GRIZZLY BEAR MANAGEMENT RECOMMENDATIONS FOR THE GREATER KLUANE ECOSYSTEM AND KLUANE NATIONAL PARK & RESERVE

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EXECUTIVE SUMMARY

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1.0 Grizzly Bear Management Recommendations for the Greater Kluane Ecosystem and Kluane National Park & Reserve

"The problem of management of grizzlies becomes more a matter of management of humans intruding into grizzly habitat." Pearson 1975

1.1 A Perspective on Grizzly Bears

Grizzly bears were once one of the most widely distributed terrestrial carnivores in the world and ranged throughout Asia, Europe, North Africa and the western half of North America. Declines in grizzly bear range due to human activities can be traced back as far as 3,700 years ago when they disappeared from Denmark (Servheen 1993). By the 12" century grizzlies *were* extirpated from England, and over the last 2 - 3 centuries the populations of Europe have been successively eliminated and reduced to small, isolated remnants (Servheen 1993). Populations in North Africa were driven to extinction about 100 years ago (Servheen 1992). The status of current populations in Europe and Asia is unclear. Some populations in Scandinavia are apparently increasing (Swenson et al. 1994), however, civil and regional strife in eastern Europe have probably contributed to further declines of local populations. Similarly, economic breakdown in Russia and a lucrative trade in bear parts are suspected to have resulted in significant exploitation of Asian populations.

Grizzly bears crossed over the Bering land bridge into North America about 50,000 years ago and spread over the western half of the continent and south into central Mexico. Estimates of the historic grizzly bear population in North America approximate 100,000 individuals, however, like their Eurasian counterparts, population declines over the last 150 years were swift and relentless. Prairie populations disappeared rapidly as settlers converted the Great Plains ecosystem into agricultural and domestic grazing systems (Servheen 1993). Populations in the mountainous western United States persisted longer, but the further intrusion of domestic livestock into mountain ranges, and accompanying human prejudice against predators, continued the process of isolation and extermination. By 1975, grizzly bears in the conterminous United States had been reduced to about two percent of their historic range and numbers, and were listed as a threatened species by the US Fish and Wildlife Service (Servheen 1993).

1.2 The Status of Grizzly Bears in Canada

Grizzly bears in Canada have fared better than the populations in the conterminous United States, however, this is the product of fewer humans rather than a difference in attitudes. Grizzly bears on the Canadian prairies, for instance, paralleled the same pattern of extinction as their counterparts on the American prairies and currently, grizzly bears are extinct over 24% of their historic range in Canada (Banci et al. 1994). Of the remaining grizzly bear occupied range in Canada, 63% is designated as either vulnerable or threatened (Banci et al. 1994).

Recent population estimates of grizzly bears in Canada are about 25,000 individuals (Banci et al. 1994) distributed across British Columbia (13,000), Alberta (800), Northwest Territories (5,000) and the Yukon (6,300). In contrast, the estimated potential of the Canadian land base to support grizzly bears is approximately 33,000 which is about 30% higher than the present day population. The difference between estimated potential and current numbers reflects the impacts of human-induced mortality, habitat alienation and fragmentation, and land-use activities (e.g., forestry) that do not permanently preclude the return of climax vegetation communities (Banci et al. 1994).

1.3 Grizzly Bears in Southwest Yukon

The southwest Yukon lies within the Subarctic Mountains and Plains (SMP) grizzly bear zone (Banci 1991), a 370,440 km* area that encompasses much of the southern Yukon and northwestern British Columbia. Human impacts throughout the region have been slight and the potential to support grizzly bears has changed little from the pre-contact era with European immigrants. Current estimates of the grizzly bear population within the SMP zone approximate 5,680 individuals (15 grizzlies/1000 km*) which is slightly lower than the estimated potential population of 6,060 (Banci et al. 1994). Grizzly bears are not presently listed as at risk, however, it is expected that human impacts will increase significantly in the future. Access and recreation are among the noted impacts that are expected to become more prevalent (Banci et al. 1994). The SMP zone was identified, however, as one where both estimated total mortality exceeded recommended levels (4%) and excessive kills of female grizzly bears (females represented >33% of total kill) occurred in most years (Banci et al. 1994).

In general, the southwest Yukon is representative of the SMP zone, however, Kluane National Park & Reserve, an approximately 22,000 km^2 area of icefields fringed by a narrow green-belt, constitutes a unique enclave within both the southwest Yukon and larger SMP zone. In particular, the green-belt represents a unique and diverse vegetation complex maintained by variable climate and geomorphic processes (Douglas 1974). Natural disturbance frequency is high and through forces such as glacial recession, active floodplains and outwash fans, significant portions of the green-belt are maintained in successional habitats important to bears. This is in stark contrast to most of the southwest Yukon where, with the exception of fire, natural disturbance frequency and habitat value to bears is much lower.

Population density of grizzly bears within Kluane's green-belt is comparatively high and for the central portion (i.e., upper Alsek and Kaskawulsh valleys), *is* estimated by both the research project and Pearson (1975) at approximately 40/1000 km^2. A gradient in grizzly bear density likely exists from south to north due to differences in rainfall and temperature that are reflected in lower habitat productivity. As a consequence of the small amount of habitat represented by the green-belt (4000 km^2), population size within the park is estimated to be approximately 160 grizzly bears. Transboundary movements by bears between the park and adjacent jurisdictions are common, and based on the average percent of time that radio-collared bears spent within the research project's DNA census grid (71%), the total number of bears that contribute to the park population may approximate 225 individuals (i.e., 160/0.71 = 225). Like many northern interior populations of grizzly bears, age of first reproduction is comparatively late (8 years), litter sizes are small (mean = 2 cubs/litter), and mortality of cubs-of-the-year is high (>50%). Modeling of population dynamics suggests that the population is marginally stable and likely at carrying capacity, as defined by climate, habitat and current visitor use levels. It is unlikely that the park can withstand a significant increase in human activities without concomitant impacts on population status.

The distribution of the green-belt, essentially a narrow band of habitat along the eastern perimeter of the park, has significant consequences both to grizzly bears and people's perceptions. Monitoring by the research project suggests that major movement corridors leading out of the park direct dispersing subadult bears into roadside habitats and areas of human habitation, conflicts with people, and ultimately control actions. Most inhabitants of the southwest Yukon also live adjacent to the park and the frequent appearance of subadult grizzly bears along highways and near communities strongly influences perceptions as to the grizzly bear density throughout the entire ecosystem. This juxtaposition of the highest density of both bears and people within the southwest Yukon has resulted in Kluane acting as a population source and the peripheral lands acting as a sink. It also creates the potential conditions where a significant decline in grizzly bear numbers could occur on non-park lands, but essentially go unnoticed since dispersing recruits from the park continually appear on the roadside creating the impression that bears are still abundant.

As with most parks supporting grizzly bears, the available base of habitat within Kluane's boundaries is too small to support many bears. Of 58 bears monitored by the research project, 25 (43%) utilized other jurisdictional lands in addition to the park and 7 bears are known to have died outside the park. The susceptibility of the grizzly bear population to increased human use of Kluane is paralleled by its susceptibility to increases in human activity (e.g., urbanization, forestry) outside the park. Over the long term, the ability of the ecosystem to provide grizzly bears with the space and security that they require, is clearly in question.

2.0 Grizzly Bear Management Recommendations for the Greater Kluane Ecosystem

2.1 Introduction

Most grizzly bears in the Yukon, as elsewhere, do not live in parks in spite of the popular view that parks are the primary providers of secure, core habitat. This is only partially true, since most national parks contain relatively little high-quality habitat, however, the general public tends to draw a strong distinction between the value of park and non-park lands to the conservation of bears. This perceived distinction tends to create tension between local residents and park managers, and strongly influences expectations as to how management activities will be conducted on those lands outside of park boundaries. Over the long term, continued existence of grizzly bears will require a shared responsibility between Kluane and the larger ecosystem, and the concept of secure, core habitat needs to migrate beyond the park. This will be a difficult transition since the only model the public has for managing core grizzly bear habitat is that of Kluane itself. Other models clearly exist that permit multiple land use practices and reduce the socioeconomic impacts of managing for grizzly bears on non-park lands.

Herrero (1994) ranked Kluane as the top priority among national parks for an interagency grizzly bear management approach that had the objectives of long-term maintenance of the population and its habitat base. Similar approaches that bring together representatives of management agencies and stakeholders, such as the Interagency Grizzly Bear Committee, have been central to conservation efforts elsewhere (Miller 1990). Of fundamental importance to the success of interagency management is the ability of participating agencies to reach agreement on compatible objectives for population size and habitat requirements, and to be able to implement those objectives. Obviously, the clarification of management goals and achieving consensus among stakeholders are the first steps in an interagency bear management plan.

The recognized plight of grizzly bears has led to numerous recommendations to promote conservation, In general, these varied recommendations converge to a small set of generalized actions that need to be undertaken. The following list, adapted from Banci et al. (1994) and the British Columbia Grizzly Bear Conservation Strategy (BC Government 1995a) provides a framework from which specific objectives for interagency bear management plans can be generated. It is recommended that these objectives be fully considered in the development phase of future grizzly bear management plans for the Greater Kluane Ecosystem.

- Pursue research on both direct and indirect population monitoring tools to support assessments of occurrence, population size and trend.

- Identify critical areas, linkages and corridors for grizzly bears and determine appropriate regulation of human activities (e.g. no hunting zones, habitat use guidelines) within these areas.

- Develop multi-scale land use and access management strategies that are long-term in scope.
- Determine sustainable bear mortality levels and document mortalities from all sources. Timely recognition of excessive mortality and action plans to mitigate the effects of unsustainable mortality arc also required.
- Improve management of human garbage and other attractants to prevent their utilization by bears.
- Conduct public education programs to: 1) enhance public awareness of bear ecology, bear safety, bear/people conflicts, and evolving legislation, and 2) encourage public support for sustainable bear mortality and waste/attractants management initiatives.
- Participate in multi-agency (and international) co-operative management of transboundary grizzly bear populations. Management efforts should be supported by advisory committees that represent both the concerns of local stakeholders and the 'knowledge base' on bears (be it of scientific, local or traditional origins).
- Increase enforcement and increase penalties for violations of provincial, territorial, park or local grizzly bear management regulations.
- Form strategic alliances with the private sector and non-government organizations to help promote financial support for grizzly bear management, research and public education.

2.2 Recommended Actions

2.2.1 Formation of an Interagency Management Board

Local initiatives that have resulted in significant improvements in waste/attractants management in the Greater Kluane Ecosystem are representative of the type of management actions achievable under interagency cooperation. Many of the remaining recommendations will require significant capital investment, committed efforts, and specialized skills, in addition to interagency cooperation, if they are to be realized. Funding, therefore, represents a major challenge going forward. Those agencies and governments, who in consultation with local fish and wildlife management boards, are responsible for managing bears should enter into an agreement to officially form an interagency bear management board. The first priority of an interagency management board would be to draft and ratify a comprehensive grizzly bear management plan that 1) outlines goals for population size, habitat maintenance, and connectivity to adjacent populations, 2) defines the acceptable level of risk that will be assumed in policies, 3) allocates the burden of proof between decision makers and proponents of developments, 4) defines and sets priorities to achievable objectives, 5) establishes monitoring protocols and performance indicators for objectives, and 6) outlines required funding levels. This is a non-trivial task, however, a comprehensive plan of this nature would serve as the basis for funding applications. In the interim, the success of funding efforts is likely to be enhanced by demonstrable progress on those initiatives that can be accomplished within current limitations of those responsible for the management of bears.

2.2.2 Public Education

Several important and achievable initiatives seem apparent and within the scope of the locally appointed Fish & Wildlife and park management boards' current funding and jurisdictional limitations. The most obvious is continued education programs directed at both visitors and most importantly, local residents. People who live within, or adjacent to, grizzly-occupied ranges tend to have more utilitarian values and less sympathetic attitudes towards bears (Kellert 1994). Clearly, the success of a management plan relies on broad public support and cooperation at the local level. Programs that explain bear ecology, traditional values of bears, why grizzly bear management is required, management goals and how they were arrived at, and the resultant socioeconomic benefits and sacrifices, should be developed and delivered to the community.

2.2.3 Increased Enforcement

Pearson (1975) drew a distinction between justifiable killing of grizzly bears in defense of life and property (DLP kills) and unwarranted killing of bears under the guise of DLP. He recommended thorough investigation of those who are involved in repeated DLP kills and, if necessary, prosecution, heavy tines and invalidation of land-use permits granted to offenders. To some degree fear of punishment may only serve to drive some activities underground resulting in more unreported kills and poorer documentation of grizzly bear mortality rates. Currently, responsibility to investigate DLP or illegal kills lies within the jurisdiction of the Warden Service or Conservation Officers, depending on the location of the event. Under a more comprehensive interagency management system that represented all governments and agencies, the responsibility to investigate, or to recommend punitive actions such as public condemnation or legal action, would be jointly shared. Such an approach would be in keeping with the transboundary nature of the grizzly bear population. It is recommended that the current management boards move toward shared responsibility in dealing with DLP or illegal kills as this would permit more resources to be directed to investigations and present a unified, high profile level of concern to the public. If it is not already the case that all occurrences of bears obtaining human food or waste must be reported, then this should become a well publicized legal requirement supported by penalties for failure to report the incident and for failure to enact recommended corrective measures.

2.2.4 Access Management

One of the most important initiatives that can be currently undertaken is access management. Motorized access has frequently been identified as one of the most fundamental parameters influencing mortality risk and habitat security for a variety of wildlife species (IGBC 1994). The requirement to promptly and permanently close roads after single pass resource extraction activities are complete could be invoked through land-use permits. For roads that may need to be open for long durations, gates could be employed to restrict access to authorized personnel conducting authorized activities. Uncertainty, however, exists over the effectiveness of road closures due to modification of public attitudes reflecting reduced industrial and recreational opportunities (Mattson et al 1996). The combination of poorly enforced access restrictions and an antagonized, armed public may lead to little reduction in bear mortality, or even increases in mortality rates (Mattson et al 1996). The effectiveness of access restrictions is clearly not independent of the effectiveness of educational programs and public involvement in the development of management plans.

While management approaches such as closing roads can be enacted immediately, other characteristics of roads (e.g., road densities within management units) can only be effectively addressed with spatial information. Future protocols for access management will need to incorporate spatially derived road density calculations, apply thresholds, and generate road prescriptions for management units. Commonly recommended thresholds for road density are <0.16 km/km^2 with localized densities <0.4 km/km^2 allowed over some portions of the land base (AECL 2000). Effective management of activities such as salvage logging, which may appear to have few ecological impacts, requires that the consequences of increased motorized access be factored into long-term, multiple-use land management policies. With the aid of road density guidelines, more comprehensive long-term plans for the location, timing, and rate of resource extraction can be generated.

2.2.5 Forestry Guidelines

Forestry is a relatively new activity in the Kluane ecosystem, however, land use planning processes, and some guidelines for cutblock layout, riparian buffers, wildlife tree patches, patch size distribution, and wildlife habitat areas are currently available from British Columbia (e.g., Biodiversity Guidebook, Identified Wildlife Management Strategy). Initiatives to maintain grizzly bears in multiple-use land management is an evolving process in British Columbia (McLellan and Hovey 2001) and additional recommendations generated from research can be expected. There seems to be few impediments to training individuals in currently available forestry protocols that reduce the vulnerability of wildlife species. Additionally, regenerating cutblocks (or burns) should be monitored as to the successional communities that arise and their attractiveness to wildlife species. In the event that early seral communities attractive to bears or other species result, it would seem prudent to invoke conservative hunting policies, create no-hunting zones, or invoke access restrictions.

Currently, resource extraction activities are progressing at a pace faster than the government's ability to set policies and evaluate potential impacts. Components of a more comprehensive management plan, such as continued identification of critical habitats, linkages, and delineation of appropriate policies on an ecosystem scale are clearly several years away. In the interim there seems little justification not to employ proactive management actions such as access and hunting management, forest buffers, and partial-cut silviculture to retain security cover (McLellan and Hovey 2001). These actions are readily available and will likely be cornerstones of future management plans for multiple-use lands in the southwest Yukon.

2.2.6 Reduction of Control Kills

The level of control kills around communities and along highways is a major concern in the Kluane ecosystem. Eighty-two grizzly bears were killed in control actions in British Columbia in 1999 and over a 10 year period between 1986 – 1995, 17 grizzlies were killed in control actions around Revelstoke. In comparison, 45 control and DLP kills have been documented along the periphery of Kluane between 1992 – 2000 for an annual average of 5 kills (Table 1, one control kill within Kluane has been excluded from the tally of mortalities along the park periphery). A similar level of conflict kills of grizzly bears within the larger Greater Kluane Land Use Planning Region has been reported for the pre-1992 period (van de Wetering and Smith 1989) indicating that little progress on reducing control mortalities or heightening of public concern has been made. In order for this annual level of control kills along Kluane's periphery to scale to annual control kill rates in British Columbia (82/13,000 = 0.0063) would require a local population of about 795 grizzlies. Additionally, control kills have a strong spatial bias with 16 and 9 kills occurring in subzones 5-21 and 7-07, respectively.

Habitats around communities and along the highways will continue to attract bears since they provide safer foraging sites for subdominant individuals seeking to avoid adult males (Mattson and Reid 1991). Additionally, highways traverse seasonally important habitats, create attractive early seral communities through disturbance of vegetative communities along the right-

Table 1. Known and suspected mortalities of grizzly bears in and around Kluane National Park Reserve, 1992 - 2000. Numbers in brackets denote bears with active radio-collars at time of death.

Source of Mortality[a]	Adult			Subadult			Unknown Age			YRLG	COY	Total
	M	F	U	M	F	U	M	F	U			
Natural	0	4 (4)	0	0	2 (2)	0	0	0	1	7[b]	30	44 (6)
Harvest	4[c]	0	0	0	1	0	27	13	0	0	0	45
Poached[d]	0	0	1	1 (1)	1	0	0	0	0	0	0	3 (1)
Control[e]	12[f] (1)	3[g]	0	18 (1)	4	0	3	5	0	0	1[h]	46 (2)
unknown	0	0	2	0	0	0	0	0	1	0	0	3
Totals	16 (1)	7 (4)	3	19 (2)	8 (2)	0	30	18	2	7	31	141 (9)

[a] Totals are known and suspected mortalities occurring in Kluane National Park, Kluane Wildlife Sanctuary (Zone 6), and adjacent Game Management Subzones from the Donjek River south to the British Columbia border (subzones 5-18, 5-20, 5-21, 5-38, 5-41, 7-01, 7-03, 7-07, 7-09).
[b] Includes 1 yearling lost by KNP 057 from a litter of triplets in 1997, 2 suspected mortalities of sibling yearlings lost by KNP 050 in spring of 1997, 2 suspected mortalities of sibling yearlings lost by KNP 044 in 1998, and 2 sibling yearlings lost by KNP 027 in 1999.
[c] Includes 2 previously collared grizzly bears (KNP 031 and KNP 040).
[d] Known mortalities with suspected poaching as cause: adult grizzly at Dalton Post, subadult male KNP 058 found dead outside of Park, subadult female found inside Park.
[e] Includes control kills by Conservation Officers and Park Wardens as well as defense of Life and Property (DLP) kills by citizens.
[f] Includes previously collared adult male KNP 007.
[g] Includes previously collared adult female KNP 0 17.
[h] Includes 1 female COY relocated from Haines Junction dump to Toronto zoo which is considered as a removal from the ecosystem..

of-way, and foster the introduction of exotic forage species such as the common dandelion. Roadsides are also sites of earlier green-up in the spring and better berry crops due to resultant opening of the forest canopy. Many options to reduce the influence of highways have already been foreclosed since right-of-ways were established prior to our current understanding of ecology resulting in poor road locations with respect to ecological features (Forman and Alexander 1998).

In many cases, bears foraging near roads are not an issue provided that they are not near human habitation and can go undetected by passing traffic. Some options such as seeding roadsides with coarse, non-forage species or removing forage species from the road edge so that bears forage deeper into natural cover may be available, however, cost and the likely need to use herbicides raise additional issues. Control kills will remain a necessary management approach, however, where possible 'problem' bears should be subjected to aversive conditioning or live-trapped and assessed for their potential to be translocated. Since Kluane will be the likely recipient of roadside bears captured along its periphery, and will provide the bulk of funding required for translocation, the Warden staff in consultation with local Conservation Officers should make the final decision as to whether translocations should be conducted. In the event that control kills can not be reduced it would seem highly prudent to substantially reduce or eliminate legal harvest in management subzones peripheral to the park.

2.2.7 Sustainable Mortality Rate

Sidorowicz and Gilbert (198 1, in Miller 1990) estimated that sustainable harvest rates for grizzly bears in the Yukon were 2 - 3% of the population. Many agencies (e.g., BC Wildlife Branch, US Fish and Wildlife Service) have adopted a maximum sustainable mortality rate from all sources of 4% for grizzly bears with a maximum female proportion of 33%. Since many kills go unreported, documented legal kills are adjusted by a factor of 1.5 to account for poaching, accidental deaths and wounding loss (BC Government 1995b; note that the multiplier may be adjusted up or down based on local information). Documented legal kills (harvest and control) along the park periphery (Table 1) averages 10 bears/year with 3 (30%) of these females. By adjusting legal kills to account for unreported losses, the average annual kill is estimated to be 15 bears. Although population size for the area over which mortalities have been documented is unknown, in order for 15 bears to represent 4% of the population would require a population of 375 grizzly bears. In comparison, based on the total area of 5795 km^2 over which legal mortalities were documented (no legal mortalities were recorded in subzones 6-01 – 6-08, 6-12, 6-13) and applying density estimates of 15/1000 km^2 and 40/1000 km^2 results in population estimates of 87 (mortality rate = 17.2%) and 232 (mortality rate = 6.5%) grizzly bears, respectively.

It is extremely unlikely that the higher density estimate applies to the entire area in question and regardless, mortality rates at either density estimate are above levels recommended as sustainable. Under the assumption that the population size over the 5795 km^2 area can be estimated as the sum of contributing Zone 6 subzones (1087 km*) with a density of 40/1000 km^2 and the sum of contributing Zone 5 and 7 subzones (4708 km^2) with a density of 15/1000 km*, it is estimated that annual adjusted legal kills could be no higher than 4.6 bears in order to be sustainable. This estimated number of sustainable legal kills does not, however, account for the strong spatial bias in kills since just 5 subzones (5-18, 5-21, 5-41, 7-01, 7-07) account for 71% of legal kills but just 45% of the area over which legal kills were documented.

Given that Kluane has the highest recorded population density of grizzly bears recorded in the southwest Yukon it is probable that dispersing bears tend to emmigrate out of the park in response to the population density gradient. Additionally, the park population appears to be at carrying capacity and density dependence in grizzly bears may manifest itself through increased emmigration (Wielgus et al. in press). The interaction between Kluane and the greater ecosystem is likely one of source and sink. It seems clear that human caused mortality of grizzly bears, which has repeatedly been identified as a prime determinant of grizzly bear population status (Herrero et al. 2000), must be reduced.

2.2.8 Enhanced Spatial-Analytical Capabilities

Many future management initiatives are inherently spatial-analytical processes and can not be conducted without access to spatial coverages (e.g., digital vegetation layers, DEM, digital feature layers such as roads, trails etc.) and databases. Significant costs and effort will be incurred in acquiring such data, however, the data is widely applicable in most land use and management decisions. It is strongly recommended that funding be sought to proceed with development of a spatial information system. Additional effort and coordination will be required to: 1) collect and digitize information on evolving developments (such as cutblocks and roads) so as to keep the spatial data up-to-date, and 2) collect and digitize information pertaining to identified wildlife habitats. Risks associated with moving towards a spatial information system are high. Significant capital investment, effort and specialized talents must uniformly converge, and expectations of how quickly useable products will emerge must be conservatively managed in order for the successful implementation of such a system. Kluane's own requirements to develop a spatial-analytical approach to management will, however, result in technologies and tools that are transferable to the greater ecosystem and there is a significant opportunity for interagency cooperation.

3.0 Grizzly Bear Management Recommendations for Kluane National Park & Reserve

3.1 Introduction

Access development in grizzly bear range has long been known to contribute to population declines. Although eco-tourism may be a relatively benign intrusion, high visitation levels in wilderness areas can be expected to eventually generate negative impacts. Access development in mountainous parks tends to be directed towards valley bottoms and alpine habitats and results in overlapping areas of use by bears and humans. Peak use of low elevations by grizzly bears, for instance, has been observed to overlap with peak rafting activities along the Alsek River. Expected human impacts on bears include increased direct mortality via control actions, and decreased energetic regimes due to costly flight responses (McLellan and Shackleton 1989) or outright avoidance of important habitats (McLellan and Shackleton 1988). Displacement and negative energetic impacts may produce a cascade of potential effects including a general reduction in carrying capacity (Wielgus et al. 1992), lower fecundity, and lower survival of dependent offspring. Disruption of family groups in alpine habitats may exacerbate (and introduce a human element into) the already high natural cub mortality rates in Kluane while periodic human intrusion into remote alpine areas may force wary family groups into closer proximity with other, possibly infanticidal, bears.

General conclusions from the research project indicate that the park's population appears marginally stable and at the park's current carrying capacity as determined by interactions between climate, habitat quality and visitation impacts. Social factors within the grizzly population likely play a role in population dynamics and may be influenced by the high mortality rates of bears (particularly males) on the park periphery. Movement and home range data indicate that a significant proportion of the population is transboundary and reliant on access to non-park lands to meet lifetime requirements, and to promote genetic exchange with adjacent populations. Reducing the influence of outside jurisdictions on the park population's status can only be achieved through modified management of these jurisdictions. Management plans for

Kluane need to account specifically for grizzly bears both in terms of a general philosophy of ecosystem management and with respect to individual access developments within the park boundary.

Unlike southern parks that support grizzly bears, Kluane is in the position to entrench conservation-oriented bear management policies prior to significant impacts. Effective management of bears in the Kluane ecosystem will require a proactive, adaptive and long-term perspective. Human tendencies to avoid decisions until a crisis looms are not acceptable. Most concerns that Kluane will face in the future are predictable based on the experience of southern parks. Kluane has the opportunity, within the scope of the current Park Management Plan Review, to prevent the precarious population status of grizzly bears, and the resultant crisis management scenarios, that are so prevalent in other parks.

3.2 Management Goals and Objectives

In the broadest sense, management goals and objectives for national parks are guided by a clause contained within the new Canada National Parks Act (2001), and every previous version of this act back to 1930, which proclaims that the national parks are dedicated, in perpetuity, to the Canadian people for their benefit, education, and enjoyment. The clause further states that the parks shall be maintained and utilized in a fashion that leaves them unimpaired for the benefit of future generations. As pointed out by Herrero (1994), in a comment on the 1988 National Parks Act, the act is vague with respect to strategic directions, however, such direction has been provided by a series of policy revisions placing increased emphasis on resource conservation (Herrero 1994). Despite significant changes to the Act, this point is still germane, and the basic tools through which Park's achieves its goals of resource conservation remain land-use zoning, the Federal Environmental Assessment and Review Process, park management plans, and bear management plans. One major weakness, identified by Herrero (1994), is the potential failure to account for cumulative effects. Since the Sunpine Resources court decision (1988), however, consideration of cumulative effects has been a requirement of all environmental assessments.

With respect to grizzly bears, Kluane has relied on four key statements embodied in the Park Management Plan (Parks Canada 1990): 1) deny bears access to human foods and garbage, 2) minimize the likelihood of contact between people and bears, 3) cooperate with other agencies to manage transboundary individuals, and 4) establish *a* formal grizzly bear protection zone. While the 1990 management plan is abound with general statements of sustainable wilderness management, effective management of grizzly bears, and preservation of the park's natural and cultural resources, no specific goals or targets with respect to population size, trend or viability are apparent. Past management of bears in Kluane, like that of some other national parks, deserves praise for its efforts at protecting grizzly bear habitat and individual bears (Herrero 1994), however, Kluane's previous efforts to protect the grizzly bears at the population level have been lacking.

The 2001 Draft Revision of the Kluane National Park Management Plan incorporates some significant advances over the 1990 Plan, including the requirement to set and monitor quantitative targets for population levels of grizzly bears, human-caused grizzly bear mortality, and grizzly bear habitat security. In keeping with the concept that parks be maintained in an unimpaired state, it is strongly recommended that Kluane adopt a formal policy on grizzly bears that operates at the level of the population and ecosystem. The scope of this policy should encompass and identify acceptable population size, status, and distribution, identify targets for habitat security, and delineate the means and timeframes over which these will be evaluated.

Further, Kluane in conjunction with the management boards, should seek to formalize policy that delineates the burden of proof and level of acceptable risk (Mattson et al. 1996). Examples of relevant issues in this process might be: 1) are management protocols based on upper, midpoint, or lower estimates of population trend or size, 2) how will management evolve in the face of incomplete information, and 3) how will management respond when suspicions are strong but information is lacking. Resolution of these latter issues is not expected to be quick or easy, but is expected to provide the participants with lively debate.

Kellert (1994) characterized wildlife policy as a "complex consequence of science, values, and politics". Recommendations contained within the remainder of this document speak primarily to the science and are based on information gathered by research projects conducted within Kluane and elsewhere. Efforts by the East Slopes Grizzly Bear Project (Herrero et al. *in press)* have been noted as a success story with respect to scientific information influencing park management policy. Six key points to this success were identified:

- A multi-stakeholder and interagency approach to research.
- Establishing a sound public understanding of the issues prior to exploring solutions.
- Experts from outside government delivered the message that the park's ecological integrity was in question.
- Key decision makers understood the issues, were involved in park management plan development, and contributed solutions.
- The scientific community provided specific targets and goals in a fashion that could be incorporated into policy.
- Persistence by scientists resulted in recommendations being incorporated into policy and timely recommendations were made even if research was incomplete.

Sections below outline specific and achievable approaches that permit a more quantitative evaluation of current and envisioned management practices. Targets and thresholds primarily based on research conducted in more southerly locations are provided, however, some modifications based on my conservation opinion have been suggested. Current recommendations fall short of recommending a cumulative effects analysis since vegetation mapping and delineation of habitats into a ordinal system reflecting seasonal value to bears is lacking. Modeling cumulative effects is a rapidly developing field and in all likelihood, a reevaluation of models will be required once the prerequisite database is developed. Additional recommendations with respect to visitor management, population indices and future monitoring are also provided.

3.3 Population Level Targets

Although managers may expect biologists to provide estimates of extinction probabilities or population numbers necessary to ensure long-term viability, Boyce (1992) points out that past efforts have proven to be dangerous due to resultant legal challenges that threaten to damage the credibility of conservation biology. Tbis is not to suggest that population viability analyses such as minimum viable population size (MVP) have not contributed to enhanced management of species like grizzly bears (Boyce 1992), but rather, that application of these models must recognize the inherent limitations that ecologists face in building such models. In most cases it is not possible to obtain sufficient data to provide reliable parameter estimates for the models (Boyce 1992), the ability to predict the future over the necessary time scales is questionable (Boyce 1992) due to assumptions that observed demographic rates and habitat conditions will remain constant over the projection period (Mattson and Reid 1991), and model validation is difficult (Beissinger and Westphal 1998). As pointed out by Beissinger and Westphal (1998), MVP analyses were among the first applications of viability analyses but their popularity has declined due to both biological and political complexities.

Recognition that data is often lacking, time is critical, and viability analyses can be costly has generated significant interest in 'rules of thumb' for MVPs (Boyce 1992). Based on empirical evidence of extinctions of various species, the general observation that populations greater than 200 individuals appear relatively secure (Boyce 1992), at least over limited time frames, provides managers with a guideline. Based on estimates of the pro-rated population size for Kluane (160 individuals) and the concomittant contributing population (225 individuals that use the park all or part of time) it seems clear that Kluane can accept no decline in current population levels due to human impacts. From this conclusion stem two others; 1) human-caused grizzly bear mortality within the park must remain at the current low levels established over the last decade, and 2) enhanced security of the transboundary component of the population through reduced mortality of bears on the periphery of the park is required.

Direct monitoring of population size, as an aid in assessing management, is a significant challenge. Successive estimates of population size are not likely to be frequent enough to permit detection of changes in population size over short time periods. Further, variability about population estimates tends to be large enough that the ability to detect changes in population size is limited to only substantial changes in numbers, which may be inappropriate in the management of sensitive species. As pointed by Knight and Eberhardt (1996), estimates of population size for species like grizzly bears should be secondary to measuring vital population parameters (survival and reproductive rates) that permit determination of both population trend and its probable causes.

Conclusions that human-caused mortality within the park must be kept at levels below those recommended as sustainable (4%) may seem contradictory, but in fact, they are not if the objective is to maintain the population mimimally at current levels. Under classic applications of density dependence and sustained yields (Miller 1990) populations at carrying capacity produce essentially no harvestable surplus. As a consequence, the allowance for increased human-caused mortality of the park population would be associated with a decline in population size until changes in the population's vital demographic rates, through density dependent processes, allowed for a surplus equal to the added mortality. Density dependence has been difficult to document in bear populations (Taylor 1994), although as Pease and Mattson (1999) point out, there are compelling theoretical reasons to support its existence. Regardless, there is little information upon which to base expectations as to the surplus produced by a population as it declines from carrying capacity and therefore, no simple formulation of the stable population size that will result from an increase in human-caused mortality. In the event that the function describing the surplus in relation to population size is strongly skewed, significant declines in population size may be required before the population stabilizes. Under excessively high levels of human-caused mortality, however, there may not be a sufficient response to prevent population collapse.

High mortality rates occurring along the periphery of Kluane have the potential to impact the long-term security of the park and transboundary population through several different processes. The most immediate impact is through direct mortality of transboundary bears as has been observed by the research project. Wielgus et al. (in press), however, also suggest that human-caused mortalities of adult males, and the resultant immigration by new males, may result in a population's decline due to either infanticidal behavior of the new immigrants or to sexual segregation by resident adult females into poor-quality habitats where infanticidal males are rare. Certainly, adult males are heavily represented in documented mortalities of transboundary bears on the periphery of Kluane and females (especially females with cubs-of-the-year) elevationally segregate themselves from males for substantial portions of the active season, however, we have not been able to document the immigration of males into the park from outerlying areas.

Additionally, theoretical source-sink models (Doak 1995) where population sources are good habitats (e.g., the park) and sinks are degraded habitats (e.g., roads and communities on the periphery of the park where mortality rates are high) suggest that when movement rates between the two habitat types are high, population stability is dependent on relatively large amounts of good habitat. The conversion of even small amounts of good habitat (either inside the park due to poorly planned developments or outside the park due to resource extraction activities) to a degraded state could result in rapid changes in the overall growth rate of the population. While results of Doak's model should be viewed from a heuristic perspective, they do suggest that the gradual, incremental degradation of habitats into population sinks may cross a threshold beyond which consequences to the grizzly bear population may be severe.

In spite of the apparent weaknesses in population census data, it is recommended that determination of population size over the Kluane Ecosytem be considered an important component of future management efforts primarily due to the lack of information available on the grizzly bear population outside the park boundary. Additionally, it is recommended that Kluane continue the current monitoring program to refine estimates of population trend, set determination of a stable trend as a management target, carefully document and manage human-caused grizzly bear mortalities within and on the periphery of park, and move towards a quantitative habitat assessment program.

3.4 Steps Towards a Quantitative Habitat Assessment Program

Although Kluane has embarked on a proactive bear management plan over the last decade it has acquired little in the way of analytical tools permitting assessment of human impacts. Currently, success of management protocols is measured with metrics such as number of human-bear conflicts and number of seasonal trail closures. While success of management initiatives is clearly indicated in measures such as reduced occurrences of bears obtaining human food there are few examples where more subtle impacts such as habitat alienation or loss of secure habitat have been addressed (e.g., Alsek River campsite ZOI analyses) Additionally, Kluane's formal effort at establishing a grizzly bear protection zone is deemed to be at an insufficient scale to provide long-term security for the bear population. It is recommended that Kluane address these deficiencies though adoption of park-wide system of analysis units, development of a human-use model, designation of visitor use thresholds, and a security area analysis. The steps below outline many of the procedures required to complete the habitat assessment program. While this approach is currently directed at management of Kluane, concerns over the impacts of developments outside the park boundary clearly indicate that these protocols should also be applied to the Kluane ecosystem in the future.

3.4.1 Bear Management Units

Bear Management Units (BMLJ) have been adopted in a number of parks (Gibeau 1993, Purves and Doering udated) as well as National Forests in the United States (IGBC 1994). They serve as the basis for impacts analyses, ensure that the analyses are spatially distributed over the entire management area, and aid in identifying areas that may require specific management prescriptions. To some degree, the current Kaskawulsh-Alsek Grizzly Protection Area can be considered a rudimentary BMU, although its size and elevational extents are inconsistent with applications of BMUs elsewhere.

Delineation of BMUs has been a somewhat arbitrary process reflecting topography, areas known to receive high bear use, and the location of human facilities (Gibeau 1993). General guidelines, however, have been established in keeping with the intent that BMUs represent areas that approximate female grizzly bear home ranges and incorporate the range of seasonal habitats and elevations that are used by bears (IGBC 1994). Typically BMUs are laid out with reference to major drainages, attempt to include subordinate drainages, and extend from the valley bottom to the hydrologic divide. In reality, it is unlikely that Kluane can be subdivided into units that are equally centered about the major valleys and not all BMUs will be equal in their ability to provide bears with the range of habitats and elevations typically used.

The average size of BMUs applied elsewhere varies although this is to be expected given their reliance of home range information. In the Flathead National Forest, BMUs were approximately 125 km^2 although BMUs laid out in drier habitat types were twice that size (IGBC 1994). The average size of BMUs applied in Banff, Yoho and Kootenay National Parks was about 235 km^2 (estimated from Gibeau 1993) although there was significant variation in size and shape among units. Similarly, BMUs in Jasper range between 156 – 490 km^2 (Purves and Doering undated). Within these simple guidelines it is likely that a large number of BMU lay-out permutations are available within Kluane. It would seem prudent to avoid excessively irregular shaped BMUs and the exercise of defining the units may be a process of attempting to capture within each unit representative areas of montane, subalpine and alpine with the least amount of boundary line work possible. Additional considerations would be that a BMU not be completely bisected by impenetrable physical barriers (e.g., glaciers, lakes).

Based on home range data from the Project it is suggested that the average size of BMUs approximate 300 km* as this value closely parallels both the largest adult female annual home range recorded (298 km^2) as well as the weighted average multi-annual female home range size (305 km^2). Designation of BMUs is a GIS oriented exercise and several information layers to serve as overlays will be needed (this is not intended to be an exhaustive list):

- a layer that outlines the green-belt of the park as a single polygon.
- a layer designating vegetation zones or a surrogate derived from a DEM.
- various features layers (e.g., major rivers and lakes, hydrologic divides, human facilities).

Completion of the BMU boundary map should be accompanied by a description of the procedure, rationale, assumptions, and a quantitative analysis detailing the size of each unit and the representation of each vegetation zone (or elevational zone). BMUs that have poor or disproportionate representations of vegetation zones should be identified. Expected values for vegetation zones can be derived from an overall analysis conducted on the green-belt although vegetational clines may need to be accounted for.

3.4.2 Potential Security Areas Analysis

In general, large patches of natural vegetation, remote from roads and humans, have been recognized as important features in the persistence of several large mammalian species (Forman and Alexander 1998). Security areas for grizzly bears have been described by Mattson (1993) and Gibeau and Herrero (in press) as an area that is free of human disturbance, and large enough that a wary female could forage within it for a 24 - 48 hr period. Based on mean daily movement distances of wary females Gibeau and Herrero (in press) defined the minimum size of a security area to be 9.0 km^2. Our movement data has not been analyzed for the same purposes as Gibeau and Herrero (in press), however, their estimate appears appropriate for defining security areas in Kluane. Additionally, standardizing our definition with theirs permits comparisons between study areas.

As an initial spatial analysis quantifying the ability of the green-belt and individual BMUs to provide secure habitat for grizzly bears it is suggested that a security area analysis be conducted to determine 'potential' extent of secure areas. This analysis would be conducted without any accounting for current human use impacts and provides a baseline value against which current and future impacts can be assessed. This analysis is essentially a backward-looking projection with the objective of determining the pre-access number, areal extent, and patch-size distribution of secure areas. It is also relatively simple and produces spatial layers that are applicable for other purposes.

Following the approach of Gibeau and Herrero (in press) two input spatial layers are required: 1) a digital elevation model of the green-belt which is used to derive a resultant layer with an elevational cutoff above which foraging opportunities for bears are few, and 2) a classified Landsat image which is used to derive a resultant layer of vegetated areas within the green-belt. Without the benefit of a habitat model an initial best guess as to an elevational cutoff is 1900m based on telemetry locations. Vegetated areas above this elevation are assumed to be of little value. Intersection of the two resultant layers produces another resultant layer representing patches of suitable habitat which are subsequently filtered against the 9.0 km^2 minimum size for a security area. A quantitative analysis for the entire green-belt follows and produces a tally of the total area that is secure, the number of secure patches and the average size of secure patches. Additional categorization of the secure patch size distribution can also be conducted.

As a final step the spatial layer defming BMUs is intersected on the secure area layer. Secure areas that are transboundary with respect to the BMU boundaries are partitioned between units. It should be noted that this approach results in an interdependency between BMUs in that an access development in one BMU can lower the availability of secure areas in adjacent BMUs. An additional quantitative analysis as above, but at the level of BMUs follows, however, it is recommended that secure area analysis also quantities the representation of secure areas across the vegetation zones (montane, subalpine and alpine) partitioning trans-zonal secure areas as above, creating another level of interdependencies.

A tabular summary for each BMU should be prepared and those units that have a low potential for secure areas or a low potential for secure areas in one or more vegetation zones should be identified. Similarly, BMUs that have high security area potential and large secure patches that extend from valley bottom through the alpine should also be determined. Target levels for secure areas vary between 57% (Mattson 1993) and 67% (Mace and Waller 1997, in Gibeau and Herrero in press). In all likelihood, secure areas within Kluane are greater than recommended targets derived from more impacted areas and it is unclear how land-use constraints may have influenced assigned targets. Pending the outcome of analyses, specific targets for Kluane may be set higher to reflect the relatively small available land base and significant mortality rates that occur along the park periphery. BMUs that can not meet targets at this level of analysis require special considerations with respect to access management.

An identified weakness in the current approach is the assumption that secure areas are of value to bears. While the project has extensive seasonal food habits data for the central portion of the park, development of a vegetation classification map, ground transects and application of a foraging model based on food habits are not likely to be completed soon. As an alternative approach, use of ‘greenness” maps derived from Landsat imagery (Herrero et al. 2000) may be feasible and would provide an initial approximation of habitat quality. In the absence of such information, target levels of secure areas for BMUs should be conservatively applied.

3.4.3 Realized Security Areas Analysis

Quantification of realized security areas incorporates the current access regimes into the analytical procedures. It is recommended that Kluane develop a human-use model that identifies and categorizes access types and assigns appropriate buffer distances based on levels of human use. For the purpose of security area analysis, human use models are relatively simple and involve identification of high-use access developments and employment of a 500m buffer (Gibeau and Herrero in press).

Threshold boundaries for delineating high human use and low human use have been defined by the USDA Forest Service (1990) as >80 vehicles/parties per month, >100 vehicles/visitors per month by Gibeau (1998), and >100 disturbance events per month (Purves and Doering undated). Access types are categorized as motorized or nonmotorized, and point, linear or polygon. An overnight backcountry trail would therefore encompass both nonmotorized linear (the trail) and nonmotorized point (the campsite) access types. Neither Gibeau and Herrero (in press) or Purves and Deoring (undated) dealt explicitly with aircraft landing sites. As a first approximation it is suggested that such sites may best be represented by a polygon that incorporates all areas likely to experience over-flights <150m (McLellan and Shackleton 1989) during approach or take-off, with each landing or take-off counting as a visitor use event. It seems immediately apparent that improvements in visitor use records and development of a relational visitor-use database will be required. Although application of the 500m buffer for security area analysis is based only on level of human use regardless of access type, development of the human-use model should identify and maintain all access definitions above.

A spatial human-use layer categorizing access type and level of human use based on park visitation records or knowledgeable opinion will need to be developed. Some trails will have segments that receive differential levels of use because those portions of the trail near the trailhead receive heavy day use. In order to adequately quantify access influences within the analysis area (green-belt), peripheral access developments at least within 500m of the park boundary need to be incorporated in the human-use layer. For the initial assessment the analysis should be conducted with reference to the period of peak visitor use (June, July, August) and in its simplest and conservative application would assign a level of human use to each access development based on the highest monthly human use level during that period.

Over-laying the buffered human-use layer onto the suitable habitat layer and filtering the resulting patches against the 9.0 km^2 size minimum produces the first assessment at the level of the green-belt. A subsequent overlay of the BMU boundary layer produces the second level of assessment at the BMU level. Comparisons between the potential security areas and the realized security areas provide a basis for assessing the impacts of current human-use levels within the park. BMUs that 1) have an inadequate amount of secure areas, 2) have suffered a loss of secure areas within vegetational zones that are poorly represented, 3) have suffered a large percentage drop in secure areas, or 4) have experienced noticeable fragmentation of secure areas, should all be identified.

3.4.4 Thresholds

Definitions of thresholds vary with respect to numeric limits, and perhaps more importantly, in the actual unit to be counted (parties, visitors, disturbance events). Currently it is unclear how these different units map into each other and it appears that there is potential for divergent applications of these thresholds. Disturbance events seems to be most appealing and biologically relevant. In this sense an event can be viewed as a vehicle or party (1 or more people) traversing a linear access type or occupying a point access type such as a campground. As such, quantifying the level of human use is not obtained by simply tallying the number of parties embarking down a trail. For instance, on a loop trail a party will traverse the trail only once (but may stay multiple nights at a campsite with each night counting as an event) while on a non-loop trail the party will traverse the trail twice (two events), once on the way in and once on the way out. Further investigation is warranted, however, I base my recommendations on disturbance events as described above.

A general trend in both cover and habitat productivity is apparent in Kluane from south to north. To some degree the security area analysis approach is conservative because buffered areas are removed from the analysis rather than pro-rated according to cover as in CEM analysis (USDA Forest Service 1990). Responses to disturbance by bears, however, are influenced by hiding cover (McLellan and Shackleton 1989, Gunther 1990) as is availability to bears of open habitats in areas receiving human use (Gunther 1990).

A threshold of 100 disturbance events per month is deemed appropriate for southerly BMUs, which are wetter and have more cover, however, a progressive stepping down of thresholds is recommended for more northerly BMUs. There is little to guide such a process other than the tenet of conservatism. Therefore, it is recommended that the threshold for central BMUs be set at 80 disturbance events per month, and for the northerly BMUs, 60 disturbance events per month.

It is worth noting here that quotas and thresholds are not the same. Thresholds define a point where human impacts are factored into the security areas analysis. Quotas define a maximum number of visitors to an area and can be applied independent of recommended thresholds. Quotas may be applied simply for the purpose of providing visitors with a quality experience or as a means of ensuring that visitor activity in sensitive areas is maintained well below threshold.

3.4.5 Protocols for BMUs

Recommendations for management of established security areas indicate that they should stay in place long enough to permit a resident adult female to replace herself with a recruit into the breeding population (IGBC 1994). This has typically been described as approximately 10 - 11 years (Mattson 1993, IGBC 1994). While some individual adult females in Kluane clearly replace themselves, the average female apparently does not, or just barely does so, as evidenced by the population's point estimate of a negative rate of increase (McCann 1998). In general, security areas should therefore be managed for much longer-term stability and persistence. This is not to imply that security areas be spatially or temporally static. Large scale stochastic events that alter habitat value may favor management responses that spatially shift security areas provided that a long-term benefit in the foraging value of security areas is achieved.

BMUs that have the potential to meet the recommended target should be managed to retain security areas at, or above, target. Fragmentation of large contiguous security areas, loss of security areas that act as 'stepping stones' to other secure areas, or progressive 'nibbling' away of large security areas should be avoided as much as possible. BMUs that do not have the potential to meet targets may need to be managed to retain all secure areas (e.g., no access development receives human-use levels that exceed thresholds). This is not to imply, however, that the highest level of protection is simply applied to the lowest quality BMUs.

Low-use access developments and dispersed off-trail use is not accounted for in the calculation of security areas, however, there is little justification to believe that a proliferation of low-use and dispersed access developments in a BMU will not produce impacts. Thresholds do not define a point between impact and no impact, but rather a point beyond which impacts are believed to be unacceptable. Assigned thresholds carry with them a real risk of being wrong. All BMUs should have a monthly cap to visitation levels that incorporates all usage types (high use, low use, linear, point, polygon, dispersed), however, determination of visitor-use caps should await completion of the security area analysis and involve consultation with the management board.

New access development proposals should be assessed by modeling the impacts on security areas based on expected access types and usage levels. If progressive access developments are likely to stem from a new or current access development additional impact modeling should be conducted. If a development must proceed, but has an unacceptable impact on security areas then mitigating management actions may be identified by exploring the impacts of altering visitor usage patterns elsewhere. By being able to choose between options that have been evaluated for their efficacy in meeting desired targets for security areas, park management becomes adaptive.

Development of the approaches, protocols and GIS/database applications to complete BMU boundary layout and security areas analyses represents a transferable technology to the greater ecosystem. Since definitions of security areas, visitor-use thresholds, buffers and desired targets have all been recommended and employed by inter-agency management efforts elsewhere, this approach provides the park and the management board with a defendable and compelling argument upon which to build a more comprehensive grizzly bear management regime than is currently in place. The use of security areas analysis also provides both the park and management board with a quantitative tool to broadly assess impacts on bear habitat and a qualitative tool to assess impacts on bears.

3.4.6 Movement Corridors

Research on the genetics of grizzly bears within the Kluane ecosystem by the University of Alberta, in cooperation with the research project, has identified the local grizzly population to be one of most genetically diverse in North America (Paetkau et al. 1998b). Connectiveness to the larger meta-population is the primary determinate of this high level of genetic diversity. A subsequent investigation into gene flow between populations, for instance, concluded that grizzly bears of the ABC Islands and coastal Alaska were not genetically isolated from grizzly bears in Kluane (Paetkau et al. 1998a). Kluane's central location within currently occupied grizzly bear range, and unimpeded movement corridors between populations, are important features supporting genetic diversity. Gene flow between these population is primarily a function of the wide-ranging movements of males, and overlapping home ranges of only two adult males and one subadult male monitored by the project have been documented to range from the Alaskan Panhandle north to Burwash on the shores of Kluane Lake.

While genetic threats to the population are not immediate, maintenance of both the current population density and major movement corridors, are prudent to long-term conservation of grizzly bears in Kluane. The isolation of populations is strongly associated with the loss of genetic diversity, especially when isolation is accompanied by reductions in population size. Such losses of genetic diversity can limit a population's fitness and evolutionary potential to adapt to environmental changes and ultimately threaten a population's long-term survival (Paetkau et al. 1998b).

Primary movement corridors within the park, and between the park and adjacent lands, follow the major drainages (Herrero et al. 1992). Within these corridors, bears frequently utilize easily traversed habitats such as floodplains and river terraces (Pearson 1975), although movements along mid and upper slopes likely also occur. Humans utilize these same major corridors as access points into Kluane and often take advantage of the same habitats offering the easiest movement. More localized movements by bears are accomplished by secondary corridors in the form of creeks, lake margins, ridges and smaller passes and in some cases these permit additional movement through the Front Ranges. As human use in the major corridors increases it is expected that secondary corridors will become more important, Some secondary corridors within the park, however, already receive human use while the immediate outflow of others are the sites of human activities beyond the park boundary.

As levels of human activity increase, the ability of bears to move between important habitats, or to undertake major movements (e.g., males) declines either because developments introduce impediments to movements (e.g., avoidance), become physical barriers (e.g., major highways) or become significant population sinks (e.g., communities). Linkage zone analyses represent one approach to identifying probable movement pathways within valley bottoms that are heavily impacted by human activities. The analysis is a relatively complicated series of GIS-oriented spatial processes that incorporate access density, human use models, buffers, moving windows, and vegetation layers classified with respect to vegetative cover and riparian/wet areas. The result of such analyses in heavily impacted valleys are relatively narrow movement pathways and perhaps a narrowed concept of a movement corridor.

It is unlikely that Kluane will be able to complete an analysis of this nature in the near future, and such an intense analysis may not be currently warranted within the park boundary (however, as land use activities intensify outside the park, linkage analyses on YTG lands should be conducted). Given that few options have been foreclosed within the major corridors, I suggest that Kluane act to maintain the functionality of both the valley bottoms and slopes to act as movement corridors. At the very least, developing models to delineate the most likely linkages (often under narrow assumptions) and eventually managing the landscape down to that state should be avoided. Management of the major drainages should, therefore, retain a significant amount of contiguous habitat offering forage, cover and security, along both the slopes and the valley bottoms. Developments within, or at the mouths of the major drainages, should be located so that ample opportunities for bears to bypass them are readily available. Developments within geographically imposed movement funnels should be avoided wherever possible or mitigated by proactive management actions (e.g., Lowell Lake restricted area).

For some major drainages, the lack of access to both sides of the valley currently imposes favorable conditions for movements by bears. For other drainages, such as the Slims River, closing the east side may be a consideration. Movement constraints, however, exist at the mouth of the Slims and bears moving along the east side may have subsequent movements to the northwest impeded by the highway and visitor center. Options for bears to utilize secondary corridors such as the pass between Sheep-Bullion Plateau and Congdon Creek need to be managed by ensuring that visitor use levels in secondary corridors do not exceed assigned thresholds. Since secondary corridors are small and limited with respect to available space, additional management options such as time of use restrictions or no travel away from campsite restrictions may need to be utilized. In those situations where there is a lack of space for bears to move around areas used by humans, spatial and temporal limitations to human activity need to be applied.

Some modeling exercises may provide insight into the status of movement corridors within the park and between the park and adjacent lands. Vegetation layers and the human-use model, combined with a DEM generated geographic barrier layer may provide a visual assessment of current or future limitations to bear movements. Topographic modeling, based on ruggedness algorithms and/or convexity analysis, could be used to identify cliffs, impenetrable ridges and mountain complexes. Additional barriers in the form of features such as major lakes and glaciers would be merged into the layer. Barriers, in conjunction with vegetation and buffered access types could be examined to determine where geographic constrictions or significant expanses of non-vegetated habitat coincide with human activities. The barrier model itself may also serve as a first approximation of secondary corridors that permit movements over hydrologic divides.

3.5 Management of Visitors

Much of Kluane's management efforts to support the grizzly bear population are associated with visitor management protocols. Managing the activities of backcountry users is a priority of all park managers, especially in those parks that have populations of grizzly bears. Yellowstone National Park, which is in the unenviable position of managing high visitation levels with the needs of an isolated grizzly bear population employs a variety of visitor management protocols. These include seasonal trail and area closures, prohibiting off trail travel either annually or seasonally, allowing access to certain areas by special permit only, recommended minimum group sizes for hiking (4 persons, Gunther 1990), group size restrictions for campsites (4 - 20, Yellowstone 1999), access restricted to day use only (e.g., 9 am to 7 pm), strict limits on the number of visitor use nights at some campsites, seasonal campsite closures, and restrictions on travel away from some campsites.

3.5.1 Prevention of Conflicts between Visitors and Bears

Aumiller and Matt (1994) defined guidelines for establishment of bear-viewing programs based on the McNeil River State Game Sanctuary in Alaska. Their general steps in development of a management plan to prevent conflicts between visitors and bears (and to prevent disturbance of bears by visitors) defme an appropriate sequence of steps and considerations for management of visitors to bear-occupied areas, including Kluane.

- Identify and assign priorities to management goals and objectives.
- Determine thresholds for visitor use and areas where visitor use is compatible with objectives.
- Establish the means through which visitor use will be limited.
- Develop a visitor bear education program and supporting literature.
- Develop a visitor supervision program.
- Develop a food/garbage management plan for front and back-country visitors.
- Locate camps, trails and facilities so that they have low human/bear conflict potential and low bear displacement potential.
- Design a monitoring program to evaluate visitor use in relation to management objectives.
- Develop strategies to identify, prevent, modify or eliminate non-compatible visitor use activities.
- Designate level of funding required to maintain visitor management and monitoring programs.

3.5.2 Camps & Trails

Increased use of the park combined with natural tendencies for campers to isolate themselves from other visitors tends to result in a proliferation of campsites. Most visitors to the park are unfamiliar with bear ecology and poor selection of campsites with respect to human safety in bear country is a predictable result. Further concerns arise from potential campsite impacts on bear movements and foraging activities. Spatial analysis of the pattern of campsites established along the Alsek corridor, for instance, indicated that campsites were numerous enough and close enough to potentially produce an almost continuous zone of influence between Serpentine Creek and Lowell Glacier. Additionally, several campsites were within, or near to, important seasonal bear habitats or movement corridors.

Some debate exists as to whether designated campsites encourages habituation of bears to the presence of people. Undoubtedly, habituation does occur in areas that receive high visitation and has been observed in some areas of the park (McDougall et al. 1998). It is likely, though, that the probability for both habituation and human-bear conflict increases with frequent human presence in habitats important to bears. It is recommended that Kluane continue to identify and designate campsites that have a low potential for bear encounters and a low potential to disrupt the normal activities of bears. Similar arguments are applicable to trail/route placement although travel routes incorporate the additional concern of close range encounters with bears due to factors (e.g., limited lines of sight) that make detection of bears (or humans) difficult. It is therefore also recommended that Kluane continue to conduct risk assessment of trails and routes. In part, the application of the security area concept may reduce concerns regarding habituation since the approach seeks to allow wary bears the opportunity safely forage in large areas free of any significant human presence.

Early on, the Grizzly Bear Research Project identified the Alsek corridor as meriting special attention due to significant levels of human activity and overlapping use of the valley bottom by bears and rafters (McCann 1994, 1996). Our ultimate goal in management of the Alsek was to provide for the safety of both bears and humans, maintain the functionality of the Alsek as a major movement corridor, and permit bears to access low elevation habitats with minimal disturbance. Specific management objectives for the Alsek corridor were: 1) avoid areas of importance to bears such as seasonal foraging habitats, localized movement corridors, or security habitat, 2) avoid areas where detection of bears by humans, (or detection of humans by bears) is constrained, 3) minimize and spatially separate the resultant zones of influence about campsites by reducing superfluous campsites, and 4) meet the basic needs of back-country users with respect to daily travel distances, access to water, etc. Protocols have since been established with respect to delineating campsites along the Alsek corridor, and elsewhere in the park (McDougall et al. 1998, Wellwood and MacHutchon 1999a, 1999b, 1999c, 1999d, 2000) and collectively provide guidelines for a park-wide system of permanent back-country campsites and improvements in trail routing. To meet these objectives throughout the park a number of currently used campsites may have to be closed. For many visitors these closures will be 'invisible' since they are one time visitors to the park. It is likely, however, that some difficult decisions will have to be made and some popular campsites may have to be eliminated. The Alsek River designated campsite model, cooperatively designed with rafting companies, provides an example of how these objectives can be met.

Kluane should continue the process of identifying and closing unacceptable or redundant campsites. Random camping should be replaced with established campsites throughout the park that have been specifically selected to reduce both interactions with bears and interference with normal habitat use and movements by bears. Backcountry camping in Yellowstone National Park, for instance, has generally been limited to designated sites since 1973 (Yellowstone 1999) with the primary goal to protect campers and bears from each other. Additionally, most designated sites in Yellowstone have food storage poles (food canisters may negate need for such poles), restrictions on group size (4 – 20), and limitations on length of stay (Yellowstone 1999).

There is a concern that frequently used permanent campsites result in localized visible degradation of plant communities due to repeated use by humans and possible degradation of the wilderness experience by park users. This is a necessary trade-off, however, the most damaging physical effects can be mitigated by-selecting permanent campsites that are not within or near habitats supporting rare endemic plant species (similar concerns may be required to protect archeological sites or habitats that are used heavily by other fauna1 species). Damage to the perceptions of park users is best mitigated by information and education. Ultimately, the continued existence of a healthy grizzly bear population will be the strongest endorsement of Kluane's wilderness character.

3.5.3 Bear Proofing Food

Bear resistant food containers (or suitable alternatives) should be a requirement for all overnight back-country users of Kluane, including commercial and non-commercial rafters. For most park users the currently supplied canisters appear sufficient and effective, provided that use of the canisters is adhered to by visitors. Some recent failures in the proper use of canisters by visitors is a concern. Instructions provided to visitors regarding use of canisters should be clear and consistent and a simple instructional brochure should accompany each canister. Visitors should be informed as to their responsibilities in food and garbage management, required to report any occurrence of a bear obtaining food or garbage, and Kluane should be relentless in punishing those who fail to follow food storage protocols.

It is also recommended that Kluane and the management board explore options to extend food management protocols for visitors to all front-country campsites in the ecosystem as well as visitors to the Wildlife Sanctuary. The use of canisters, for instance, could be required for any user of front-country campsites within Kluane that do not have hard-sided vehicles. Some campsites at the developed campgrounds within YTG jurisdiction could be fitted with bear-proof structures and reserved for those who do not have hard-sided vehicles. Access providers that deliver visitors to the park periphery could also be required to ensure that clients are properly equipped with canisters and instructions. Given the cost and effort that has been invested in closing and bear-proofing garbage dumps, and the expectation that local residents will adhere to protocols for bear attractants, there seems little justification not to manage front-country visitors more intensively.

Although overnight users are more likely to attract bears (because of longer stays and move involved food preparation) requiring day hikers to use canisters should be implemented for some trails. The required investment in additional canisters and the inability to adequately regulate all trailheads will clearly limit this option. Combining mandatory use of canisters for day hikers with other trail management protocols such as group size requirements (e.g., 4, Gunther 1990) or day-use only restrictions, however, should be feasible and would result in more cohesive management of visitors in sensitive areas.

Rafters represent a special case within the current context of grizzly bear management in Kluane as they, unlike other users, traverse a current Zone 1 Grizzly Bear Special Preservation Zone and use a mode of transport that allows for more options in reducing access to foods and waste by bears. In the absence of a suitable bear-proof container for their food, rafters should be required to employ an electric fence to act as a deterrent to bears obtaining food or waste. If rafters are reluctant to provide bear proof containers or utilize electric fences then consideration should be given to installing permanent bear proof containers (Wellwood and MacHutchon 1999a) at established campsites. Any failure on the part of rafters to comply with all aspects of Kluane's bear management protocols is unacceptable. Rafting guides should view themselves as educators of the public (their clients) and custodians of the resource with respect to ecosystem integrity and contribute to inter-agency efforts through exemplary behavior.

3.5.4 Education

Extensive recommendations for visitor education have been included in several research reports prepared for Kluane (McDougall et al. 1998, Wellwood and MacHutchon 1999a, 1999b, 1999c, 2000) and should be implemented by the park. Educational tools for park visitors should include descriptions of the major foods used by bears, indicate their seasons of use, and explain feeding or other signs of localized bear activity. Visitors should be instructed to be wary, make noise, and avoid (or minimize their time within) areas where bear foods are abundant. Guidelines for appropriate camping techniques in bear country should be included as part of a brochure for back-country users and media such as the Staying Safe in Bear Country video (Wild Eye Productions) should be available for viewing at the Visitor Reception Centre. Kluane should follow the example of Denali National Park (NPS 2001) and establish a means through which foot travellers within the park are discouraged from knowingly approaching to within 400m of bears, and should provide concise advice as to appropriate actions to take when chance encounters at close range occur.

Permanent campsites implies established trails/routes and it should be possible to produce brief descriptions of trails/routes that point out specific bear safety issues. Most trails in the park traverse seasonally important habitats and information may be of a general nature (e.g., general comments regarding the use of outwash fans as important berry-foraging sites) or site-specific such as noting the large Oxytropis flats at the top end of the Slims. There is always the possibility that some individuals will abuse such information and behave in an irresponsible fashion. It must be assumed, however, that the majority of users will benefit from increased knowledge of bears. Brochures should also identify any area closures, time of use restrictions, or restrictions on travel away from campsites that may be in effect.

Media explaining management objectives for both the park and the regional ecosystem objectives and approaches to managing grizzly bears should be readily available to visitors to the park or ecosystem. Simple and effective explanations of goals and examples of how they are being achieved will make management activities transparent and will likely foster cooperation and support from visitors.

3 5.5 Access by Other Means

As a general management principle, aircraft supported access into the park should be a tightly controlled activity since its primary purpose is to deliver people into remote areas. Park management, research and cultural activities can collectively constitute a significant number of landings in the park, and while limiting others similar access opportunities will be controversial, the purpose and benefits of aircraft-supported access must be factored into the evaluation. It is recommended that the park and management board adopt a resolution of limited aircraft access into the park by the general public, and utilize their own privileges carefully, sparingly, and with purpose.

While aircraft access can be evaluated within the context of thresholds, buffers, and security areas, it is suggested that this should not be the only measure of potential aircraft impacts. Areas remote from humans have been established as an important feature in grizzly bear conservation and human access in remote areas has been demonstrated to invoke more severe flight responses from bears. McLellan and Shackleton (1989) for example, concluded that of the disturbances they evaluated, the most pronounced flight responses of grizzly bears were to people on foot in remote areas. Arguments that by allowing more access, bears are able to adapt to human presence (e.g., become habituated), defeats a central tenet of security areas in that they are places where wary bears can go undisturbed and remain wary bears. Ultimately, wary bears are likely to live longer.

Aircraft overflights, such as flight-seeing, have been noted as a concern in other parks such as Yellowstone National Park (Yellowstone 1999) due to the disruption of 'wilderness quiet'. Yellowstone is currently seeking, through legislative protection, to limit flight-seeing and other activities that disrupt wildlife and visitors via excessive noise. In the absence of specific regulations limiting flight routes and elevations, Kluane should meet with operators of aircraft that provide access to, or overflights of, the greenbelt. Operators should be informed of preferred flight routes, minimum flight elevations and should be discouraged from permitting or promoting close range wildlife viewing from aircraft. In general, many aircraft flights into the park have specific objectives (access to the icefields, ferrying rafters) that tend to dictate which routes are chosen. Additional considerations due to weather conditions can be important. It is recommended that overflights of the green-belt be conducted only along routes that permit a minimum distance to any point of land of 500m. It is also recommended that any non-essential flight (e.g., flight seeing) that can not be conducted within this restriction due to weather conditions not be allowed.

As for the myriad proposals for other access developments (jet boats, tundra buggies) park management and management boards should consider that access developments, like ecosystems, evolve. In many cases it is not the initial development that is so much the problem as it is the many, and much changed, descendants. It is difficult to imagine, for instance, that a jet boat service to the Lowell Glacier will not eventually give birth to a shelter from the inclement weather (especially since boat passengers will be unprepared for peri-glacial environments), an interpretation center or a day use development. While Kluane has adopted policies dictating that access developments must be reversible if impacts are severe, the ability to decommission established developments may not be feasible either socially or legally. The most probable access candidates for eventual closure due to impacts will be the most popular, and hence, most profitable to expeditors. It can be expected that once established, popular access developments (especially those that involved significant capital investment) are in fact, not reversible. The management challenge facing Kluane will be to anticipate the potential cumulative effects and pattern of incremental development when reviewing new access or activity proposals.

3.5.6 Visitor Use Monitoring

Movement towards a more comprehensive visitor management plan necessitates development of a visitor supervision program. An increased warden presence in the back-country is clearly indicated as is increased responsibilities with respect to monitoring of visitor activities. To support these extended activities funding and human resources will have to allocated accordingly. Evaluating the success of the bear management plan, which relies heavily on managing human use levels and activities, will be confounded if Kluane does not have the staff or resources to enforce compliance or to monitor the effectiveness of new visitor use management programs such as quotas, group size restrictions, and area closures.

It is recommended that all trails and designated campsites be inspected annually by the Warden Service. Wardens should ensure that random campsites are not being used and designated campsites should be examined to ensure that bears are not being attracted to the site due to excessively heavy use and concurrent build up of attractive scents. If bears are being attracted to campsites, site-specific measures to deal with issues such as 'gray water' may be required. If suitable mitigating measures are unavailable then the level of campsite use may need to be regulated by trip duration restrictions (i.e., length of stay restrictions), lower visitor use quotas, or maximum group size restrictions. Evidence of garbage in fire pits or evidence that bears have obtained food or garbage should be also be looked for. Additionally, the Warden Service should monitor interactions between visitors and bears at, or near, campsites by reviewing campsite use and bear observation forms annually.

Popular trails such as the Alsek trail that may have associated restrictions on off-trail travel should be monitored frequently to ensure adherence to regulations. The Warden Service should have sufficient resources to rat? the Alsek at least once per year. Additionally, a warden should camp at Lowell Lake periodically to monitor rafter activities. Wardens should also periodically monitor trailheads and ensure that visitors have adhered to specific regulations such as registering out and use of canisters. Visitors should also be briefly interviewed to ensure that they are aware of specific regulations such as closed areas, time of use restrictions, and restrictions regarding approaching bears.

3.5.7 Family Groups

Frequent use of alpine and subalpine habitat by females with cubs-of-the-year (COY) requires specific consideration in future management protocols. Both the history and current restrictions on Sheep-Bullion Plateau speak clearly to this need. New hiking routes and proposals for heli-hiking access may impact the security that high elevation habitats confer on family groups and place visitors in potentially devastating conflict situations. Displacement of family groups from these habitats may magnify the already high rate of COY mortality.

In general, Kluane should discourage the exploration and popularization of new access routes by the general public. Predictably, such public initiatives will be concentrated in high elevation habitats that allow for easy travel. Options for managing already established routes include permit access with strict control over visitation rates, group size restrictions, evaluation of routes and campsites for displacement and conflict potential, and seasonal access restrictions. This latter suggestion may need to be designed in a hierarchical fashion with 1) early season access restricted due to the documented vulnerability of COY early in active season, and 2) late season access modified to reflect important foraging patterns. Ground evaluation of routes may need to explicitly account for potential localized movement patterns whereby family groups move between sites offering foraging opporhmities and sites offering security.

While our elevation data indicate that family groups tend to occupy higher elevation habitats, family groups can and do occur throughout all vegetation zones. The public should not be left with the impression that appropriate bear safety measures are less applicable in lower elevation habitats.

3.5.8 First Nations Hunting

Although this section is included under visitor management the intent is not to suggest that First Nations are visitors to the park. There are, however, valid concerns should hunting by First Nations coincide with periods of park visitation. First, most park visitors are not likely to employ standard hunter safety measures such as wearing bright colors and visitor safety is a concern. First Nations hunting in some parks in British Columbia have been accompanied by temporary closure of affected areas to the general public.

Traditional hunting also creates a potential for ungulate kill sites to become conflict sites between visitors and bears. A cooperative management plan should be implemented between Kluane and First Nations to ensure that ungulate carcasses and remains be handled in fashion that does not result in bears being attracted to trails, campsites or other areas frequented by visitors. As bears tend to aggressively defend resource such as carcasses and gut piles, proper management of ungulate remains is of the utmost importance to visitor safety. Options to enhance visitor safety include prolonged closure of facilities that are the site of hunter kills, or carcass warning signs. Conflict between hunters and bears must also be incorporated into management plans. Inadvertent killing or wounding of bears by hunters must be reported.

3.5.9 Area Specific Recommendations

- *Bear Flats:* the floodplain flats at the junction of the Dezadeash and Kaskawulsh Rivers should be closed on both north and south of the Kaskawulsh, except to those conducting research or management activities. The flats provide significant foraging opporhmities for bears throughout the active season, and the junction of the rivers is a major movement corridor.

- *Alsek trail:* the Alsek Trail should be designated for no off-trail travel and Kluane should act on previous recommendations of a campsite assessment program. Off-trail travel restrictions are in support of the closure of the entire Bear Flats area.

- *Mush & Bates Lakes:* previous recommendations to close the creek between Mush and Bates Lakes to visitors and for restrictions on hiking away from identified campsites should be enacted.

Slims East: recommendations for closure of Slims East should be strongly considered to permit access by bears to the river corridor for movement and foraging. Allowing access to Slims East when the west side is closed due to family groups would appear inappropriate given the short distances from one side of the valley to the other. Additionally, Slims East permits human access to the upper portions of the Kaskawulsh River which is the only major drainage in the park not currently receiving some level of human use.

- *Campsite* 9 on *Alsek* River: rafters' activities should be monitored at this campsite since it permits access to early successional peri-glacial areas. Restrictions to limit hiking activities away from the campsite may be required.

- *Lowell Lake:* it should be ensured that the restriction on hiking away from the campsites (except for organized trips to Goatherd) is being adhered to.

- *Overland routes to Goatherd:* Kluane should enact group size limits, allow permit only access, assess campsites, and manage for low level of visitation. There is little to guide determination of visitor use quotas, however, consideration should be given to the potential to disturb family groups using high elevation habitats early in the year, as well potential cumulative effects of increased disturbance to the goat population at Goatherd. Allowed timing of use of the route is an important consideration due to the high rates of early COY mortality, and preferably visitation should not be allowed prior to the end of June, however, this is not independent of habitat types (e.g., berry fields) traversed by the trail.

- *Sheep – Bullion Plateau:* implement and enforce minimum group size restrictions, require use of canisters for all users, and restrict visitation on the plateau to the hours of 9am – 7pm to permit bears the opportunity to utilize the plateau without human disturbance.

- *Jarvis – Serpentine Loop:* Kluane should allow permit-only access, designate campsites, require mandatory use of canisters, and manage for a low level of visitation.

- *Cottonwood Trail:* Kluane should apply a group size limit during the berry season in conjunction with no off-trail travel and restrictions on hiking away from campsites. Additional options may include a time-of-travel restriction to permit bears to utilize berry fields without human disturbance.

- *Congdon Loop campsite:* apply a restriction on hiking away from the campsite to permit activities and movements by bears within this corridor.

- *Peri-glacial* areas: in general, peri-glacial areas support early successional habitats that receive use by bears and tightly convoluted landforms make close range encounters predictable. Management of visitor activities and area closures may be required. Obvious examples include the large Oxytropis flats (and areas south) at the headwaters of the Slims where bears are frequently sighted and the frequent use of the north side of Lowell Glacier during the berry season by grizzly bears.

4.0 Linking Management to the Population

4.1 Introduction

Approaches such as BMUs and security areas analysis that permit a more quantitative assessment of management have several deficiencies, although they represent a marked improvement over Kluane's current ability to evaluate management. Ultimately, the parameter of interest is the population measured over the ecosystem, and includes measures such as size, distribution, trend and associated processes. As outlined below, there are few options to gain reliable information on these measures without significant capital expenditure and handling of bears. While it is duly noted that there are sensitive issues associated with these activities, decisions to employ recommended actions are a reflection of the value society places on grizzly bears.

4.2 Indices, Models and Population Size

Simple animal-centric indices (e.g., annual counts of females with COY, visitor sighting records) that correlate well with population trends are lacking for grizzly bears. General characteristics of grizzlies such as low densities, high mobility, annual variations in visibility related to forage availability, and variation in observer effort have all been noted as complicating factors (Lefranc et al. 1987, Eberhardt et al. 1994, Mattson 1997). Trend indices that have uncertain relationships with actual population trend, and lack demonstrated reliability as an indicator of short-term changes in population size, can not be recommended as part of a conscientious management plan. Errors in assessment of population status have differential consequences and costs (Mattson 1997) and a failure to detect a significant decline in a sensitive species carries with it the greatest costs to society and managers.

The security areas analysis approach provides a basis for evaluating current and future management impacts but does not readily provide insight into actual population numbers. While a decline in security areas can be interpreted as an increasingly precarious situation for bears it does not permit a quantitative estimation of concomitant declines in carrying capacity or density. More advanced habitat modeling, such as habitat effectiveness models, provide a quantitative comparison of the land base's current ability to support bears relative to the potential ability, but stop short of estimating actual population size or number of individuals lost due to some impact (Gibeau 1998). Other habitat models, however, (e.g., Schoen et al. 1994) have attached bear densities to habitat types and expressed the outcome of hypothetical scenarios as percentage declines in populations or carrying capacity. Newer approaches to population viability modeling based on resource selection functions and landscape-scale variables (Boyce et al. 1994, Maraj 2000) seek to more directly relate the linkages between habitat capability, documented mortality, human impacts and animal populations. No model can complete these linkages without independent assessments of population trend and density. Ultimately, the value of these models will likely lie within the realm of adaptive management whereby assumptions and secondary model predictions can be tested through research, leading to successive iterations of new model formulations and new testable predictions (Boyce 1992).

An estimate of population size and density obtained via a repeatable methodology is fundamental to both park and ecosystem management of grizzly bears, particularly in the absence of data on the grizzly bear population throughout most of the ecosystem. In spite of the weakness of population census techniques to detect changes in population size, subjective estimates are even less powerful and too vulnerable to criticism to promote significant changes in management. Genetic mark-recapture techniques have been employed extensively in British Columbia in recent years and provide a non-intrusive means of obtaining bounded estimates of population size and density. The costs of these programs, however, are significant. A recently completed genetic mark-recapture in the Parsnip drainage of BC conducted over approximately 6400 km^2 cost $150,000 for field sampling (100 grid cells, 4 replicates, 66% of cells accessed by helicopter) and $50,000 for laboratory expenses (D. Seip pers. comm.). Additionally, 95% confidence intervals about population estimates tend to be large (>20% of the mean, Poole et al. 2000) and therefore, managers are still faced with a significant uncertainty that must be managed for by policy. An experimental application of genetic mark-recapture methodologies by the research project has provided an estimate of minimum population size for a small portion of Kluane (800 km^2), however, it is not possible to derive a confidence interval about the estimate, nor is it feasible to extend the estimate beyond the boundaries of Kluane.

There are compelling reasons for Kluane and neighbouring governments to pursue population estimation over a large area that encompasses both park and YTG lands through genetic mark-recapture techniques. The most obvious product of this census method is a benchmark estimate of population size and density against which future population levels (and the success or failure of management) can be compared. A lack of baseline population information for grizzly bears has been identified as a significant impediment to scientifically demonstrating demographic and population consequences due to human-induced impacts in Katmai National Park (Miller 1990), Glacier National Park (Hayward 1989, Keating 1989, both in Miller 1990) and the Central Canadian Rocky Mountains (Gibeau and Herrero in press). The inability to draw clear relationships between levels and types of human activities and grizzly bear population status and viability clearly limits the ability of managers to assess the likely impacts of increased human use of Kluane and the regional ecosystem. Additionally, a census program would contribute to national management of grizzly bears by contributing to current efforts in British Columbia to verify population estimates based on modeling of habitat capability/suitability and extrapolations of population size from previous research (Fuhr and Demarchi 1990, Banci et al. 1994, Pool et al. 2000).

Other benefits also accrue from genetic mark-recapture programs. Spatial trends in density can be determined from results, and through buffering overlays of successful and non-successful hair-trap sites onto digital layers such as vegetation and roads, information on factors influencing grizzly bear habitat use and site selection can be derived. Little is currently known of how such factors affect grizzly bears throughout most of the greater ecosystem since radio-telemetry data is unavailable. Estimates of population size have further application in determining mortality rates attributable to documented sources such as harvest and control kills. All such information derived from genetic mark-recapture will also contribute to modeling efforts currently being conducted in the park and ecosystem (Maraj 2000).

The Draft 2001 Park Management Plan will create a requirement for monitoring of grizzly bears as a keystone indicator of ecosystem integrity. Suggestions have been made that monitoring of grizzly bears can be achieved through visitor sighting surveys and berry productivity surveys, however, such an approach may have the potential to create a "house of cards". In essence, an untested index of unknown responsiveness to population change will serve as an index of grizzly bear population size, which in itself will serve as an index of ecosystem integrity. Reliable options for monitoring grizzly bear population size on an annual basis are lacking, however, research is currently being conducted on modifying genetic mark-recapture techniques (J. Boulanger pers. comm.) so that subsequent to an initial population estimate, additional cost-effective genetic sampling can be conducted periodically to provide trend information. While the final outcome of this research effort is unclear, it seems likely to be reliant on a bounded baseline population estimate obtained through current genetic mark-recapture methodology. In order for Kluane to meet its objectives of monitoring (and maintaining) grizzly bears, a large-scale population estimate conducted over the park and ecosystem must be considered a priority and it is recommended that such an estimate be obtained within the relatively short time frame of 2 - 3 years, *4.3 Monitoring for Trend and Processes*

Kluane should continue of the current monitoring program so as to reduce the risks and consequences of managing a bear population without the benefit of information that provides estimates of trend and associated population processes. Although the grizzly bear population in Kluane is of comparatively high density (40/1000 km*), the total population size is apparently small (160 individuals). As with protected park populations elsewhere (e.g., Yellowstone), ensured population viability will require continual vigilance and improved dam collection (Eberhardt and Cherry 2000). Elimination or reduction of research efforts can predictably result in a failure to detect a declining population population trend (Eberhardt and Cherry 2000), should it occur.

Future monitoring of radio-collared grizzly bears with respect to population dynamics must meet three basic criteria: 1) it must be conducted at a level such that data on population parameters accrues at a sufficient rate to permit clarification of the population's growth rate, 2) it must be within the park's budget and time constraints, and 3) it must meet with broad approval of stakeholders in the Kluane ecosystem.

Projections of sample sizes to the end of the 1998 field season indicate that in comparison to other studies that have provided bounded estimates of population growth rate (Hovey and McLellan 1996), the current data is insufficient to achieve a similar level of confidence. High mortality of cubs-of-the-year (59%) has resulted in little monitoring of yearlings and subadults as compared to the Flathead (Hovey and McLellan 1996). Additionally, long intervals between successfully weaned litters has resulted in few observations of non-truncated interbirth intervals. In spite of markedly larger sample sizes for several population parameters, Hovey and McLellan (1996) concluded that confidence limits about their estimate of population growth rate were still wide and that additional data were required to address both sampling (parameter estimation error) and process (spatial or temporal) variation. While sampling variation can be addressed with larger sample sizes, process variation can only be addressed through longer monitoring (Hovey and McLellan, 1996).

It is recommended that additional monitoring of the female component of the population be continued at a minimum level of 12 females per year with effort split between adult and subadult females. To reduce the need for frequent handling of subadult females due to growth, use of eartag transmitters with staggered duty cycles should continue to be utilized. Since monitoring is directed towards reproductive parameters as compared to movements, habitat use, and home ranges, monitoring intensity need not be as high as in previous years. Intensive monitoring to document timing of den emergence and spring cub counts can be followed by monitoring at 2 - 3 week intervals throughout the summer months.

Few research projects on grizzly bears are conducted over a sufficient period of time to document lifetime parameters such as spatial requirements and reproductive success. Generally, studies document a "snapshot" of the population over a relatively short time span which often fails to capture or adequately assess variation over time and space (e.g., process variation). Consequently, estimates of spatial requirements and population dynamics may be strongly influenced by chance events that did or did not occur over the sampling period.

It is recommended that a long-term view towards monitoring grizzly bears in Kluane be adopted to address lifetime parameters, process variation and ecosystem health. Given that the only research being conducted on grizzly bears in the Yukon is in Kluane, results from this research may be widely applied. The opportunity to augment the current database, which dates back to 1989, should not be lost nor should the view be taken that the documentation of current population parameters will be relevant far into the future.

5.0 A Conclusion

Quantitative cumulative effects assessments (CEA) cannot quantify expected numerical declines in population numbers due to impacts, however, a qualitative CEA by Hegmann (1995) concluded, under a human use build-out scenario, that grizzly bears would be adversely affected within 5 – 10 years by 1) road and trail use in the Dezeadeash, Kaskawulsh and Slims River valleys, 2) aircraft and watercraft use along the Alsek, and 3) hunting and encounters outside the park. Expected causes for population declines were direct mortality, reduction in genetic exchange, and habitat alienation. Although the envisioned rate of increase of human use has not yet occurred (T. Elliot pers. comm.), Hegmann's conclusions are still relevant. The actual time span over which these impacts may arise is less relevant than the realization that substantial or uncontrolled increases in human activity will, as they have in other national parks and surrounding ecosystems, eventually threaten the ecological integrity of Kluane. Some mitigating management actions are available and have been employed by Kluane or the local community (e.g., management of attractants, Alsek River management initiatives) while others have clearly not been addressed (e.g., reduction of grizzly bear mortalities along periphery of park).

Managers of Kluane and the greater ecosystem do not have the luxury of waiting for noticeable impacts on the bear population prior to enacting further conservation-oriented management actions. In many cases, by the time impacts are demonstrable through population monitoring, significant declines in abundance have already occurred. Further, Kluane's grizzly bear population cannot be managed as a independent entity, insulated and isolated from events occurring outside the park. Effective interagency management that is able to articulate both broad goals and specific objectives for grizzly bears and their habitat is required if grizzly bears are to survive over the long term. The will and power to act on decisions will be a critical component of any management plan.

This report has tried to establish several themes that are integral to successful management of sensitive, wide-ranging species such as grizzly bears. Cooperation and communication between jurisdictions is of paramount importance, as is the establishment of common goals that operate at the level of the ecosystem and grizzly bear population. Common goals need to be translated into specific and achievable objectives that have the power to maintain or improve the situation for grizzly bears. The successful implementation and efficacy of objectives must also be verified through monitoring. Finally, the results of monitoring management actions should point the way to new objectives and enhanced management actions in an iterative process.

Although grizzly bears are often cited as an indicator species of ecosystem integrity, determining the health of a grizzly bear population is a formidable task. In most cases, their recognized value as an indicator species has been gained through their rapid extirpation from landscapes. In many places where grizzly bears still remain, their future lies in the hands of small groups of people who commit their time and efforts to conserve the species. Ultimately, grizzly bears may be as much an indicator of human integrity as that of the ecosystem.

6.0 Tabular Summary of Recommendations

Table 2. Recommendations for the Management of Grizzly Bears Throughout the Greater Kluane Ecosystem

[illegible]	Report Sections	[illegible]	[illegible] Priority [illegible]		Approximate Cost
1.0	2.1, 2.2.1	***Formation of an Interagency Management Board***			
		Key Points:			
1.1		Determine goals for population size, habitat maintenance, and connectivity.	✓		
1.2		Define acceptable level of risk assumed in policies.	✓		
1.3		Allocate burden of proof between decision makers and proponents of developments.	✓		
1.4		Define and set priorities to achievable objectives.	✓		
1.5		Establish monitoring protocols and performance indicators.	✓		
1.6		Outline required funding levels and form alliances to promote financial support.	✓		
2.0	2.2.2, 3.5.4	***Conduct Public Education Programs***			< $25,000.00
		Key Points:			
2.1		Enhance public awareness of bear ecology, bear safety, bear/people conflicts, traditional values of bears, bear management goals, and evolving legislation.	✓		
2.2		Encourage public support for sustainable bear mortality, waste/attractants management, and bear management goals.	✓		
2.3		Ensure that media explaining ecosystem management objectives and approaches for grizzly bears are readily available to residents and visitors.	✓		
3.0	2.2.3	***Enact Increased Enforcement***			
		Key Points:			
3.1		Develop a shared responsibility in dealing with DLP or illegal kills of grizzly bears.	✓		
3.2		Require that all occurrences of bears obtaining human food/garbage be reported.	✓		
3.3		Enforce penalties for illegal kills, unjustified DLP kills, unreported occurrences of bears obtaining human food/garbage, or failure to enact recommended corrective measures to prevent bears obtaining human food/garbage.	✓		

4.0	2.2.4	***Enact Access Management***			
		Key Points:			
4.1		Promptly and permanently close roads after single-pass resource extraction activities.	✓		
4.2		Use gates for roads that must be kept open for long durations.	✓		
4.3		Ensure that the public understands reasons for need to close roads.	✓		
4.4		Develop spatial approaches to incorporate road densities and thresholds into long-term planning for multiple land usage.		✓	
5.0	2.2.5	***Adopt Forestry Guidelines***			
		Key Points:			
5.1		Train individuals in available forestry guidelines from British Columbia (Biodiversity Guidebook, Identified Wildlife Management Strategy).	✓		
5.2		Monitor regenerating cutblocks and burns as to their attractiveness to wildlife species and where needed invoke conservative hunting policies, no hunting zones, or access restrictions.		✓	
5.3		Review management and scientific literature regularly for new forestry management protocols.		✓	
6.0	2.2.6	***Reduce Control Kills***			
		Key Points:			
6.1		Document and assess level of control, DLP and poaching kills annually by management subzone.	✓		
6.2		Employ aversive conditioning or translocation of individuals where possible.	✓		
6.3		Investigate potential to reduce visible road-side foraging by bears especially in those management subzones which account for most of control kills.		✓	
6.4		If necessary, reduce legal harvest mortalities in management subzones with high levels of control kills.	✓		

	Report Sections	[illegible]	Implementation 1st	Implementation 2nd	Approximate Cost
7.0	2.2.7	***Achieve a Sustainable Mortality Rate***			
		Key Points:			
7.1		Document and assess kills from all sources (harvest, control, DLP, poaching) annually by management subzone.	✓		
7.2		Seek to bring annual adjusted known mortalities of grizzly bears (harvest, control, and DLP) to within recommended levels of 4% of population with females accounting for no more than 33% of kill.	✓		
7.3		Pursue refined estimates of ecosystem population density to guide estimation of mortality rate (see point 12.0).		✓	
7.4		Address strong spatial bias in mortalities through efforts to reduce control, DLP and harvest kills in management subzones that have high grizzly bear mortality levels.	✓		
8.0	2.2.8	***Pursue Enhanced Spatial-Analytical Capabilities***			> $75,000.00
		Key Points:			
8.1		Pursue funding to support development of a spatial information system.	✓		
8.2		Ensure compatibility of data with that of Kluane.	✓		
8.3		Employ a knowledgeable individual to support development of system.	✓		
8.4		Recognize and manage risks inherent in pursuing a costly and complicated system	✓		
8.5		Collect and digitize information on evolving developments.		✓	
8.6		Collect and digitize information on identified wildlife habitats (see point 13.0).		✓	
9.0	3.4.1, 3.4.5	***Establish Bear Management Units***			
		Key Points:			
9.1		Transfer Bear Management Unit concept, once developed by Kluane, to the greater ecosystem.		✓	
9.2		Use Bear Management Units as analysis units for assessment of current and future impacts and as the basis for management prescriptions.		✓	

[illegible]	Report Section	[illegible]	[illegible]	[illegible]	[illegible]
10.0	3.4.3, 3.4.4	***Develop a Human-Use Model***			
		Key Points:			
10.1		Transfer the human-use model and associated thresholds, once developed by Kluane, to the greater ecosystem.		✓	
11.0	***3.4.2, 3.4.3***	***Conduct Potential and Realized Security Area Analyses***			
		Key Points:			
11.1		Conduct a potential (e.g., without the human-use model) security areas analysis for ecosystem Bear Management Units following protocols established by Kluane.		✓	
11.2		Conduct a realized (e.g., with the human-use model) security area analyses for ecosystem Bear Management Units following protocols established by Kluane.		✓	
11.3		Determine impacts of current human activities on availability of security areas for grizzly bears.		✓	
11.4		Use security areas analyses to assess impacts of future developments on security areas.		✓	
12.0	4.2	***Pursue Research on Population Monitoring***			$200,000.00
		Key Points:			
12.1		Conduct a genetic mark-recapture census to: 1) establish baseline population size and density as an aid in assessing success of management, 2) support inventory efforts and assessment of population size based on modeling of habitat capability/suitability being conducted by British Columbia, 3) support determination of ecosystem mortality rates, 4) permit determination of factors influencing grizzly bear habitat use and site selection, 5) support current and future modeling efforts		✓	

	Report Sections	[illegible]	Implementation Priority 1st	2nd	Approximate Cost
13.0	2.1, 3.4.6	***Identify Critical Areas, Linkages and Movement Corridors***	I		
		Key Points:			
13.1		Use scientific, local, and traditional knowledge to identify critical areas for grizzly bears that will require management actions such as access or hunting restrictions or other multiple land-use protocols.	✓		
13.2		Use scientific, local, and traditional knowledge to identify major movement corridors for grizzly bears.	✓		
13.3		Use models to delineate probable linkages between critical habitats in areas that are currently, or likely to become, heavily impacted by human activities.		✓	
14.0	2.2.3, 3.5.3	***Continue Improvements in Management of Attractants***			
		Key Points:			
14.1		Ensure that all occurrences of bears obtaining human foods or garbage are reported.	✓		
14.2		Invoke penalties for failure to report occurrences of bears obtaining food/garbage or for failure to act upon recommended corrective actions.	✓		
14.2		Provide options for visitors that do not have hard-sided vehicles to safely store food in YTG campsites.	✓		
14.3		Require use of canisters for overnight visitors to the Kluane Wildlife Sanctuary or other back-country areas where bears are common.	✓		
15.0	2.2.8, 4.2	***Support Development of Spatially Explicit Models***			
		Key Points:			
15.1		Provide support (e.g., spatial data) to students or researchers interested in developing spatially explicit models that will aid in development of secondary model predictions, that through evaluation, will aid in adaptive management.		✓	

Table 3. Recommendations for the Management of Grizzly Bears within Kluane National Park & Reserve.

[illegible]	Report Sections	[illegible]	Priority [illegible]	[illegible]	Approximate [illegible]
1.0	3.2	***Define Broad Management Goals and Objectives***			
		Key Points:			
1.1		Adopt policies on grizzly bears at the level of the population and ecosystem.	✓		
1.2		Identify targets for population size, status, and distribution.	✓		
1.3		Identify targets for habitat security.	✓		
1.4		Delineate the means and timeframes over which population and habitat targets will be evaluated.	✓		
1.5		Develop policies that delineate the burden of proof between management and proponents of development.	✓		
1.6		Defme the level of acceptable risk in management policies.	✓		
2.0	3.3	***Define Population Level Objectives and Targets***			
		Key Points:			
2.1		In accordance with roles of thumb for viable populations, set current population size as the minimum that is acceptable.	✓		
2.2		Maintain human-caused mortality within Kluane at current low levels established over the last decade.	✓		
2.3		Cooperate with other jurisdictions to reduce mortality levels on the periphery of Kluane.	✓		
2.4		Set determination of a stable population trend as a management target.	✓		
3.0	3.4.1	***Establish Bear Management Units***			
		Key Points:			
3.1		Adopt a park-wide system of Bear Management Units to serve as the basis for habitat security analyses and visitor management prescriptions.	✓		
3.2		Bear Management Units should approximate 300 km^2 , extend from valley bottom to the hydrologic divide, and include habitats in montane, subalpine and alpine zones.	✓		

	Report Section	[illegible]	Implementation by		Approximate Cost
4.0	3.4.3, 3.4.4	***Develop a Human-Use Model***			
		Key Points:			
4.1		Develop a spatially registered human use model for Kluane that categorizes access types and assigns appropriate buffers based on thresholds for high levels of human use.	✓		
4.2		Define thresholds within the context of disturbance events with high use defined as 100, 80, or 60 disturbance events per month according to trends in cover and habitat productivity.	✓		
4.3		Utilize park visitation records and knowledgeable opinion to determine monthly levels of disturbance events based on peak park visitation.	✓		
5.0	*3.4.2, 3.4.3*	***Conduct Potential and Realized Security Area Analyses***			
		Key Points:			
5.1		Define security areas as vegetated patches that are minimally 9.0 km^2 and below 1900m in elevation.	✓		
5.2		Determine for each Bear Management Unit the potential for security areas, overall and by elevational zone (exclude human use model from analysis).	✓		
5.3		Determine for each Bear Management Unit the realized security areas, overall and by elevational zone (include human use model in analysis).	✓		
5.4		Utilize comparisons between the potential and realized security areas analyses to assess current impacts of management on habitat security.	✓		
5.5		Use results of analyses to help set targets for security areas with the lower limit to be not less than 67% as set in more southerly areas.	✓		
5.6		Identify for management consideration Bear Management Units that have 1) deficits of security areas overall, or by elevational zone, 2) have suffered large impacts due to current visitation, or 3) have particularly favorable distributions of security areas.	✓		
5.7		Incorporate 'greenness' maps into analytical procedures to aid in classifying habitat quality of security areas.		✓	

	Report Sections		[illegible]	[illegible]	Approximate Costs
6.0	*3.4.5*	***Follow Protocols for Bear Management Units***			
		Key Points:			
6.1		Ensure that established security areas are managed for long-term persistence.	✓		
6.2		Bear Management Units that have the potential to meet or exceed established targets for security areas should be managed to retain security areas at, or above, targets.	✓		
6.3		Bear Management Units should have monthly visitation caps that incorporate all access types so as to account for low-use access that is not incorporated in security area analyses.		✓	
6.4		New access proposals should be assessed by modeling the impacts on security areas based on expected access types, usage levels, and potential for progressive developments.		✓	
7.0	*3.4.6*	***Maintain Functionality of Movement Corridors***			
		Key Points:			
7.1		Management of major drainages, which serve as primary movement corridors, should retain significant amounts of contiguous habitat offering forage, cover and security both along the slopes and the valley bottoms.	✓		
7.2		Developments within, or at the mouths of major drainages, should be located so that bears can easily bypass them.	✓		
7.3		Developments within geographically imposed movement funnels should be avoided or mitigated by proactive management actions.	✓		
7.4		Restricting access to one side of a valley may be an appropriate management approach.		✓	
7.5		Visitor activities in secondary corridors should be below established thresholds denoting high use.	✓		
7.6		Secondary corridors over hydrologic divides, which are limited with respect to available space, should generally have camping and time of use restrictions.	✓		

	Report Sections	[illegible]	Implementation Priority		Approximate Cost
			[illegible]	2nd	
8.0	3.5.1	***Employ Established Visitor Management Guidelines***			
		Key Points:			
8.1		Consider the following guidelines when developing plans for visitor use in bear-occupied areas: 1) Identify and assign priorities to management goals and objectives. 2) Determine thresholds for visitor use and areas where visitor use is compatible with objectives. 3) Establish the means through which visitor use will be limited. 4) Develop a visitor bear education program and supporting literature. 5) Develop a visitor supervision program. 6) Develop a food/garbage management plan for front and back-country visitors. 7) Locate camps, trails and facilities so that they have low human/bear conflict potential and low bear displacement potential. 8) Design a monitoring program to evaluate visitor use in relation to management. 9) Develop strategies to identify, prevent, modify or eliminate non-compatible visitor use activities. 10) Designate level of funding required to maintain visitor management and monitoring programs.	✓		
9.0	3.5.2	***Designate Campsites and Trails***			
		Key Points:			
9.1		Identify and close redundant campsites or campsites that have high potential for human/bear conflicts or bear displacement.	✓		
9.2		Random camping should be replaced with established campsites throughout the park that have been specifically selected to reduce both interactions with bears and interference with normal habitat use and movements by bears.	✓		
9.3		Conduct risk assessment of established trails and routes.	✓		

9.0	3.5.2	***Designate Campsites and Trails cont'd.***			
		Key Points cont'd:			
9.4		Discourage exploration and popularization of new access routes by the general public.	✓		
9.5		Employ minimum group size restrictions for campsites and trails to promote visitor safety in bear country.	✓		
9.6		Employ maximum group size restrictions and/or limitations on length of stay at campsites to prevent accumulation of attractive scents or excessive site degradation.	✓		
9.7		Some campsites and trails may require permit access, restrictions on time of day or season of use, and restrictions on hiking off trail or travel away from campsites.	✓		
10.0	3.5.3	***Continue Improvements in Management of Attractants***			
		Key Points:			
10.1		Bear resistant food containers or suitable alternatives (e.g., electric fences) should be a requirement for all overnight back-country users including commercial and private rafters. Additionally, day hikers on some trails should be required to use canisters.	✓		
10.2		Visitors should be clearly informed of their responsibilities in food and garbage management.	✓		
10.3		Visitors should be required to report any occurrences of bears obtaining food or garbage.	✓		
10.4		Kluane should be relentless in punishing those who do fail to follow food storage protocols and publicize its willingness to do so.	✓		
10.5		Front country campsites within Kluane should provide bear resistant food storage devices for campers who do not have hard-sided motor vehicles.	✓		

[illegible]	Report Sections	*Kluane [illegible] Recommendation[illegible]*	Implementation [illegible] 1st	[illegible]	Approximate Costs
11.0	3.5.4	***Conduct Public Education Programs***			$40,000.00
		Key Points:			
11.1		Extensive recommendations for visitor education which have been presented in several research reports prepared for Kluane should be implemented.	✓		
11.2		Educational tools for park visitors that describe major foods used by bears, their seasons of use, and foraging signs should be prepared and made readily available.	✓		
11.3		Trail specific brochures that identify relevant bear safety issues, area closures, time of use or travel away from campsite restrictions should be prepared and made available at time of registering out.	✓		
11.4		Visitors should be discouraged from knowingly approaching within 400m of bears.	✓		
11.5		Media explaining safety in bear country (e.g., Staying Safe in Bear Country) should be readily available to visitors. Back-country hikers should be encouraged, if not required, to view media as part of the registration procedure.	✓		
11.6		Media explaining management objectives for both the park and ecosystem should be readily available to visitors.		✓	
12.0	3.5.5	***Regulate Mechanized Access***			
		Key Points:			
12.1		As a general management principle, aircraft supported access into the park should be a tightly controlled activity.	✓		
12.2		Kluane should meet with operators of aircraft that provide access to, or overflights of, the green-belt to discuss preferred flight routes, minimum flight elevations, and wildlife viewing.	✓		
12.3		Overflights of the green-belt should be conducted only along routes that permit a minimum distance of 500m from any point of land to be maintained.	✓		
12.4		Any non-essential flight that can not be conducted within the 500m restriction due to weather conditions should not be allowed.	✓		

12.0	3.5.5	***Regulate Mechanized Access cont'd.***			
		Key Points cont'd:			
12.5		Wildlife viewing from aircraft should be discouraged.	✓		
12.6		Kluane should follow initiatives of other parks and seek to limit activities that disrupt wilderness quiet.		✓	
12.7		Kluane should anticipate the potential cumulative effects and pattern of incremental development when reviewing new access or activity proposals.	✓		
13.0	3.5.6	***Employ Visitor Use Monitoring***			
		Key Points:			
13.1		An increased warden presence in the back country to monitor trails, campsites, and human activities is required.	✓		
13.2		All trails and designated campsites should be inspected annually to ensure compliance with campsite locations and regulations.	✓		
13.3		Evidence of campsites becoming attractive to bears will require mitigating actions such as disposal of 'gray water' or reduced levels of campsite usage.	✓		
13.4		The warden service should raft the Alsek River at least once per year and a warden should camp at Lowell Lake periodically to monitor rafters' activities.	✓		
13.5		Popular trails such as the Alsek trail that may have associated restrictions on off-trail travel should be monitored frequently to ensure adherence to regulations.	✓		
13.6		Wardens should periodically monitor trailheads and ensure that visitors have adhered to specific regulations such as registering out and use of canisters.	✓		
13.7		Monitoring interactions of people and bears at or near campsites by reviewing campsite use and bear observation forms should be conducted on an annual basis.	✓		

[illegible]	Report Sections	[illegible]	Implementation Priority [illegible]	2nd	Approximate Cost
14.0	3.5.7	***Account for Family Groups***			
		Key Points:			
14.1		Recognize importance of habitats (subalpine and alpine) remote from people and other bears to the security of family groups.	✓		
14.2		Conduct route and campsite assessments on trails traversing high elevation habitats.	✓		
14.3		Account for potential localized movement patterns between security and foraging sites by family groups in assessment procedures.	✓		
14.4		Restrict access on high elevation trails to permit only, with group size restrictions and seasonal access restrictions.	✓		
14.5		Restrict access on high elevation trials prior to the end of June as this is the period of high COY mortality.	✓		
14.6		Ensure that public is aware that family groups can be encountered anywhere.	✓		
15.0	3.5.8	***Maintain Good Communication with First Nations***			
		Key Points:			
15.1		Cooperate with First Nations to ensure that ungulate carcasses and remains from subsistence hunting are handled in a fashion that does not result in bears being attracted to trails, campsites or other areas frequented by visitors.	✓		
15.2		Consider closing trails to the public if significant hunting activity is being conducted.		✓	
15.3		Close or place carcass warning signs if hunters have made kills near trails or facilities.	✓		
15.4		Ensure that conflicts between bears and subsistence hunters are reported.	✓		

16.0	3.5.9	***Act on Area Specific Recommendations***			
		Key Points: Act on recommendations for the following specific areas: 1) Bear Flats -close to public. 2) Alsek Trail -conduct a campsite assessment, restrict off-trail travel. 3) Mush & Bates Lakes - close creek between lakes, restrict travel away from campsites. 4) Slims East-consider closing trail to maintain functioning of corridor. 5) Campsite 9 on Alsek River - monitor if rafters' are accessing peri-glacial habitats. 6) Lowell Lake - ensure that travel away from campsite restriction is being adhered to. 7) Overland routes to Goatherd - assess route and campsites, enact group size limits and permit only access, restrict access until after period of high COY mortality. 8) Sheep-Bullion Plateau - enforce minimum group size restrictions, require use of canisters, restrict visitation to 9:OOam - 7:00pm. 9) Jarvis-Serpentine loop - allow permit only access, designate campsites, require use of canister, maintain low visitation level. 10) Cottonwood Trail -apply group size limits during berry season in conjunction with no off-trail travel and no travel away from campsites. Also consider time of travel restrictions. 11) Congdon Loop campsite -apply no travel away from campsite restriction. 12) Peri-glacial habitats - early successional habitats resulting from glacial recession require management of visitor activities and possible area closures.	✓		

[illegible]	Report Section	[illegible]	Implementation Priority 1st	2nd	Approximate Cost
17.0	***4.2***	***Participate in Population Census Initiatives***			
		Key Points:			
17.1		Coordinate with stakeholders and managers of adjacent jurisdictions to achieve a grizzly bear population census of the park and surrounding ecosystem.		✓	
18.0	***4.3***	***Continue Monitoring for Trend and Processes***			$35,000.00
		Key Points:			
18.1		Kluane should adopt a long-term view to monitoring grizzly bears so that information on lifetime parameters, process variation and ecosystem health can be obtained.	✓		
18.2		Kluane should continue the current monitoring program, maintaining a minimum of 12 radio-collared females (adults and subadults).	✓		

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