducted from the maximum allowable total human caused mortality for that period.

If population estimates are revised every three years and are considered to account for past excessive mortality this section of the procedure may no longer be applied (see comment on Section 3.5 above). This would allow a situation to potentially occur where population estimates were gradually reduced over time (with the limit of 50% of habitat capability at which point the population would be designated as Threatened).

There is also an open question about how past excess mortality is considered in developing new population estimates. In some cases managers may feel that allowable mortality rates based on this procedure are so conservative that such "excess" mortality did not represent a population impact and estimates may not be reduced. Combined with not carrying forward excess mortality balances this would effectively eliminate these deficits from future calculations of allowable harvest.

5.6 Known human caused mortality of female grizzly bears within each GBPU must not exceed 30% of the maximum allowable known human caused mortality for the GBPU over an allocation period.

See comment on Section 5.3 above. Some believe that it is inappropriate to treat all female grizzly bear mortalities as identical under this threshold regardless of age and believe that the focus should be on breeding age females.

5.7 Grizzly bear translocations will be counted as if they were known mortalities in the source GBPU. Translocated bears will not be added to the population estimate used for harvest purposes of the area of relocation, however, if they die as a result of human causes they will not be counted as a mortality in the new area.

This section of the procedure does not make it clear that translocations within a GBPU will not be counted as mortalities which is the actual and intended practice.

Some believe that translocation is an effective management response to human/bear conflicts and do not think it is appropriate to count bears that are translocated to other GBPUs as mortalities from the source population. Others believe that if an animal is removed from a population it is irrelevant from that population's perspective whether it has died or has been translocated.

6 Population Objectives

6.1 Regional Fish and Wildlife Managers have discretion to prepare and recommend objectives for grizzly bear populations for GBPUs. Objectives will be for specific population numbers, recognizing that there is always uncertainty concerning populations. Objectives may be higher, lower, or equal to the current population estimate. It is not mandatory to prepare objectives. In the absence of approved objectives, grizzly bear populations cannot be managed to reduce numbers. All objectives must provide for a grizzly population that is viable over the long term.

Some believe that population objectives should be mandatory and should consider the possibility of setting spatially explicit sub-objectives (i.e. for low density near a community).

6.2 The Director of the Wildlife Branch approves population objectives based on recommendations from the Regional Fish and Wildlife Manager and the Chief of Wildlife.

6.3 Population objectives must be justified by a written rationale that includes: a conservation assessment including threats to the population, assessment of population trends, current population estimate, current habitat capability, and results of stakeholder consultations. Consultations with non-hunting and hunting stakeholders are required. Total human caused mortality of grizzly bears will be managed to facilitate meeting the objective for each GBPU over time.

6.4 Objectives lower than current population estimates would normally only apply in areas where there is documentation of chronic high levels of grizzly bear - human conflicts, and where the problems are shown to be linked to grizzly population size rather than other factors such as poor management of attractants. Such objectives should normally only apply where there is high public demand to reduce grizzly populations.

It has often been suggested that there is a link between the level of the grizzly bear harvest and grizzly bear/human conflicts – most notably attacks. The mechanism that is suggested is that hunting removes animals that are less wary of humans and that these animals pose a greater risk to human safety (Dood et al. 1986). One of the problems with this theory is that there is very limited information to suggest that hunting influences the general level of wariness in a grizzly bear population (Swenson 1999). Even more importantly, in the absence of food-conditioning, the grizzly bears that are most likely to be involved in attacks appears to be strongly biased toward those that are the most wary of humans.

Herrero and Higgins (1999) reviewed serious grizzly bear attacks in British Columbia from 1960 – 1997 and found that 79% of the animals involved in these attacks whose sex and age class were known were adult females. Grizzly bear hunting is biased against the killing of adult females for conservation reasons. Most notably, grizzly bear hunting of female grizzly bears with young under two years old is illegal whereas the majority of serious grizzly bear attacks involve these animals.

The level of serious grizzly bear attacks, including attacks per capita based on the provincial population has increased during the period 1960 – 1997. Grizzly bear harvest declined over the same time period, however, the level of serious attacks also declined in national parks where grizzly bear hunting is restricted. The simplest explanation for the provincial trend is that increasing human activity in areas occupied by grizzly bears has resulted in an increased frequency of serious grizzly bear attacks (Herrero and Higgins 1999).

The fact that serious attacks have declined within national parks despite increasing human activity demonstrates the degree to which bear attacks can be prevented through the management of attractants, timing of human activity in areas frequented by bears and public education. Most serious grizzly bear attacks in British Columbia have involved startling animals at close range in backcountry areas and as a result many are likely preventable. Of all activity types, hunters are at disproportionate risk of grizzly bear attack due to the nature of their activities (i.e. moving slowly and quietly through backcountry areas and being closely associated with ungulate carcasses) (Herrero and Higgins 1999).

6.5 Where approved objectives are lower than the current population estimate, regions may deduct control kills and translocations from the population estimate for the GBPU, instead of incorporating them as part of the maximum allowable human caused mortality. No other human caused mortalities may be deducted from the population estimate. All control kills and translocations will be accounted for in either human caused mortality or population reductions.

To date population objectives have not been set for any harvested grizzly bear population and, as a result, the default objective of maintaining populations is currently applied.

The potential problem with the approach to reducing population size outlined in the procedure is that it treats the population estimate and the allowable human-caused mortality limits as though they are precise which they are not. To suggest that exceeding the allowable mortality levels set through the procedure by one animal will cause the population to decline by one is clearly not accurate. The population estimates used for harvest purposes are intended to be minimum estimates and it is recognized that the true population size is unknown. Perhaps more importantly, the application of the provision for objectives that result in populations declining allows hunting seasons to remain open in areas where they would otherwise be closed and may provide a disincentive to reducing grizzly bear mortality from bear/human conflicts. Others believe that allowing grizzly bear hunting seasons to remain open under these circumstances can increase community support for addressing local conflicts issues such as efforts to improve the management of non-natural attractants such as garbage.

Another problem with population objectives that allow populations to decline in order to reduce conflicts is that in some areas natural habitat values (e.g. spawning salmon, high value spring habitat) may attract grizzly bears to areas in close proximity to human activity. Under those circumstances a population "sink" could be created that may not result in a substantial decline in the number of grizzly bears in the area until the population in a large surrounding area has been seriously impacted.

Future Directions

Population Estimates and Inventory

Work is underway to improve the starting point for Fuhr/Demarchi based estimates by mapping ungulate density and salmon availability to grizzly bears so that this can be directly considered instead of being incorporated indirectly through the assignment of habitat capability classes. This effort could be assisted by research studies using instrumented animals to examine the importance of these food sources as well as stable isotope analysis of hair or tissue samples (Hilderbrand et al. 1996).

Another technique that is being evaluated as an alternative or addition to habitat capability ratings of Ecosection/BEC variant combinations is a model that assesses habitat suitability based on terrain features and a green vegetation index derived from remote sensing (Mace et al. 1999, Apps 2002).

In order to address the subjectivity of the Fuhr/Demarchi method a potential future direction is the development of a more objective step-down model to incorporate human impacts. Such a model could be based on the approaches that have been developed for quantifying the cumulative effects of human activities on grizzly bears (USDA Forest Service 1990). Pilot projects using more detailed and objective assessments of habitat impacts have been conducted in a number of areas around the province. One of the limitations to provincial application is the intense data requirements of the models used.

It will be a major challenge to develop an objective method for incorporating the impact of past human-caused mortality. One approach that has been used is to construct a population model that predicts the current population size based on an estimate of past population size combined with actual past known human-caused mortality (Mowat et al. 2002a, b, Taylor 1987*)*. The potential to apply population models in this way is limited, however, by the fact that reliable mortality data at the GBPU level is only available from 1976 onward. For example, in the 11 Threatened GBPUs the majority of the mortality impact is believed to have occurred prior to 1976.

It has been suggested that the entire stepdown process could be approached through the application of a Bayesian Belief Network (BBN) (Marcot et al. 2001). Such an approach would explicitly recognize the inherent uncertainties in inputs and make assumptions more transparent. The strength of BBNs is that they are helpful in combining expert experience with available empirical data. Preliminary work on constructing a BBN for the North Coast of British Columbia is underway. The draft population model attempts to apply the analytical approaches reviewed by Foley (1994) and further investigated by Boyce et al. (2001).

An alternative or complementary approach that is currently being investigated for estimating grizzly bear population size is the use of DNA mark-recapture results to build a model of predicted grizzly bear density that incorporates habitat values and human impacts through the application of resource selection function analysis (Apps et al. In prep.).

The DNA mark-recapture inventories that have been conducted to date have supported and helped to refine the population estimates derived through the Fuhr/Demarchi method, however, these inventories are expensive and tend to have low precision (Boulanger and Hamilton 2002) It is not practical to conduct DNA mark-recapture inventories broadly across grizzly bear range in the province. The northern interior, west of the Rocky Mountains, and the central coast where no inventories have been successfully completed are considered a priority for any additional DNA mark-recapture inventories.

Considering the cost involved in conducting a DNA mark-recapture inventory (normally over $100,000) and the fact that the result is a point estimate of population size with broad confidence intervals, many believe that a greater scientific benefit would be obtained through long-term radio-telemetry studies. Such research would provide additional population density information as well as data on habitat use, human impacts, population dynamics and human mortality that could be used to guide the application of the Fuhr/Demarchi method and the harvest management procedure. In addition, it would provide valuable information to efforts to conserve and manage grizzly bear habitat.

A future direction for population inventories that is being considered is the mark-resight technique developed in Alaska (Miller et al. 1997). While the sightability of grizzly bears is believed to be too low to successfully apply the technique in many ecosystems in the province, a mark-resight inventory has been proposed for the Flathead area. Unfortunately, sightability has been considered to be too low due to relatively low berry crops to conduct the inventory in both 2000 and 2001 (B. McLellan, Wildlife Habitat Ecologist, B.C. Ministry of Forests, Revelstoke, British Columbia, personal communication). If mark-resight does prove to be feasible in some areas of the province marked animals will be required which represents an additional benefit of long-term radio-telemetry studies.

Notwithstanding the potential improvements to the techniques used, the current approach to managing grizzly bear hunting in British Columbia is considered by many to be overly reliant on population estimates. The availability of information on population trends is a substantial limitation on the management of grizzly bear hunting and to grizzly bear conservation in general. Instead of population inventories that yield “snapshots” of population size or density with wide confidence intervals, a potential future direction is to place more emphasis on monitoring population trends. A greater emphasis could also be placed on long-term research to better understand grizzly bear habitat associations, population dynamics and the impacts of human activities on grizzly bears. Additional inventory is most critical in representative areas of the province where long-term research is not available in order to confirm or revise the densities used in the Fuhr/Demarchi method and as a baseline for trend monitoring.

Monitoring of population trends could include counting bears on coastal rivers and streams during salmon spawning and in shrubfields and other open habitats in the interior during the peak of berry production. Reports of females with cubs of the year should also be tracked carefully using similar procedures to those applied in the Yellowstone Ecosystem (Eberhardt et al. 1986, Knight et al. 1995). Carefully tracking of all sightings could be used to monitor “Threatened” populations but would likely not be feasible for larger populations (Gyug 1998, North Cascades Grizzly Bear Recovery Team 2001).

In areas with poor sightability of grizzly bears, or in addition to the above, monitoring could be conducted using DNA sampling of hair and, if practical, scats (Woods et al. 1999, Kendall and Waits 2001, Himmer and Boulanger 2002).

The value of improved information on grizzly bear populations in British Columbia goes well beyond harvest management. From the harvest management perspective alone, an alternative to the current approach is to simply set grizzly bear harvest levels at a very low, fixed level (e.g. 100 grizzly bears/year for the province) that would be sustainable by even the most conservative population estimates. This would also avoid the need for constant adjustments as a result of non-hunting mortalities. Others believe that current harvest levels are sufficiently conservative to account for our current level of knowledge of population levels and trends.

Harvest Management

Much of the debate around grizzly bear hunting comes down to a question of the acceptable level of risk of overharvest and the associated impacts to populations. This risk can be reduced by reducing harvest levels (as well as possibly reducing other sources of human-caused mortality) and/or obtaining and applying improved information on sustainable harvest levels including population estimates and trends. In order to qualitatively solve for any one of the three variables: risk, harvest level and information required (or alternatively the resources available to obtain this information), the other two variables must be known.

For the areas of the province that have both spring and fall hunting seasons decisions must be made about hunting opportunities before all of the information is available on the harvest from the previous season. This overlap can increase the risk of overharvest that would have to be mitigated for in future hunting seasons. Fall grizzly bear hunting seasons have a higher percentage of females taken than spring seasons, make it very difficult to insure that hunters are not using ungulate carcasses as bait and allow hunters to hunt in areas where bears are feeding on salmon. Spring hunting seasons generally show an increase in the proportion of females taken as the season progresses allowing for female mortality to be reduced through relatively minor changes in season dates (e.g. by closing the hunting season on May 31 as opposed to June 10).

In order to improve the reliability of harvest data, measures could be implemented to confirm the sex of harvest animals. One possibility is DNA analysis of tissue or hair samples taken from compulsory inspected grizzly bears. A requirement could established for the baculum of any harvested male grizzly bears to remain attached to the carcass and for it to be removed during the inspection.

A potential future direction is the elimination of fall grizzly bear hunting seasons. Spring hunting seasons have lower proportions of females taken, opportunities to illegally use bait or to legally hunt over salmon concentrations would be greatly reduced, hunter success is lower in the spring allowing for more hunting opportunities to be provided, spring hunts provide a unique opportunity as opposed to fall hunts that overlap with ungulate hunting, and enforcement of grizzly bear hunting regulations would be improved by separating it from ungulate hunting seasons (Mark Hayden, Director, Enforcement and Emergencies Branch, B.C. Ministry of Water, Land and Air Protection, Victoria, British Columbia, personal communication). Some believe that the rationale for the elimination of fall season is debatable and may be more associated with social values such as "fair chase" concerns than with biology.

There has been at least one situation in which a number of grizzly bears were poached and the hides sold to taxidermists (Wayne Campbell, Regional Enforcement Manager, Skeena Region, Ministry of Water, Land and Air Protection, Smithers, British Columbia, personal communication). Although these grizzly bears were poached, it is currently legal to sell the hides of harvested grizzly bears and the value – estimated at over $1,000 Canadian – may be an incentive for harvest by some individuals. A potential future direction is for a legislative change that would make it illegal to sell grizzly bear hides and claws in order to reduce the commercial value of dead grizzly bears in addition to the enforcement of existing legislation.

It has been suggested that a point system where guides are given a quota in points, males equal one point and females two or three points, would reduce female harvest by non-residents (Smith 1988). This approach – including a video to assist hunters in differentiating males and females – has been used in the Yukon with no evidence of long-term success in reducing the harvest of females (J. Hechtel, A/Carnivore Specialist, Yukon Department of Renewable Resources, Whitehorse, Yukon Territory, personal communication). One concern with this approach is that it may provide a substantial disincentive to reporting kills of females.

Establishing a province-wide network of GBMAs as refugia is a potential future direction. These areas could serve as Benchmarks, Core areas and Linkages across potential population fractures (see comment on Section 3.2 above). Such as system would help to avoid excessive human-caused mortality and would assist populations in recovering from such mortality if it occurred.

A proposed Benchmark GBMA has been developed for each of the ecoprovinces with a significant grizzly bear population based on the location of protected areas, grizzly bear habitat capability, road density and representation (Figure 1). A target of the percentage area within each harvested GBPU that would be closed to grizzly bear hunting as Core GBMAs could also be set (e.g. 10-25% of each GBPU could be incorporated into GBMAs).

A substantial number of grizzly bears are killed as a result of conflicts with hunters. Hunter education could be improved with particular focus on responding the bear encounters including the use of pepper spray, handling of carcasses and keeping a clean camp. Education on species identification could be focused on black bear hunters to avoid grizzly bears being killed accidentally through misidentification as has occurred on a number of occasions.

There are varying opinions on the need for, and best use of, population objectives for grizzly bears. In many cases these objectives are seen as a method for reducing conflicts through the reduction of populations and/or as a means to avoid reducing hunting opportunities as a result of mortalities due to grizzly bear/human conflicts. Others feel that using population objectives in this manner is not necessary based on the view that bear/human conflicts are much more closely linked to human behaviour than to bear density. Instead of focusing on population objectives that allow populations to be reduced, some feel that the emphasis should be on efforts to reduce bear/human conflicts through public education and the management of non-natural attractants. One potential future direction for population objectives is to set them as a percentage of habitat capability – the same scale that is used to designate populations as Threatened or Viable.

Conclusion

Grizzly bear hunting as it is currently managed in British Columbia is not considered to represent a threat to the conservation of the species in the province or to individual populations. The harvest management system used has been evolving over the decades that grizzly bear hunting has been regulated by the provincial government and the future directions described represent potential options for its continuing development and improvement.

The most substantial threats to the conservation of grizzly bears are not related to grizzly bear hunting but to the loss of effective habitat. If habitat impacts continue to reduce the ability of landscapes across the province to support grizzly bears, the harvest management system will need to recognize and respond to this trend by reducing harvest opportunities over time as populations decline. It is expected that in some cases this decline will result in new populations being designated as Threatened and being closed to grizzly bear hunting.

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