A Cumulative Effects Assessment of Proposed Projects in Kluane National Park Reserve, Yukon Territory

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Preface

This report was completed under contract for Ray Breneman, Kluane National Park Reserve, Parks Canada. This report was also part of research conducted by the report's principal researcher and author, George Hegmann, for a Master's thesis in Environmental Design at the University of Calgary. Support and technical advice for both this report and the research was also provided by Dr. Tony Yarranton, Environmental Research Center, University of Calgary.

The author would like to thank the many individuals contacted for this study (a full list is provided in Appendix A), and particularly thank Mr. Breneman for his interest and continuing support for this work, and Dr. Yarranton for providing vital research guidance.

This report performs two functions. It provides a response to the park's current specific needs, and provides an example of a practical application of a cumulative effects assessment methodology. As no standard approach yet exists in implementing a cumulative effects assessment, considerable effort is made throughout to explain the methodology used.

Executive Summary

A cumulative effects assessment was performed for Kluane National Park Reserve in the Yukon Territory. The assessment focussed on effects on five wildlife species (grizzly bear, dall sheep, mountain goat, moose and golden eagle) caused by current park and regional activities, and particularly, future projects proposed in the park's 1990 *Park Management Plan* and in the surrounding region.

A framework was developed to define and guide the assessment process. This included a baseline review of resources, projects and human use; a screening whereby the number of possible cause-effect relationships were reduced to a few hypotheses representing only the most significant relationships; a qualitative analysis of the hypotheses based on a review of the evidence obtained; and a summary and conclusions of significant projects and effects.

The analysis incorporated a variety of cumulative effects concepts or tools to assist in the effects evaluation. These included the use of conservation biology principles, observed wildlife responses to disturbances as obtained from the scientific literature, human use scenarios (successive periods in time in which various projects and activities will occur), disturbance nodes, zones of influence and disturbance factors.

The following conclusions and recommendations are presented to indicate to Kluane National Park Reserve managers which projects and activities as identified in the 1990 Park Management Plan are the most important in regards to cumulative effects in the Park, which regional projects and activities have an important influence on the Park, and what the possible cumulative effects may be from the combined influence of these projects and activities on Park Valued Ecosystem Components: grizzly bear, dall sheep, mountain goat, moose and golden eagle.

Analyses and conclusions were qualitative, based on best available information and professional judgement. The assessment results must be viewed as preliminary — some are inconclusive — given the uncertainty and often limited availability of information. All conclusions and recommendations regarding effects on wildlife must be considered preliminary until the recommended actions are implemented as considerable uncertainty exists about the status and trends of wildlife populations in the park.

Conclusions

The following conclusions were reached in the KNPR cumulative effects study.

General conclusions

1. Cumulative assessments of effects on wildlife due to human activity can not yet be determined through any available quantitative technique. A review of available information (evidence) and precedent, subject to analysis by a hypotheses-induction process and consideration of fundamental ecological principles, is the most suitable assessment approach.
2. Tourism and industrial projects are the driving forces of human use change in the park and region. Tourism is expected to increase at a steady but slow rate with the exception of destination adventure travellers, resulting in a significant increase in demand for access into the park backcountry, particularly for rafting on the Alsek River. Backcountry use restrictions may reduce this rate of growth. Industrial growth is expected to be low unless a few major projects occur. If this happens, economic and resident population growth may result in increased capitalization to support more mechanized forms of access into the park; and perhaps, into areas that as of yet are not heavily used but have considerable potential (e.g. Onion Lake). This may occur in the form of one-day excursions that cater to the highway traveller market, currently the largest visitor segment.

3. Recent and pending aboriginal land claims settlements may have significant impact on park operations, projects and resource management. The significance of these changes is very uncertain.
4. Road proliferation and hunting in the Greater Kluane Region may have a significant effect on wildlife in the future, especially if increases occur in the aforementioned tourism and industrial project activities.
5. Although there are many valued ecosystem components (VECs) in the park, screening has determined that effects from many proposed projects are probably trivial (i.e. local, mitigable and reversible). Some large mammals and raptors however (grizzly bear, dall sheep, mountain goat, moose and golden eagle), valued for their representation of the Northern Coast Mountains Natural Region and for providing viewing opportunities for visitors, make use of habitat that is and may be significantly influenced by human activity.
6. Screening has determined that the most significant effects in the park on the selected wildlife VECs are direct mortality, reduction in genetic exchange due to blockage of movement corridors and behavioural changes due to increased visitation leading to habitat alienation. Effects due to direct habitat loss and fragmentation, and removals, are probably negligible.
7. (a) If impacts cause wildlife alienation due to exceeding of tolerance of disturbances, it is very uncertain if habitat would be available elsewhere in the park for emigrants from their historical range. (b) Habitat elsewhere is likely to be already occupied so emigrants from the park would have to displace them or die. Those displaced would face the same problem. (c) Where populations are large and dispersed over large areas freedom of movement between portions of the range is essential to survival because of the potential for the pattern of decline referred to as the extinction vortex.
8. Predicting wildlife response to disturbances involves significant uncertainty that makes any effects assessment very probabilistic.
9. The species that would be most affected in the park by proposed projects are grizzly bear and mountain goat, with effects on the remaining species probably not significant provided that the recommended mitigation measures are applied effectively.
10. The proposed park projects with the greatest significance for contributing to overall cumulative effects in the park are Alsek River rafting management, aircraft support at Lowell Lake for rafters and hikers, Alsek Pass road and day use area, and the boat shuttle to Lowell Lake.
11. Regional projects and activities outside the park with the greatest significance for contributing to overall cumulative effects in the park are, in order of significance: hunting, mining, highway travellers, road proliferation and community growth.

Species specific conclusions

The following are the cumulative effects hypotheses conclusions. The impacts and VECs they address represent cause-effect relationships that, after screening, were suspected as possibly significant to wildlife viability. The conclusions were reached after each hypothesis was tested with available information. It is important to note that lack of Park specific data on wildlife created considerable uncertainty, particularly for grizzly bear and golden eagle. The conclusions are therefore stated as probable as opposed to definitive outcomes. These results must be considered as preliminary until further research and monitoring, as identified in the recommendations, are conducted.

1. Road and trail use in the Dezadeash, Kaskawulsh and Slims River valleys will probably adversely affect grizzly bear survival in the park within the next 5 to 10 years.
2. Aircraft and watercraft use along the Alsek River Valley will probably adversely affect grizzly bear survival through behavioural changes and habitat alienation within the next 5 to 10 years.

3. Hunting and encounters outside the park are probably already adversely affecting grizzly bear survival through behavioural changes and direct mortality; however, the effects may not become significant until another 5 to 10 years from now.
4. Road and trail use on and near Sheep Mountain will probably not adversely affect dall sheep survival through behavioural changes and habitat alienation.
5. Aircraft use over Sheep Mountain will probably not adversely affect dall sheep survival through behavioural changes and habitat alienation.
6. Trail and aircraft use around Goatherd Mountain will probably adversely affect mountain goat survival through behavioural changes and habitat alienation within the next 5 to 10 years.
7. Recreational use and hunting along Alder Creek and the Mush-Bates Lakes will probably not adversely affect moose survival through behavioural changes, habitat alienation and direct mortality.
8. Human activities along the Slims River Valley will probably not adversely affect golden eagle survival through behavioural changes and habitat alienation.

Impact specific conclusions

The following conclusions were made after a qualitative review of evidence and conclusions from the previous species specific hypotheses.

1. Aircraft use at Lowell Lake will probably adversely affect the long-term viability of wildlife VECs within the next 5 to 10 years.
2. Road and trail use at Alsek Pass will probably adversely affect the long-term viability of wildlife VECs within the next 5 to 10 years.
3. River rafting on the Alsek River will probably adversely affect the long-term viability of grizzly bears and mountain goats within the next 5 to 10 years.
4. Causes of direct mortality inside and outside the park will probably adversely affect the long-term viability of wildlife VECs within the next 10 to 20 years.
5. The combined effects of all park and regional activities may result in reduced populations or extirpation of some or all wildlife VECs in the park within the next 20 years.

Recommendations

The following recommendations should be considered by park management in interpreting the cumulative effects issues in the park and determining appropriate management responses.

1. The following mitigation measures should be implemented (or, for existing measures, continued) to reduce adverse effects on the wildlife VECs.[1] Mitigation measures are listed in order of importance, as perceived by the author, given the nature of activities in the park and the known and hypothesized effects. Mitigation measures *1* to *6* are suggested as very important (highest priority).
    1. visitor, local resident and industry education;
    2. commercial operator permitting and adherence to industry guidelines or park policy;
    3. aircraft landing restrictions, minimum cruising altitudes, no-fly zones, and flight corridors (for warden and commercial flights);[2]

[1] A complicating factor for some of these initiatives is that they require the participation of various jurisdictions, some which are outside the direct control of Parks Canada (e.g. Yukon Government, Transport Canada).

[2] Such restrictions are difficult to enforce and often may not be possible to follow given typical weather conditions (e.g. low cloud ceiling) in the park.

4. rafting party size restrictions and scheduling quotas;
5. backcountry trail registration and quotas;
6. bearproof food containers for hikers;
7. concentration of "highway traveller" visitors in local controlled areas (e.g. VRCs, trails);
8. garbage disposal controls;
9. use restrictions according to park management zones, especially Special Preservation Areas;
10. controlled (gated) access roads;
11. trail hardening (e.g. on Sheep Mtn.);
12. area and trail closures;
13. adherence to no hunting zones; and
14. poaching patrols.

2. The following wildlife related research and monitoring should be conducted to refine further effects assessments and validate or refute the conclusions reached.
   - Grizzly bear: population and trends, dispersal and immigration, use of movement corridors, degree of habitat alienation and available quality habitat, significance on park bear population of mortalities outside park;
   - Dall sheep on Sheep Mtn.: verification of habitat carrying capacity estimates and degree of movement between Sheep Mtn. and Donjek (and how influenced from activities in Burwash area), monitoring of nature of sheep response to hikers;
   - Mountain goat: more frequent monitoring of Goatherd Mtn. goat population, monitoring of aircraft and trail use;
   - Moose: effects of hunting inside and outside park on park population; and
   - Golden eagle: more information on status of population in park.
3. The following human use related research and monitoring should be conducted to refine further effects assessments and validate or refute the conclusions reached.
   - future regional trends in tourism growth and hunting;
   - backcountry visitor use trends and investigation of possible control measures;
   - aircraft use patterns (e.g. "flightseeing" trips and backcountry support);
   - implementation of trail use quotas for high use trails and degree of access afforded by roads outside the park;
   - peak use conditions for aircraft and rafts, and monitoring of good camping practices (e.g. food storage) along Alsek River; and
   - continued use of warden surveys and field observations (by wardens and visitors) as problem "flag raisers".
4. Conservative assumptions should be made about the significance of effects on VECs when data are limited and the potential for continuing human encroachment is high. The "safe minimum standard of conservation" and "precautionary principle of biodiversity" are appropriate guiding concepts.
5. In the absence of specific population targets in the park (e.g. 95% probability of population survival in 100 years, 250 sheep on Sheep Mountain), and uncertainty regarding future project development and the effects of such projects on wildlife, the guiding principles of Parks Canada regarding ecosystem protection should be referred to when evaluating the potential significance of effects and when objectives are sought. The *Guiding Principles and Operational Policies* (Parks Canada, 1994a) states that "National park ecosystems will be

given the highest degree of protection to ensure the perpetuation of natural environments essentially unaltered by human activity. Human activities within a national park that threaten the integrity of park ecosystems will not be permitted" (p. 33). This study should provide evidence to assist park managers, staff and various stakeholder groups in determining if these policies are being compromised.

6. Parks Canada should conduct a risk assessment (based on a subjective review of issues and perception of importance) as a follow-up to this study. This would determine the risk of loss of a wildlife VEC in the park. The assessment would consider evidence in the form of trends experienced in other wilderness areas, and results of studies of species response to disturbances. An opportune time for such assessments would be as part of future park management plan updates. Information so obtained could also be used to assist the Park in determining Kluane's ecosystem needs.

7. Parks Canada should re-examine the conclusions about effects reached either when more data (as identified in this study) become available or at a later park management plan review. This would represent an adaptive approach to managing the park's resources, wherein original assumptions are questioned and data updated, perhaps providing new conclusions about the nature of environmental effects occurring in the park.

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List of abbreviations

BNP	Banff National Park
CAB	Champagne-Aishihik Band
CEA	Cumulative Effects Assessment
CEAA	Canadian Environmental Assessment Act
CEM	Cumulative Effects Model
CPS	Canadian Parks Service
DF	Disturbance Factor
DLP	Defense of Life and Property
EIA	Environmental Impact Assessment
GKR	Greater Kluane Region
KNPR	Kluane National Park Reserve
KWS	Kluane Wildlife Sanctuary
NPP	National Park and Preserve
PMP	Park Management Plan
SPA	Special Preservation Area
VEC	Valued Ecosystem Component
VSC	Values Social Component
VRC	Visitor Reception Centre
WSE	Wrangell-St. Elias (National Park Reserve)
YRR	Yukon Renewable Resources
YT	Yukon Territory
YTG	Yukon Territorial Government
ZOI	Zone of Influence

1.0 Introduction

1.1 Purpose

The primary purpose of this study is to assess cumulative environmental effects arising from projects proposed in the Kluane National Park Reserve 1990 *Park Management Plan* (Parks Canada, 1990), and determine the significance of those projects now and in the future on park resources. The *Park Management Plan* (PMP), updated every five years, describes park issues, projects and priorities. The Plan serves as the fundamental guiding document for Park activities, and is subject to public review. This study will provide information as part of the next Plan update in 1995.

The second purpose of this study is to determine the implications of the assessment's results to park resources (specifically, selected wildlife species) to assist park managers in prioritizing management actions within the park.

The final purpose of this study is to define and demonstrate the application of a cumulative effects assessment (CEA) methodology for a national park. This methodology may be modified as required, and serve to identify data gaps and monitoring needs to fulfill the information requirements of a future CEA. Kluane National Park Reserve (KNPR) may take this report's methodology and results and use it again when other research resources become available or new priorities require a more detailed examination of park management issues.

1.2 Study background

Kluane National Park Reserve, established in 1976, covers 22,015 km^2 in the far south-western corner of the Yukon Territory (see Maps 1 and 2), 160 km west of the Territory's major settlement and capital of Whitehorse. This UNESCO World Heritage Site includes the St. Elias icefields and a mountainous area that is home to "some of the largest concentrations of large mammals found anywhere in North America" (Slocombe, 1993), including grizzly bear, dall sheep and mountain goat. Hiking and rafting are popular backcountry activities; the frontcountry provides day use areas and park interpretation facilities.

Various projects to facilitate visitor use of the park have been proposed by Parks Canada and commercial tour operators. These projects include zoning changes, road upgrades, construction of trails, day use areas and roads, river rafting, aircraft 'flightseeing' and tripping support, and river boat use. Such proposals are in response to projected tourism growth in the Greater Kluane Region[3] — Parks Canada wishes to retain visitors for longer periods of time to experience a wider range of activities.

Projects proposed by Parks Canada must be reviewed under the federal *Canadian Environmental Assessment Act* (CEAA) review process, which requires consideration of "any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out" for any "screening or comprehensive study" (Government of Canada, 1995, s. 16.1).

The proposed activities, with the exception of aircraft use, are contained within a relatively narrow strip between the Alaska/Haines Highway and the park's icefields. This 'green zone' includes most of the park's wildlife habitat. The proposed activities are largely constrained within

[3] The Greater Kluane Region was created for regional planning purposes, and includes the far south-western region of the Yukon. KNPR is not however in its jurisdiction. It is bounded by the U.S. border to the west and south, and a diagonal line running (approximately) from west of Whitehorse to north of Beaver Creek (DRR, 1989a).

narrow linear corridors (e.g. river valleys) that extend into the backcountry from the highways, and amongst a few visitor activity centres (e.g. Sheep Mountain Visitor Centre).

Each activity on its own has the potential for unacceptable environmental effects, of which the major concern is disturbance of and direct conflicts with certain wildlife species. Together, all proposed activities may result in interactions that introduce further unacceptable effects. Identification of any such interactions is fundamental to a cumulative effects assessment.

This study defines and implements a 'framework' which determines how the CEA proceeds. The framework includes four stages: 1) Baseline — identifies the valued ecosystem components (VECs) and projects, and describes the park resources and human use scenarios; 2) Screening[4] — describes potential project effects based on a preliminary review of project synergies and effects on selected wildlife VECs; 3) Analysis — formulates cause-effect hypotheses and performs analysis of hypotheses; and, 4) Summary and conclusions — describes the overall effect of the projects on the wildlife. Management recommendations are finally offered to address cumulative effects issues in the park.

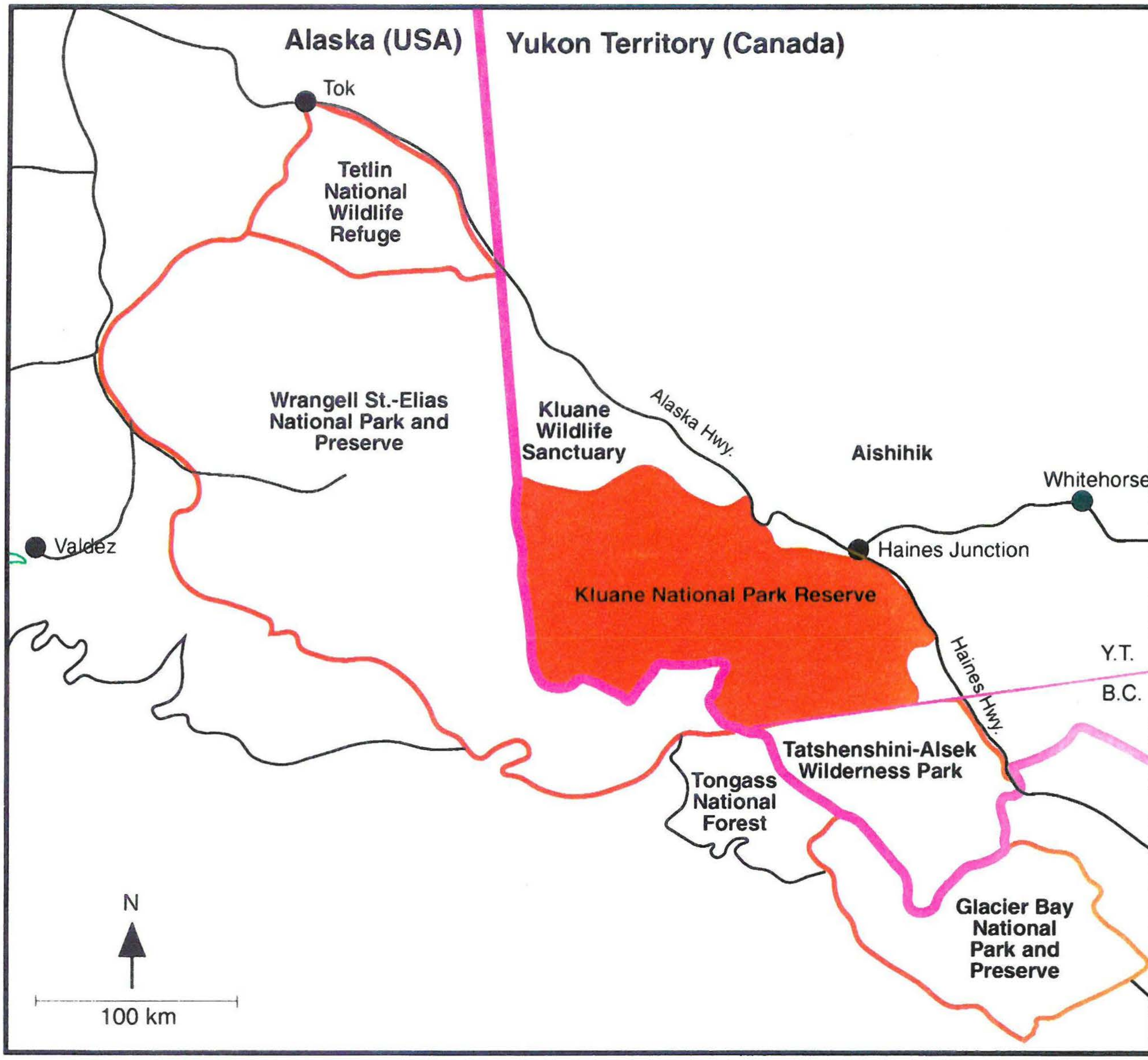
1.3 Study overview

Section 2 provides an overview of cumulative effects assessments: what they are and how they can be done. Section 3 outlines this study's methodology. Section 4 describes the baseline information. Section 5 describes the effect's screening. Section 6 provides the hypotheses analysis. Section 7 provides a summary and the conclusions.

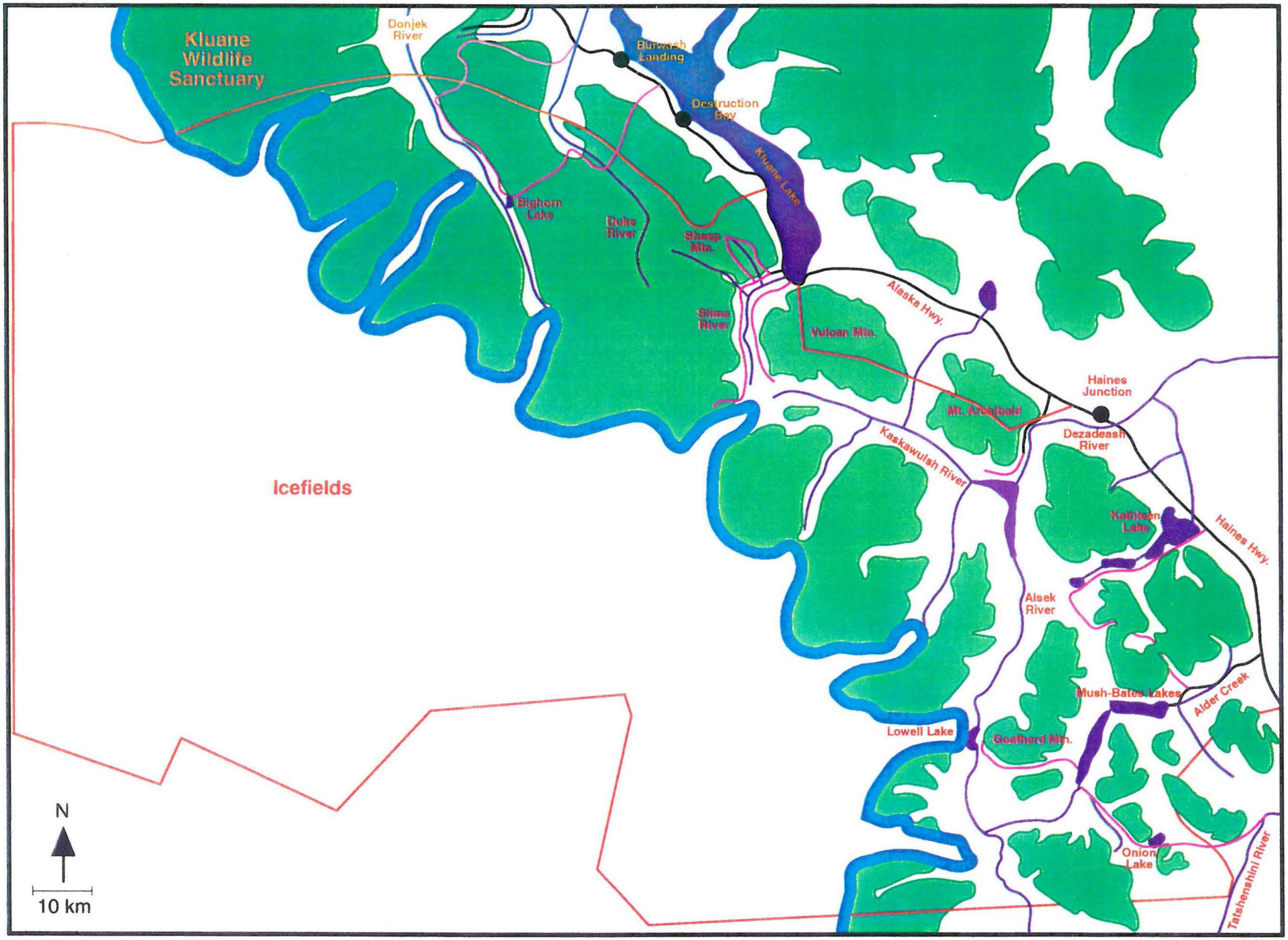
1.4 Terms of Reference

Appendix B contains the study's Terms of Reference. Restrictions on the study as defined in these terms include: a limited number of wildlife species were selected as VECs; analysis was based on available literature and interviews; recognition that little information is available on park wildlife; and the analysis was to be qualitative.

[4] Screening as used here does not refer to the separate "Screening" activity as defined in the CEAA federal assessment process. The term is used in its most general sense, i.e., as a procedure in which issues are identified (scoped) for further consideration. In this Kluane CEA, there are a series of such "screenings", each successively reducing the number of issues (e.g. projects, VECs) until a final subset is produced for which hypotheses analysis is made. Such a reduction of issues is especially important in a CEA when many projects and VECs may have to be "sifted" through.



Map 1: Kluane National Park Reserve and Region



Map 2: Kluane National Park Reserve

KNPR border
Lakes/Rivers/Creeks
Roads
Limit of Icefields
4000 ft (1600m) elevation
Trails

2.0 Cumulative effects overview

This section defines cumulative effects assessments and discusses how CEAs may be implemented given the state of current practice and expectations. This will assist readers in better understanding the intent and limitations of CEAs. This background information also serves as an introduction to the study methodology described in section 3.

2.1 What Cumulative Effects Assessment is

As stated earlier, in CEAA, assessments must now include the consideration of the effects arising from other current and possible future projects that are incremental to the specific project under review. From the point of view of implementing cumulative effects assessments (CEAs), one must determine what is causing an effect on what, and attach some degree of significance to that relationship. CEA is fundamentally no different from the current practice of environmental impact assessment (EIA). Where there is a difference is in how far one pursues a cause-effect relationship through a 'line-of-inquiry' that investigates the implications of one or more projects (i.e. impacts, activities) on one or more valued ecosystem components (e.g. wildlife species, water quality).

There is no single working definition of CEA. The *Canadian Environmental Assessment Act* does not define what CEA is or how to do CEAs (it only states what it wants as a result of the assessment), although the Canadian Environmental Assessment Agency, responsible for administering the federal EIA process, does assist CEA practitioners in defining likeliness and significance of project effects (FEARO, 1992 and 1994).

Environmental impact assessments have often only assessed the impacts resulting from a single project, over an area relatively local to the project (e.g. over the project "footprint"), and for a relatively brief period of time into the future (e.g. until the project is first operational). Such an approach is often quite suitable for certain projects and effects (e.g. campsite construction and soil erosion) where the effects are temporary, the magnitude low and the probability of significant impact is low. This may be partly due to the inherent low nature of the impact, the resiliency of the natural environment to stress, and the high success of mitigation.

However, in some cases, such an approach is inadequate. Such cases include areas in which *many* projects may be affecting one *or more* valued ecosystem components (i.e. affecting something for which humans have placed value or importance on or accept for its own inherent value). This may happen over a large area (e.g. in the order of hundreds of square kilometres) and over extended periods of time (e.g. decades). Such projects however do not usually occur in a coordinated fashion under the control of a single jurisdiction that has specific long-term objectives for a state of environmental components (e.g. air quality, wildlife populations). An assessment approach is then required to overcome the "process of post-hoc decision making" (Odum, 1982, p. 728) that results in significant effect arising from the accumulated effects of seemingly inconsequential single projects.

A CEA attempts to address these shortcomings by not, early in the assessment process, spatially or temporally limiting the assessment of a cause-effect relationship. Therefore, the assessment of that relationship follows a line of inquiry that continues until the effect is deemed trivial or significant (in which case mitigation or cancellation of the project is warranted), in effect limiting or 'bounding' the assessment review at a later rather than earlier stage. Each line of inquiry continues as far afield and into the future as is necessary to determine, based on the best available evidence, the nature of the effect. This may mean examining issues in other jurisdictions and some time in the future.

For example, a dall sheep population, as it returns to winter range at lower elevations, may pass through active mines or access roads outside the park and be subject to harassment or poaching. An assessment that only examined conditions within the park would therefore be inadequate if one, while also analyzing the effects of aircraft overflights on the sheep, wished to determine the long-term viability of the population. The line of inquiry therefore should 'follow the sheep' until all potential significant effects are accounted for.

This does not necessarily mean a costly and time consuming assessment — a CEA, just like an EIA, can be performed based on any amount of information; however, the degree of certainty one places on the conclusions will be in proportion to the quality and availability of data and the confidence placed on the meaning of interpretation of that data.

Such an approach is especially appropriate for far reaching 'agents of change': when either the valued ecosystem component moves away from a project area (e.g. far ranging bears, contaminants in rivers or airsheds), or the project includes an activity that covers a large area (e.g. road traffic, aircraft flights). If this happens, an interaction or synergism occurs between various projects and VECs.

A synergy can be either spatial or temporal. A spatial synergy is a physical overlap of effect between two or more projects (e.g. two streams converging after each passing through a project, the combined noise levels from a motorboat and aircraft). A temporal synergy is an occurrence of events at the same time (e.g. seasonally, as with bears foraging along river flats in the summer during peak hiker activity; or daily, as with flightseeing every afternoon over a herd of goats on a mountain summit).

Such interactions however are usually too difficult or impossible to define and predict. The assessment therefore makes use of best professional judgement, subjective valuation and risk assessment (i.e. the probability of a significant event occurring) to determine what the appropriate issues are, and the significance of those issues (e.g. do we know enough about the effect to consider it trivial or non-trivial?).

2.2 CEA methods

Synergies (also referred to as interactions or linkages) between impacts are the defining hallmark of CEA methods (as opposed to EIAs); many attempts have been made to provide some quantitatively based approaches for the sake of completeness, repeatability and rigour. However, few single approaches prove satisfactory: there are no definitive CEA methods. Furthermore, despite considerable emphasis by CEA advocates (see Contant, 1991) on defining CEA through the fine tuning of linkages and associated project impacts (e.g. as multiplicative, additive, compounding, nibbling, or space crowding), no technique is yet available to investigate whether such a specific change is occurring, and if so, how to assess it, thus rendering for now such concepts impractical in implementing CEAs.

What *is* available is an assortment of techniques, each practical for only a limited number of applications, and developed as part of the evolution of EIAs. A few newer techniques attempt to define relationships or linkages through the use of network diagrams, matrix analysis, overlays from geographic information systems, ecological thresholds and carrying capacity, and energy and mass flow balances.

Cumulative effects methods often attempt to determine the degree of spatial overlap of effects from various projects, the assumption being that areas of overlap represent cumulative effects. There is a problem however in applying this approach to wildlife: animals as individuals and in groups rarely behave in predictable fashion. Spatial overlap alone can not account for the cause and effect relationship that may be occurring.

Models cannot yet adequately simulate the complex dynamics of an ecosystem. This is no more true than in dealing with the effects of projects on wildlife, where each species is unique in its behavioural response to human disturbances and in its environmental needs. Most quantitative methods deal with airsheds or aquatic systems — usually at the watershed level — owing to the relative simplicity of modelling mass and energy flows in air and water. A CEA therefore cannot expect to use a single prescriptive method to analyze such complex cause-effect relationships.

As an example of the limits of modelling and analytical capability, the most sophisticated cumulative effects model for terrestrial wildlife currently available still cannot answer the basic and vital question: does habitat degradation cause reduction in population viability?[5] The U.S. Forest and Wildlife Service cumulative effects model (CEM) for grizzly bears (U.S. Forestry Service, 1990), first developed in Yellowstone National Park, uses extensive habitat mapping (heavily relying on geographic information systems) and comprehensive disturbance coefficients to determine effective habitat remaining for grizzly bears.

However, no readily available threshold exists (the limit of acceptable changes in habitat and mortality) to translate the model results into population response (Dave Mattson, pers. comm.), except as determined by experts in workshops reviewing those results. The failure to develop a threshold even in this relatively advanced model for a well studied species points to a fundamental flaw in the assumption that ecological thresholds may provide the analytical solution to cumulative effects assessments, and to the difficulty in applying the concept of a zone of influence to describe the spatial extent of effects from a certain impact. After a review of the application of the CEM for Yellowstone National Park's grizzly bear population, Mattson (1991b, p. 6) concluded that a "conservative approach to management of [bear] habitat and mortality" is warranted because of a high risk to the long-term viability of the park's bear population (partly due to increased access, visitor use and direct mortalities along the park periphery). Mattson recommended "no increase in mortality risk" be allowed, and defined a practical working threshold: "that the situation should be no worse than at present and improved by any means possible".

Therefore, one must draw on various techniques, make value judgments, and rely on various sources of information at different levels (e.g. individual animal responses to helicopters, historical population responses to increased road access) as input into an assessment's conclusions. Such an approach was used for this study and is described in the next section.

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5 This does not mean that the ultimate result of this cause-effect relationship is not predictable — see the hypotheses analysis (section 6) for a discussion of this based on historical precedent.

3.0 Study methodology

This section describes the CEA methodology used in this study. The overall assessment framework is discussed, followed by a brief description of some specific elements of this CEA process. The methods used are described in detail to ensure that the process is understood, and by way of example demonstrates how a CEA may be done, given that no 'prescriptive' methodology yet exists for Parks Canada to follow.[6] The framework steps and extensive referencing to source literature provide an 'audit trail' that explains the assumptions and information used.

Analysis is largely qualitative, based on professional judgement — continuing research in ecological processes and the availability of more data will allow the gradual introduction of more quantitative techniques if they may be used to add useful information to the analysis.

3.1 Assessment framework

Figure 1 illustrates the CEA framework used in this study. Adopted from the "Adaptive Inquiry Process" (Hegmann and Yarranton, 1995), the framework defines each step in implementing the CEA. Step 1, Baseline, identifies the information on which the analysis will be made. Step 2, Screening, focusses the cause/effect relationships into a few impact hypotheses. Step 3, Analysis, analyzes the hypotheses to predict effects. Step 4 provides a summary of the impacts and effects, and provides conclusions regarding proposed projects and implications to park management due to cumulative effects issues.

The objectives of screening were to identify early on what was important to examine, identify the relevant projects according to the PMP and activities outside the park, and remove for consideration projects or effects that were not significant enough to consider (separate the trivial from the non-trivial).

The framework is general enough to be used for CEAs in other parks or other jurisdictions. Also, team-based input at any step (e.g. workshops with experts and stakeholders) could be used to assist in identifying VECs and important cause-effect relationships.[7]

The analysis of impact hypotheses, central to the framework, is based more on carefully reasoned thought than on specific quantitative tools. This was done because adequate tools were not seen as available to do the job of assessing cumulative effects on wildlife. Some tools, such as the Habitat Evaluation Procedure and the Weaver Habitat Disturbance Model, could provide some information but at considerable cost beyond the scope of this study. Furthermore, it is questionable if results from such models would provide enough new information, given the specifics of this case study's impacts and effects, to justify their use.

In summary, the analysis method is based on the following:

1. Review of available information;
2. Identification of important issues (through screening) and synergies based on best professional judgement and conservative assumptions of significance of effects; and

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[6] It is probable however that for a National Park, regarding environmental effects on wildlife, some approach could be adopted as a guiding framework, given the consistent occurrence of certain human activities and species within a well defined area, and the need to simplify the processing of assessments (e.g. the need for a series of simple-to-use steps) for a large organization such as Parks Canada.

[7] Budget and time constraints did not allow such efforts for this study; however, to a certain extent, that 'deficiency' was overcome by interviewing experts in various fields for information and perceptions.

3. Creation of hypotheses and their analysis to predict effects resulting from human activities, where each hypotheses introduces relevant data and discusses various types of effects, based on best professional judgement and ecological principles.

An important element of this process is that it is iterative. One should be able to re-examine (given availability of resources) work done; for example, some of the effect's ratings used, or even examine another VEC. The arrow in Figure 1, returning to a previous screening stage, illustrates this.

3.2 Methodological elements

Certain methodological elements or concepts are introduced as convenient artifices or models of the 'real' world for the purposes of assessment. These assist in organizing the complex and varied information, on which the assessment is based, into simpler forms that allow the assessment to be more easily and practically accomplished. This is necessary due to the inherently complicated task of including a wide body of knowledge and data for many projects, VECs, and time frames.

3.2.1 Scenarios

A scenario groups existing and "reasonably foreseeable projects" into distinct timeframes.[8] This allows future projects, and changes to existing projects and human use, to be projected in a stepwise fashion. The three scenarios used are:

Scenario A: Existing	Existing projects and activities[9] in and around the park. The area surrounding the park includes the Kluane Wildlife Sanctuary, the Alaska/Haines highway corridor and its communities, and the western edge of the Aishihik region. Areas beyond are also included (e.g. U.S. National Parks) if necessary to fully investigate effects on a VEC.
Scenario B: Build-out	Projects proposed by the park in the 1990 PMP or region that may take place within 5 to 10 years from now.
Scenario C: Long-term	Projects that may take place between 10 to 20 years from now.

Figure 2 illustrates the temporal extent of these scenarios relative to one another. Note that the further ahead in time one goes, the greater the uncertainty in predicting if that project will proceed.

[8] Although CEAA interprets such projects as those for which approval has already been sought, this study expands that definition to include projects that have been proposed but for which no formal application or actual development has yet occurred.

[9] In this study, projects are specific planned courses of action. Activities are the type of human use associated with projects (e.g. the Park planning to build a road is a project, hiking along the road is an activity).

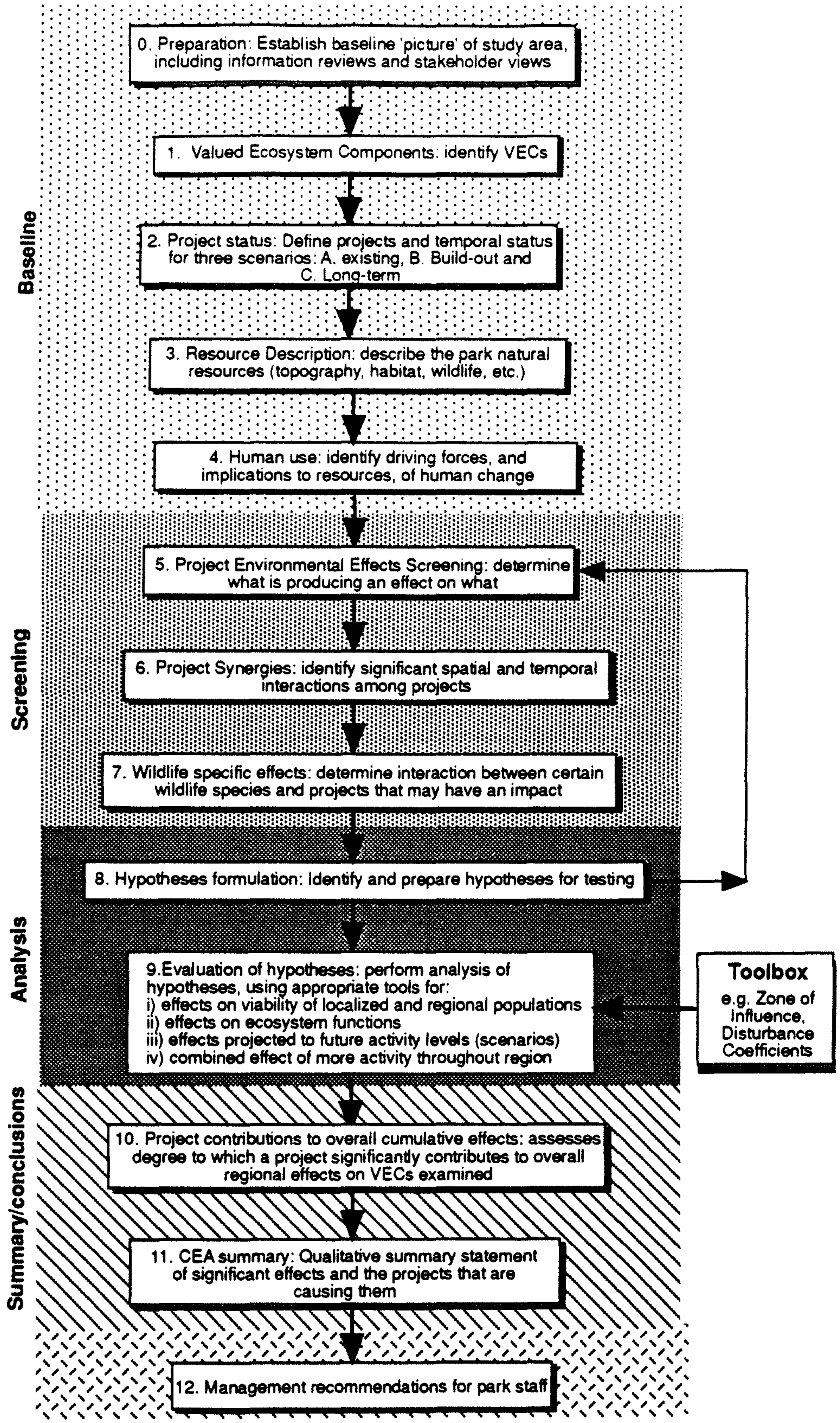


Figure 1: CEA framework

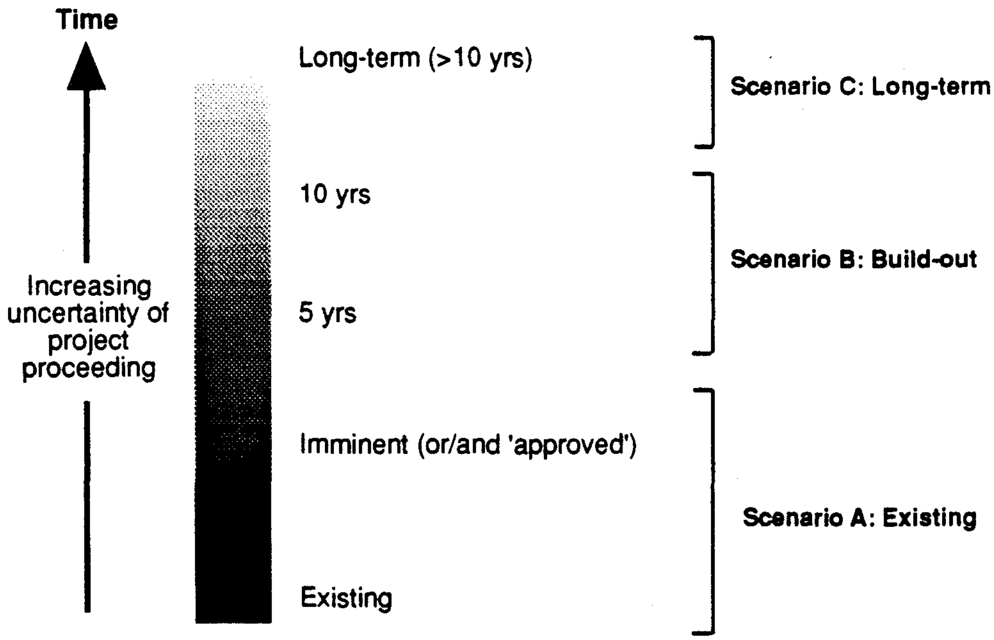


Figure 2: Temporal extent of scenarios

3.2.2 Disturbances and disturbance nodes

Disturbances are any impacts (projects or activities) that may cause a significant effect on VECs. Disturbance nodes are areas where one major impact exists, or the influence of several impacts may overlap due to spatial or temporal proximity. Disturbance nodes are used to 'condense' the many projects in the park and region into a smaller number of areas of potential and significant adverse disturbance. This approach is similar to that proposed in the Yellowstone grizzly bear Cumulative Effects Model which aggregated "all human activities into groups reflecting similar effects" (Weaver, 1986, p. 368).

Disturbance nodes may occur as a result of one or more projects at various spatial scales. Figure 3 illustrates the various scales (adopted from Antoniuk, 1994) considered in this study, from very local project 'footprints' (which are usually not of concern) to the inclusion of U.S. National Parks due to wildlife trans-boundary movements. Synergies can occur between disturbance nodes if:

- far ranging species come into contact with many nodes (e.g. bear, moose, wolf) and suffer adverse effects;
- far ranging human activity crosses over various nodes (e.g. flightseeing, backcountry hiking, rafting, snowmobiling);
- a human activity in one node creates a sensory disturbance (e.g. noise) that can be perceived by the VEC while in another node; or
- activities also occur at the same times of day.

Disturbances and disturbance nodes occur in four shapes: linear (e.g. a corridor along a river or road), point (e.g. a single well defined location), area (e.g. a very large region) and dispersed (e.g. activity can occur anywhere over a large area). The shape influences to what degree the location of the disturbance can be predicted, the degree by which the disturbance is concentrated within a certain area, and the amount of edge the node has next to its surrounding environment. Hiking and flightseeing in the Donjek area for example do not always follow the same paths; they can be as much random as they are directed along certain routes. River rafting (e.g. along the Alsek River) and trail hiking (e.g. along the Cottonwood Trail) are fixed along prescribed routes; they are linear. Day use areas and campsites (e.g. at Kathleen lake) are also fixed at certain locations; they are point disturbances.

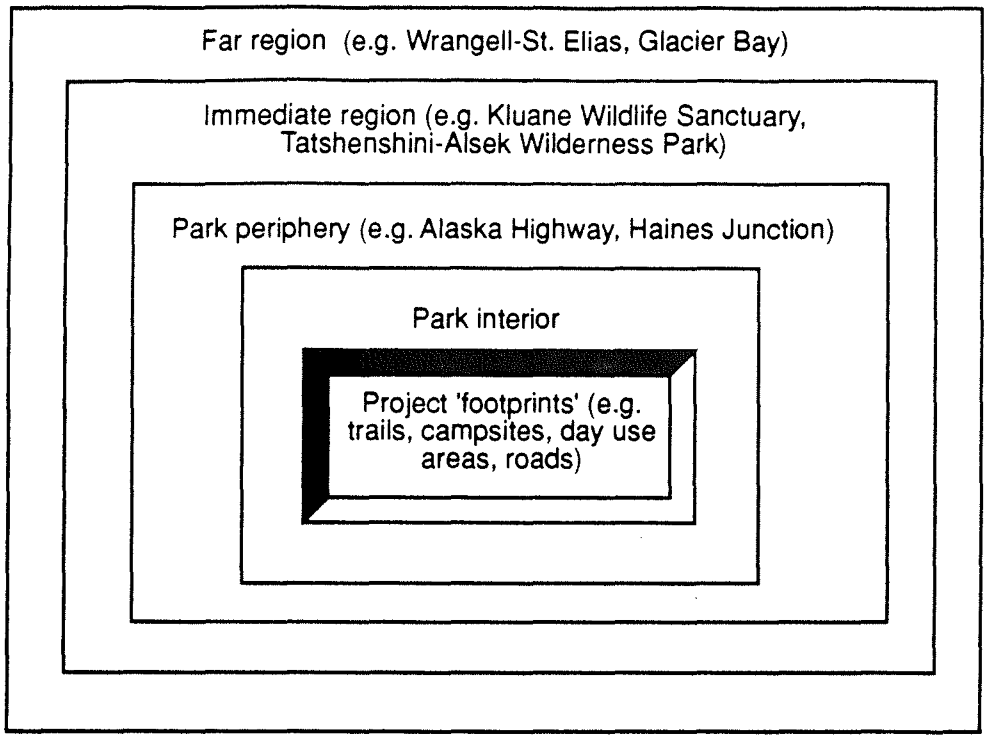


Figure 3: Spatial scales

3.2.3 Zone of influence and disturbance factors

A human caused disturbance may result in a response from an animal that results in reduced fitness or death. The zone of influence (ZOI) and disturbance factor (DF) are attempts to distill many disparate observational based field studies into one single numerical or ranked quantity, albeit crude, for assessment purposes. Further refinement and interpretation will require further data, and since that is unlikely to be available soon, these semi-quantitative values can provide an assessor and reviewer with 'models' of species responses. These concepts, when used alongside information from other sources, may prove useful in adding one more piece of information to the larger assessment 'picture'.

A ZOI is the distance from a disturbance within which a significant effect on an animal may occur. A significant effect can be under-use of habitat, increased stress levels if the animal remains within the zone, or flight from the zone, all which may lead to reduced species viability. The DF gauges the sensitivity of the animal to the disturbance.

The ZOI may be used to show the degree of overlap of the disturbance's effects to wildlife habitat and wildlife sensory acuity. It can then allow a qualitative assessment of the combined effects of many projects, or help identify critical areas where the combination of effects may have significant consequences (e.g. along critical range, within the confines of a narrow river valley). The DF may be used to provide a qualitative assessment of the degree of effect from one or more projects on the VEC. A combination of road and aircraft flights, for example, may result in a combination of a Medium and High disturbance factors, leading the assessor to conclude that the combined effect may be significant.

Each disturbance node represents a simple interpretation of a ZOI before more case specific issues are considered (e.g. species specific response to aircraft and roads). Linkages (synergies) occur if there is a spatial or temporal cause/effect relationship between any two nodes that in some way influences (i.e. negatively stresses) a VEC. The implication of a linkage is that the strength of the effect on the VEC increases.

4.0 Baseline

This section describes in detail the results of each step in the "Baseline" (steps 1 to 4) stage of the CEA framework. Sources of data and information were obtained from an extensive literature review from public and private collections and interviews with park wardens and managers, wildlife experts, aboriginal groups, territorial government staff, environmental groups, rafting operators, and community leaders.

This research is necessary to identify and obtain general background information on issues to assist in the subsequent screening and analysis. The following summarizes what subject material will be examined and how it will be used:

1. Identify VECs ....Recognize which VECs may be relevant and select those for further consideration.
2. Identify projects ....Rank projects according to scenario timeframes to determine when they may occur and likelihood of future projects.
3. Describe resources..................Describe park topography and zones, wildlife VEC habitat in park and region, and human use (resident and tourist) to determine VEC population status, types of human activity, and changes in those activities into the future.

4.1 Identification of valued ecosystem components

Table 1 lists VECs and, for the sake of completeness, Valued Social Components (VSCs) in the park. VECs include wildlife (particularly the large ungulates and carnivores), rare vegetation, unique landforms and various areas with representative value due to unique combinations of landforms, vegetation and wildlife habitat.

The VECs selected for this study were: grizzly bear (Ursus arctos), dall sheep (Ovis dalli), mountain goat (Oreanmos americanus), moose (Alces alces) and golden eagle (Aquila chrysaetos). They were selected on the following basis:

- Review of previous screening reports (CPS, 1990a; CPS, 1991) and the PMP indicated that, in general, most significant effects due to park projects were on a few wildlife species (including the five selected above, in addition to wolf, trumpter swan and some species of fish); and, that any potential adverse effects are insignificant or mitigable.
- The reviewed literature did not reveal other species for which there was nearly as much concern or to which there was much value attached (e.g. being 'charismatic' species, by receiving the attention of most park wildlife research and visitor interest).
- There was a need to limit the CEA analysis for a few VECs to allow some useful analysis to be performed within the time and budget restrictions of the contract. The five species listed were then written into the contract Terms of Reference as the study VECs. This was a compromise between number of VECs and depth of analysis.

Table 1: Valued Ecosystem and Social Components

VECs	Primary location of concern	Rationale
Wildlife		
Dall sheep	Sheep Mtn.	Common, large ungulate, viewing
Golden eagle	Slims Valley	Common, large raptor, viewing
Grizzly bear	Kaskawulsh-Dezadeash-Alsek Valley	Common, predator, COSEWIC "vulnerable"
Moose	Mush-Bates-Alder creek	Common, large ungulate, hunting
Mountain goat	Goat Mtn.	Common, large ungulate, viewing
Trumpeter swan	Dezadeash flats, Fraser Creek fen	Rare, COSEWIC "vulnerable"
Wolf	Unknown	Uncertain presence, important predator
Black bear	Unknown	Present, status unknown
Kokanee salmon	Kathleen, Louise, Sockeye lakes	Rare, interpretation, fishing
Peregrine/Gyrfalcon	Unknown	Rare, COSEWIC "vulnerable"
Rainbow trout	Unknown	Common, fishing
Wolverine	Unknown	Common, COSEWIC "vulnerable"
Vegetation		
Oxytropis viscida	Hoge/Donjek	Rare
Artemisia rupestris	Hoge/Donjek	Rare
Draba spp.	Hoge/Donjek	Rare
Braya purpurascens	Duke River	Rare
Aster yukonensis	Slims Delta	Rare
Puccinellia nutkaensis	Slims Delta	Rare
Taraxacum ceratophorum	Slims Delta	Rare
Carex sabulosa	Alsek-Kaskawulsh	Rare
Other rare vascular plants	Various	Rare
Landform		
Sheep Mtn. loess slopes	Sheep Mountain	Fragile/interpretation
Bullion Creek dunes	Sheep Mountain	Fragile/interpretation
Icefield nunatuks	Logan Nunatak	Fragile/interpretation
Lake Alsek beach ridges	Alsek-Kask	Fragile/interpretation
Glaciers	Icefield ranges	Interpretation, climate change research
Slims River Delta	Slims Valley	Fragile/interpretation
Physiochemical		
Water quality	Alsek River	Canadian Heritage River status
Ecozone		
Fraser Creek fen	Fraser Creek	Fragile
Northern Alpine	Steele Creek	Representation
Montane	Front ranges "Green" area	Representation
North Coast Mountains Natural Region	Entire park	Representation
Coastal Alpine Ecosystem	Goatherd Mtn.	Representation
Moderate Coastal Climate	Lower Alsek	Representation
Valued Social Component		
Human use		
Visitor access	Anywhere	Facilitate human use
Interpretation/visitor education	Front Ranges	Facilitate human use

Table 1: Valued Ecosystem and Social Components (cont.)

Backcountry adventure travel	Backcountry	Recreational use
Tourism facilitation	Anywhere	Economic growth
Aboriginal hunting rights	Hunting areas	First Nation's Land Claims
Local community development	Alaska/Haines Hwy. Corridor	Economic growth
Designations		
Alsek River	Alsek River	Canadian Heritage River status
KNPR	Anywhere	World Heritage Site status
Sheep Mtn./Mt. Wallace	Sheep Mtn./Mt. Wallace	IBP sites (International Biological Programme)
Mt. Archibald/Mt. Decoeli	Mt. Archibald/Mt. Decoeli	IBP sites
Lowell Glacier	Lowell Glacier	IBP sites
Kaskawulsh Glacier	Kaskawulsh Glacier	IBP sites
Park Interpretation "Themes"	Anywhere	KNPR
Archeological sites	Anywhere	KNPR
Jurisdictional		
Aboriginal co-management and hunting	Throughout park	Regional development and conservation
Liasion with YTG, BC and US parks	Anywhere	Regional development and conservation

4.2 Project status

Table 2 lists the existing and proposed projects (total of 38) as described in the 1990 *Park Management Plan*. The list excludes initiatives that largely constitute project mitigation. Projects that were proposed in the Plan and are now known to exist are identified as "existing", even if they did not exist at the time the document was published. This project review is therefore from a 1995 'as is' perspective. Furthermore, it is assumed that the same project priorities exist now as defined in the 1990 PMP and that projects not yet started may still be done in the same time frame.

Table 3 lists all projects within and immediately surrounding the park, listed according to the three scenarios as described in section 3.2.1. There are 54 existing projects (Scenario A), 16 5-year and 9 10-year Scenario B projects, and 8 long-term Scenario C projects (for a total of 87 projects). Scenario B is broken down into 5 and 10 year timeframes to reflect a breakdown used in the PMP. Future scenarios are defined by the assumed start date of a project's operation. Information on projects came from the PMP (current and proposed projects in the park within the next 10 years, shown with a shaded cell under the "PMP" column in the table) and various documents by the Yukon Government, Village of Haines Junction, Champagne-Aishihik Band and other regional private and government organizations (Section 4.4 references many of these sources).

Note that most of the Scenario B projects, which constitute most of the projects proposed in the PMP, are largely upgrades or a continuation of existing projects (e.g. road maintenance). The only new projects that do not directly build on existing facilities or activities are the boat shuttle proposals. Much of the significant difference between Scenario A and B projects is the magnitude and type of visitor use (e.g. vehicle or foot traffic). Scenario B projects are based then on the assumption of visitor growth. Many of the A and B projects will continue to cause the greatest impact (and hence, effect) within the same local area. The nature of project interactions will then depend in part on the change of intensity of use within the area or corridor of the project activities.

Table 2: Park Management Plan projects

Project	Location
Existing	
Manage rafting	Alsek River
Manage rafting campsites	Alsek River
Rafting support (Lowell Lake) with aircraft	Alsek River
Reduce Donjek Valley SPA*	Donjek Valley
Backcountry tripping support with aircraft	Duke/Donjek area
Icefields support with aircraft	Icefield Ranges
Expand Alsek Valley Grizzly Bear Protection Area SPA	Kaskawulsh Valley
Allow snowmobiling	Kathleen Lake
Cottage removals	Kathleen Lake
Motorboat access	Kathleen, Mush Lake
Backcountry day use hiking support with aircraft	Lowell lake
Delete Bates Lake Island and Shaft Creek SPA	Mush-Bates
Backcountry tripping support with aircraft	Onion, Bighorn and Lowell lakes
Expand Sheep Mountain SPA	Slims River Valley
Add archeological site SPA	Airdrop Lake
Proposed	
Mush Lake road maintenance	Alder Creek**
Upgrade Mush Lake (includes campground) Day Use Area	Alder Creek (at end of road)
Build Alsek Pass Road	Alsek Pass
Build Alsek Pass Day Use Area	Alsek Pass (at end of road)
Motorboat shuttle	Bates Lake
Sugden Creek Road (trail) maintenance	Dezadeash River to Sugden Creek
Shuttle to Bear Camp	Dezadeash/Alsek River
Shuttle to Lowell Lake (Jetboat, hovercraft)	Dezadeash/Alsek River
Upgrade Kathleen Lake day use trails	Kathleen Lake
Upgrade Kathleen to Louise Lake portage	Kathleen Lake
Build Alaska Highway pulloffs	Kluane Wildlife Sanctuary
Canoe rentals	Louise, Mush-Bates Lakes
Upgrade Goatherd Mtn. (from Lowell Lake) trail	Lowell Lake, Goatherd Mtn.
Upgrade Mush to Bates lake portage upgrade	Mush-Bates**
Upgrade Mush-Bates trail to Goatherd Mtn.	Mush-Bates
Build Observation Mtn. (from Slims West Day Use area) trail	Slims Valley
Build Sheep Mtn. Sheep Interpretation trail	Slims Valley
Sheep Creek road maintenance	Slims Valley**
Upgrade Kaskawulsh Glacier (from Vulcan Creek) trail	Slims Valley
Upgrade Sheep Creek Day Use Area	Slims Valley
Vulcan Creek Road maintenance	Slims Valley**
Build West Day Use Area	Slims Valley (at end of road)
Upgrade integrated trail system	Throughout park

* "SPA"= Special Preservation Area

** Completed or partially completed

Table 3 Scenario projects

Class	PMP	Projects	Location
Scenario A: Existing			
Activity			
Air travel		Backcountry day use hiking support	Lowell Lake
Air travel		Backcountry tripping support	Duke/Donjek area
Air travel		Backcountry tripping support	Onion, Bighorn or Lowell lakes
Air travel		Flightseeing	Anywhere
Air travel		Icefields support	Icefield Ranges
Air travel		Photo/film support (incl. random helicopter landings)	Anywhere
Air travel		Rafting support (Lowell Lake)	Alsek River
Air travel		Rafting support (return from Turnback Canyon)	Alsek River
Air travel		Research (incl. random helicopter landings)	Anywhere
Air travel		Warden operations	Anywhere
Consumptive		Fishing	Various lakes
Consumptive		Grazing (horse)	YT and KNPR
Consumptive		Hunting: aboriginal subsistence	CA traditional lands
Consumptive		Hunting: legal (regulated by YT)	YT
Consumptive		Hunting: poaching	Anywhere
Consumptive		Land staking for mining	Kluane Wildlife Sanctuary
Consumptive		Trapping	Kluane Wildlife Sanctuary
Consumptive		YT Wolf cull	YT (Aishihik)
Land travel		Backcountry (overnight) Hiking	Designated trails/bushwacking
Land travel		Cross country skiing	Front ranges
Land travel		Frontcountry (day) hiking	Designated trails
Land travel		Horseback riding	Designated trails
Land travel		Mountain Biking	Designated trails
Land travel		Mountaineering (icefields)	Icefield Ranges
Land travel		Ski touring	Icefield Ranges
Land travel		Snowmobiling	Kathleen Lake
Land travel		Horseback riding	Trails
Water travel		Rafting	Tatshenshini River
Water travel		Canoeing	Various lakes/rivers
Water travel		Motorboat access	Kathleen, Mush Lake
Water travel		Rafting	Dezadeash/Alsek Rivers
Water travel		Serpentine Creek Launch (Sugden Creek Road)	Alsek River
Facility			
Buildings		Cottage removals	Kathleen Lake
Buildings		Sheep Mountain VRC	Slims Valley
Campsites		Designated backcountry	Designated sites on trails
Campsites		Icefields	Icefield Ranges
Campsites		Kathleen Lake car camping	Kathleen Lake
Campsites		Rafting campsites	Alsek River
Campsites		Random backcountry	Anywhere
Communities		Burwash Landing growth	YT

Table 3 Scenario projects (cont.)

Communities		Destruction Bay growth	YT
Communities		Haines Junction growth	YT
Linear infrastructure		Alaska/Haines Highway	YT
Mining		Access Roads	Kluane Wildlife Sanctuary
Mining		Gravel pits	Kluane Wildlife Sanctuary
Mining		Hardrock mine pits	Burwash Uplands
Mining		Placer mines	Kluane Wildlife Sanctuary
Zoning			
SPA (zone 1)		Add archeological site	Airdrop Lake
SPA (zone 1)		Delete Bates Lake Island and Shaft Creek	Mush-Bates
SPA (zone 1)		Expand Alsek Valley Grizzly Bear Protection Area	Kaskawulsh Valley
SPA (zone 1)		Expand Sheep Mountain	Slims River Valley
SPA (zone 1)		Reduce Donjek Valley	Donjek Valley
Scenario B: Build-out (5 years)			
Activity			
Consumptive		Forestry	Regional
Water travel		Canoe rentals	Louise, Mush-Bates Lakes
Water travel		Motorboat shuttle	Bates Lake
Water travel		Shuttle to Bear Camp	Dezadeash/Alsek River
Water travel		Shuttle to Lowell Lake (Jetboat, hovercraft)	Dezadeash/Alsek River
Facility			
Buildings		Sheep Mountain VRC relocation	Slims Valley
Day Use Area		Alsek Pass	Alsek Pass (at end of road)
Day Use Area		Mush Lake (includes campground)	Alder Creek (at end of road)
Linear infrastructure		Shakwak project (highway upgrading)	YT
Road		Alaska Highway pulloffs	Kluane Wildlife Sanctuary
Road		Alsek Pass Road	Alsek Pass
Road		Mush Lake road maintenance	Alder Creek
Road		Sugden Creek Road maintenance	Dezadeash River
Trails		Goatherd Mtn. (from Lowell Lake)	Lowell Lake, Goatherd Mtn.
Trails		Mush to Bates lake portage upgrade	Mush-Bates
Trails		Mush-Bates link to Goatherd Mtn.	Mush-Bates
Scenario B: Build-out (10 years)			
Facility			
Day Use Area		Sheep Creek	Slims Valley
Road		Sheep Creek road maintenance	Slims Valley
Road		Vulcan Creek Road maintenance	Slims Valley
Trails		Integrated trail system	Anywhere
Trails		Kaskawulsh Glacier (from Vulcan Creek)	Slims Valley
Trails		Kathleen Lake day use	Kathleen Lake
Trails		Kathleen to Louise Lake portage	Kathleen Lake
Trails		Observation Mtn. (from Slims West Day Use area)	Slims Valley

Table 3 Scenario projects (cont.)

Trails		Sheep Mtn. Sheep Interpretation	Slims Valley
Scenario C: Long-term			
Activity			
Air travel		Helihiking/skiing	Unknown
Facility			
Building		Kaskawulsh loop highway	Slims-Kaskawulsh-Dezadeash
Building		Matatana Resort	Kathleen Lake
Building		Paint Mtn. Tram	Paint Mtn. (Pine Lake)
Building		Slims River Valley West Road	Slims Valley
Building		Vulcan Mtn. tram	Vulcan Mtn.
Linear infrastructure		Foothills Pipeline	Kluane Wildlife Sanctuary
Mining		Wellgreen	Kluane Wildlife Sanctuary

4.3 Resource description

4.3.1 Physical geography and habitat

4.3.1.1 Topography and ecozones

Kluane National Park Reserve has an area of approximately 22,000 km^2, more than twice that of Jasper National Park, the largest park in the Central Rocky Mountain Ecosystem. Total vegetated area in the park is only 18% of this (3963 km^2) (Grey, 1987), an area 60% the size of Banff National Park. The remainder of the park is alpine and icefield, with only a few isolated areas supporting plant or animal life. The St. Elias Mountains in the icefields include the highest mountains in Canada, and are part of the world's largest non-polar icefields.

Glaciation, uplift, flooding caused by surging glaciers on rivers, and large loess deposits are examples of some of the mechanisms of physical change in the park. Some areas in the park, such as the Alsek River valley, have very rich and diverse vegetation due to variable climate and the frequency of disturbances (from glaciers). The resulting park topography is characterized by narrow river valleys amongst numerous mountain ranges, often forested with a continuous cover, with extensive braided river flats and benches. The park contains two major watersheds: the Yukon to the north and the Alsek to the south.

Parks Canada has classified the park's ecoregion as the Northern Coast Mountains Natural Region, which includes a unique confluence of various biomes: boreal forest, arctic and alpine tundra, western cordillera, and grassland (Peepre, 1992; Grey, 1987).

4.3.1.2 Biogeoclimatic zones

The vegetated portion of the park with the greatest habitat potential for wildlife consists of a narrow strip paralleling the Shakwak trench along the eastern edge of the park. The largest contiguous portion of this zone extends south from the Slims River to the B.C. border for approximately 140 km, and is approximately 70 km at its widest extent. Smaller patches of vegetation exist along a few river valleys in the northern reaches of the park.

The vegetated area consists of three biogeoclimatic zones: montane, sub-alpine, and alpine. Each can be roughly (given the highly varied topography in the park) defined by elevation (see Table 4). The montane zone, providing important habitat along the valley bottoms is only 7% or 1540 km^2 of the total park area. Together, the areas covered by the three zones are termed the park 'green zone'. Map 3 approximates the green zone at the 4000 ft (1219 m) contour, half-way into the subalpine.

Table 4: Park biogeoclimatic zones

Biogeoclimatic zone	Elevation	Representative vegetation
montane	<1100 m (3609 ft)	continuous climax white spruce; also with aspen, balsam poplar, willow, alder, bogs, fens, marsh, shrub
sub-alpine	1100-1400 m (4593 ft)	willow, alder
alpine	>1400 m	heath-krumholz

Source: Grey, 1987

4.3.1.3 Critical wildlife habitat

Vegetation mapping in the park has not yet been completed, and ecological land classifications have not been done.[10] Regarding correlation of vegetation to habitat potential and knowledge about wildlife, there is "little specific information on the broader ecological interrelationships between mammals and vegetation, food habits and predator-prey relationships" (Grey, 1987, p. 17).

Nonetheless, certain general areas or 'hotspots' are known to be important areas of wildlife habitat based on observed or suspected range (see Map 4 and Table 5). These areas provide further localized habitat components such as cover, mineral licks, escape terrain, and winter forage and shelter (winter conditions of weather and available forage for example are a significant limiting factor in the park for ungulate populations). The hotspots shown in Map 4 were derived from identifying the most commonly used areas for the VECs as identified in maps and descriptions from various sources (Hoefs, 1973; DPWC, 1977; Harbridge and McIntyre, 1978; Parks Canada, 1978; FPL, 1979; Gray, 1987; KNPR, 1988; DRR, 1989b; Jingfors, 1990; Giroux, 1991; Ray Breneman, pers. comm., Kevin McLaughlin, pers. comm.).

The 'green zone' (as defined in the previous section), based on a coarse estimate of the biogeoclimatic zones, is largely only useful in indicating the area of lower elevational versus higher elevational habitat. Sheep and goat remain at higher elevations in the summer, and descend to lower elevations in the winter. Grizzly bears emerge from alpine and sub-alpine dens, gradually move to lower elevations in the summer, and return to denning areas in the fall. Moose remain in the valley bottoms. Eagle make use of cliff faces at higher elevations.

Vertical seasonal movements may result in occupation of the same areas as humans during visitor use seasons.

[10] Montane vegetation and soils have been mapped on airphotos; the data is being input to a Geographic Information System.

Table 5: Wildlife habitat 'hotspots'

Hotspot	Species
Auriol Range (N. of Kathleen lake)	Dall sheep, Mountain goat
Alder Creek Wetland	Moose
Alsek River valley	Grizzly bear
Archibald Mtn.	Dall sheep, Mountain goat
Burwash Uplands	Dall sheep
Dalton Post	Moose, Grizzly bear
Dezadeash Flats	Moose
Donjek River valley	Dall sheep, Moose, Mountain goat, Grizzly bear, Golden eagle
Duke River valley	Moose, Golden eagle
Goatherd Mtn.	Mountain goat
Mush-Bates Lakes	Moose, Grizzly bear
Sheep Mountain	Dall sheep, Golden eagle, Mountain goat
Slims River valley	Grizzly bear
Sockeye Lake	Moose, Grizzly bear
Vulcan Mtn.	Dall sheep, Mountain goat

4.3.1.4 Park management zones

Parks Canada management zones indicate a valuation of a park's natural features and define degrees of park access. Zones are therefore useful in identifying types of allowed visitor use and valued ecosystem and social components. The five zones (Special Preservation, Wilderness, Natural Environment, Outdoor Recreation and Park Services) are described in Table 6.

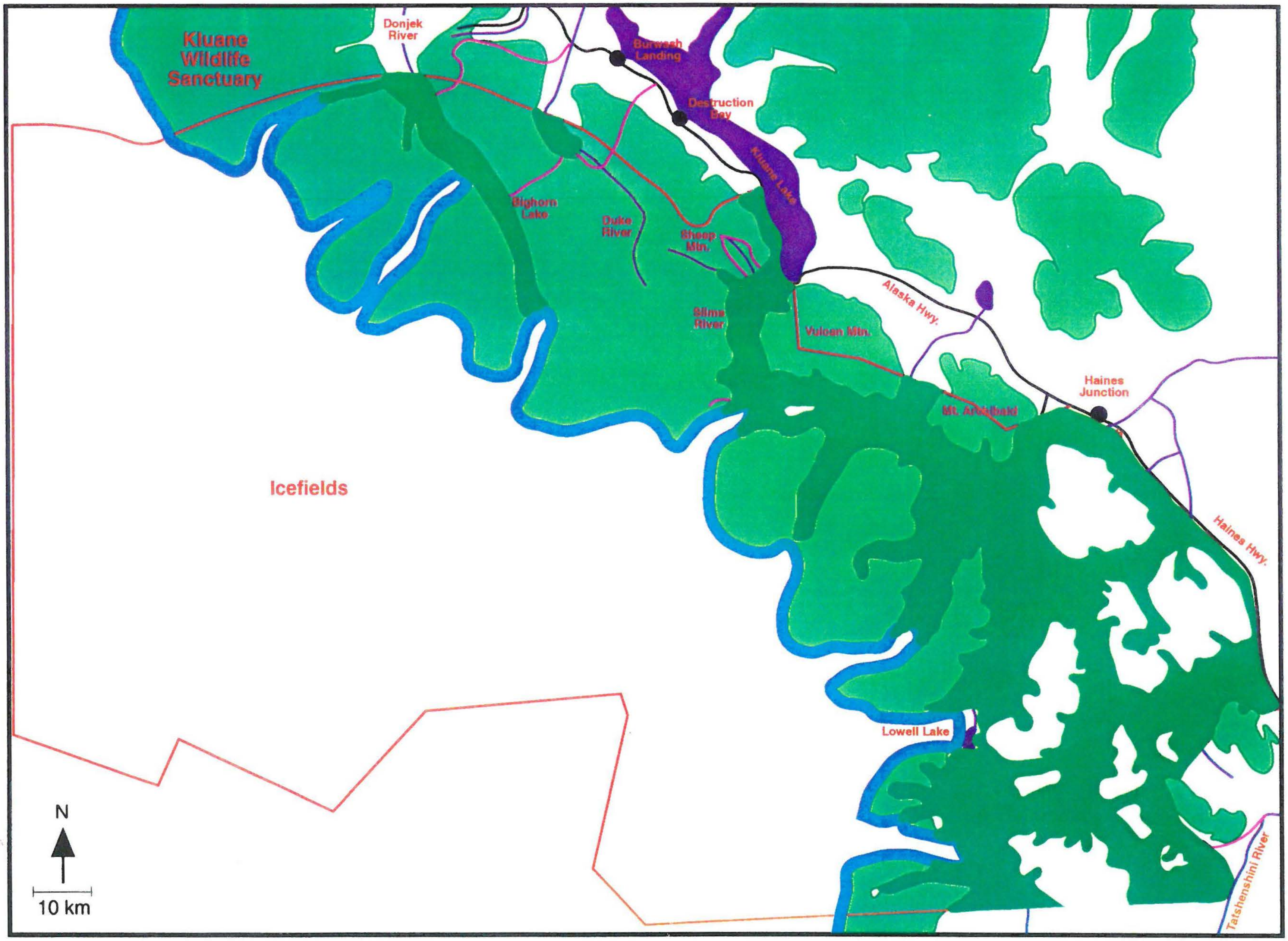
Table 7 lists the 13 Special Preservation Area (SPA) zones. Although they are not especially useful in determining wildlife habitat, as they deal largely with rarity of landforms and plants and representation of natural areas, a review of the SPAs reveals some important park wildlife species and important areas in which they exist.

Table 6: Park management zones in KNPR

Zone	Basis of zonation	Access control	Use/facility control	General area
1. Special Preservation	Unique, rare, endangered or representative features (many based on rare plants)	Controlled/ prohibited, no motorized access	No facilities	12 relatively small zones throughout park (with exception of the large Kaskawulsh-Alsek Grizzly Protection Area)
2. Wilderness	Representation of natural history themes	Limits on number of users, no motorized access, dispersed use	Maintained in a wilderness state, limited to certain activities, primitive facilities	Balance of the park not included as zone 1, 3 or 4
3. Natural Environment	Facilitate basic public access	Non-motorized preferred, use of public transit, private vehicle use if historical precedent	Low density use, minimum facilities	Relatively small (except for narrow but long corridor along Alsek river), typically around front-country day use areas and some access routes into backcountry
4. Outdoor recreation	Accommodate educational and recreational use	Motorized access permitted	Facilities to support use as needed	Small frontcountry areas around day use areas and access roads
5. Park Services	Infrastructure for support of park operations and use	Normal public access	Buildings, roads, etc.	Facilities along Haines highway (outside of park boundaries)

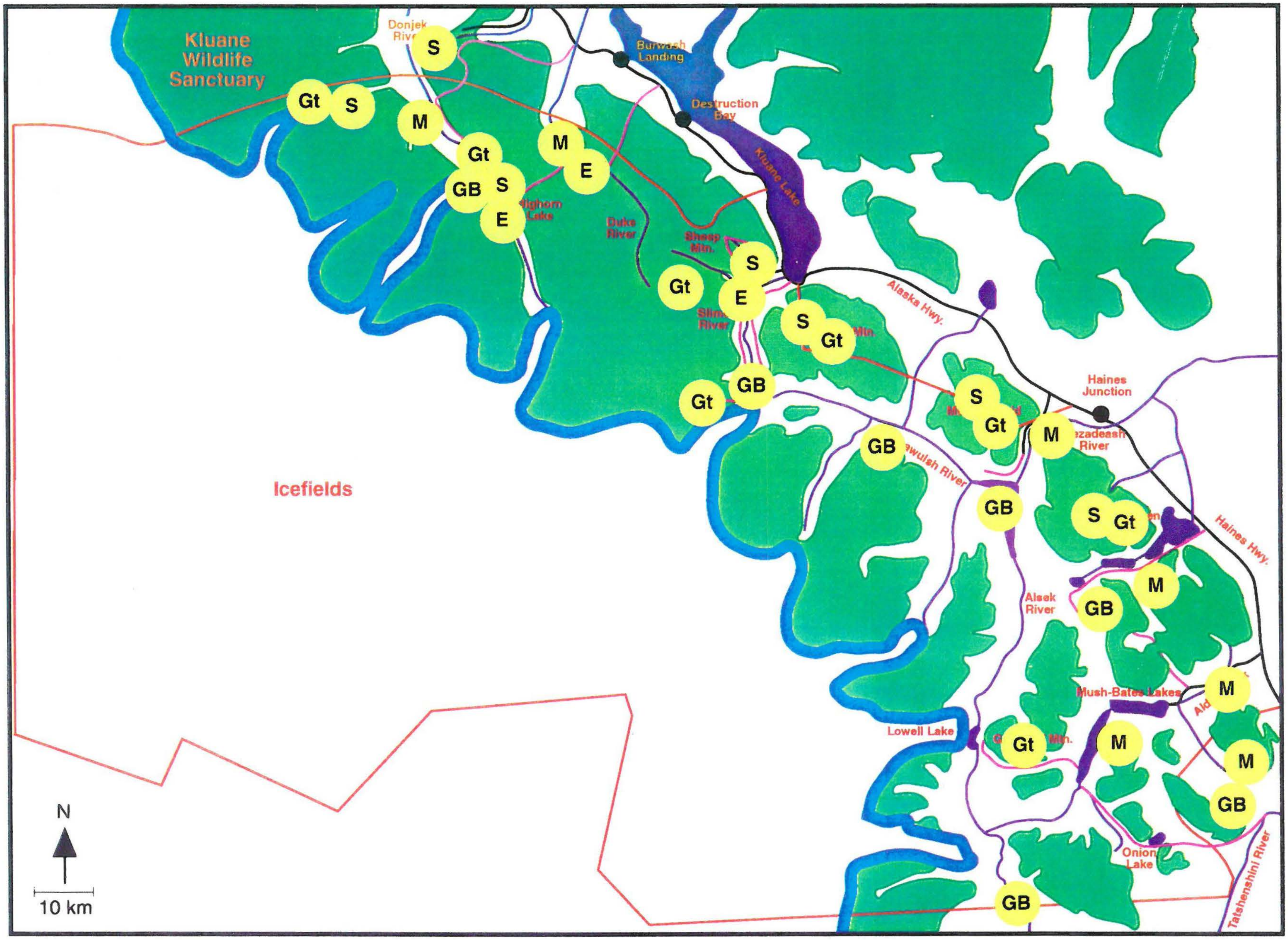
Table 7: Special Protection Areas

Area	Major VECs
Airdrop Lake/Hoodoo Mountain	archeological site
Alsek-Kaskawulsh Grizzly Protection Area	Grizzly bear habitat, dunes, rare plant, alpine/subalpine transition zone
Bullion Creek Dunes	loess slopes
Duke river headwaters	rare plant
Fraser Creek fen	wetland
Goatherd Mountain	coastal alpine, Mountain goat
Logan Nunatak	isolated plants and animals
Lower Alsek River	coastal climate transition zone
Mt Hoge/Donjek Valley	wildlife habitat (Dall sheep, Wolf, Grizzly bear, Mountain goat, Golden eagle, falcon), rare plants
Sheep Mountain	loess, loess based vegetation, Dall sheep
Slims River Delta	rare plants
Sockeye Lake and River	Kokanee salmon
Steele Creek alpine	northern alpine ecosystem, rare plants



Map 3: Park Green Zone

KNPR border
Limit of Icefields
Lakes/Rivers/Creeks
4000 ft (1600m) elevation
Roads
Trails
"Green Zone"



Map 4: Significant wildlife occurrences

- KNPR border
- Limit of Icefields
- Lakes/Rivers/Creeks
- 4000 ft (1600m) elevation
- Roads
- Trails
- Wildlife 'hotspots'/important range

GB = Grizzly Bear, Gt = (Mountain) Goat, S = (Dall) Sheep, M = Moose, E = (Golden) Eagle

4.3.1.5 Surrounding regions

Map 1 showed the regions adjacent to KNPR: Wrangell-St. Elias National Park and Reserve, Tongass National Forest, Glacier National Park and Preserve, Tetlin National Wildlife Refuge, Tatshenshini-Alsek Wilderness Park, Kluane Wildlife Sanctuary and the Yukon Territory's Aishihik region. Except for the Aishihik, they represent together one of the worlds largest contiguous protected areas (Herrero, 1993.); Wrangell-St. Elias, Kluane and Tatshenshini-Alsek form the world's largest UNESCO World Heritage Site.

Map 5 shows possible movement corridors for trans-boundary wildlife (principally grizzly bear and moose, and to a lesser extent dall sheep), based on interpretation of the information used to derive wildlife hotspots. These corridors between KNPR and other areas of potential habitat are important from a cumulative effects point of view, as they represent linkages of wildlife populations that may on a regional basis ameliorate adverse local effects that would have resulted in population declines. Such corridors are few owing to the mountainous nature of the entire region; for example, in the southern border with B.C. where grizzly bear are suspected to move only along the Alsek and Tatshenshini River valleys (Ray Breneman, pers. comm.).

The 5000 km^2 Kluane Wildlife Sanctuary is the most immediate adjoining area to the north and east of KNPR. Under the jurisdiction of the Yukon Territorial Government (YTG), the Sanctuary acts as a buffer along some of the eastern and all of the northern edge of the park. The Sanctuary is considered "a 'seed area' for wildlife" (Jingfors, 1990, p. 20). The 2500 km^2 Aishihik region to the east of Kluane Lake includes large and diverse vegetation communities that provide sheep winter range and areas for moose winter forage and cover (Bastedo and Theberge, 1986).

To the south of KNPR, the Tatshenshini-Alsek Wilderness Park has only recently been examined for habitat quality and wildlife populations (Herrero, 1993; Peepre, 1992). However, preliminary studies done prior to the recent establishment of the park indicate that although understanding of wildlife is poor, some habitat and species could be rated as provincially and nationally significant (Peepre, 1992).

Wrangell St.-Elias National Park Reserve (NPR) is ecologically separated from KNPR by high mountain ranges and icefields, and Glacier Bay NPR is separated by the Tatshenshini-Alsek Wilderness Park. These U.S. parks therefore have limited wildlife linkages with KNPR.

4.3.2 Wildlife populations

4.3.2.1 Overview of status of all species

Kluane supports an unusually high diversity of large mammals for such northern latitudes (north of the 60th parallel) (Peepre, 1992; Yukon Government, 1989a, Slocombe, 1993), a situation that results in many species being at or near the northern or southern limit of their ranges in North America (Grey, 1987). Only a rudimentary knowledge of wildlife status in the park currently exists; data are collected from various research studies, aerial surveys and reported observations from visitors and wardens. No population objectives yet are in place; neither are there adequate data to determine if long-term population trends are declining. A six-year grizzly bear study is currently underway in the park (to be completed in 1997); however, population trends will still be difficult to infer (Robb McCann, pers. comm.).

The warden service has so far no reason to believe that significant adverse fluctuations (causing increasing risk of unrecoverable populations) are occurring in moose, sheep and goats (for which annual surveys are made in certain areas — surveys are not made for grizzly bear or eagle), and no evidence that the long-term viability of any populations are immediately threatened (Kevin McLaughlin, pers. comm.). However, data are limited and this limitation has handicapped interpretation of wildlife trends.

The degree that the wildlife populations are naturally regulated, particularly for hunted and trans-boundary species, may be minimal given the nature of impacts both inside and outside the park (Ray Breneman, pers. comm.). An assumption of natural regulation conditions in the park implies limited intervention by park personnel (except in the case of conflicts affecting human safety) and a 'wait-and-see' position regarding possible intervention.

All the mammals selected for analysis are listed as "common" in the park (on a four point scale from very rare to rare to uncommon/occasional to common) (Grey, 1987). Of the wildlife VECs selected for analysis, the only COSEWIC listed species in the park is grizzly bear, which is rated as "vulnerable" (CNF, 1994).

4.3.2.2 Status of wildlife VECs

This section provides brief overviews of the status of the selected wildlife species. Table 8 provides a detailed listing of relevant available data (with references) for the selected wildlife species. Information is provided for both park and regional populations.

Grizzly bear

The Dezadeash-Kaskawulsh confluence (after which flows the Alsek River) has one of the highest quality areas of bear habitat in the park, the highest bear densities, and the most stable population. Observers on Alsek River rafting trips have reported numerous sightings. Active denning sites exist in the area.

Data on bear populations and supposition on population trends have not been updated since original field work in the Alsek region in the 1970's. Bear populations are currently perceived as "healthy" in the park; but population estimates are suspect as being high (Kevin McLaughlin, pers. comm.; Ray Breneman, pers. comm.). Populations outside the park appear to be stable and possibly growing in the immediate Aishihik region despite concerns of overhunting (especially of females). Population estimates place park numbers between 150 to 400, with numbers based on quality habitat and bear densities suggesting the lower number as more realistic.

Grizzlies have shown regional movements south into the Tatshenshini-Alsek Wilderness Park, east into the Aishihik region and north in the Kluane Wildlife Sanctuary. The park has a significant trans-boundary bear population owing to the large ranges of bears and the relatively narrow topology of the park's green zone. In two recent years of the grizzly bear study, 21% and 36% of the tracked bears made out-of-park movements. These bears are then subject to various sources of direct mortality, principally hunting and management controls.

Dall sheep

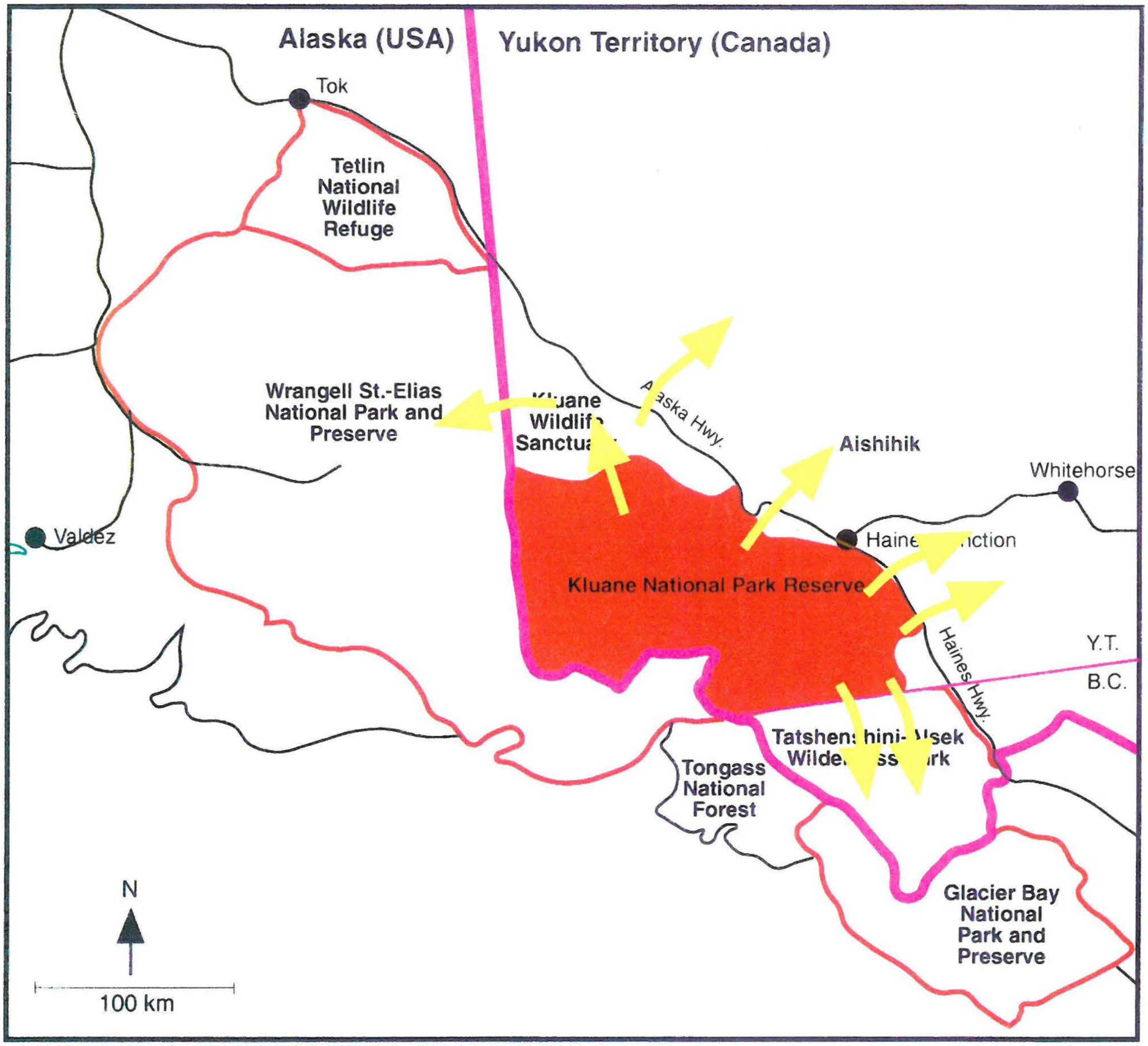
Dall sheep are well distributed throughout the green zone, particularly the northern half, and are the most common large mammal in the park. Populations appear stable and under no significant threat; poaching and harsh winters may be the only current threats to the sheep. Sheep Mountain has the most intensively studied herd, which is also the most popular with park visitors due to relatively easy access.

Hunting outside the park is limited and does not seem to yet affect the large Yukon population. Mining activities in the Burwash Uplands area may have increasing adverse affect on northern park and regional populations.

Park population is estimated at 5400 in 1985 , an increase of 35% since 1973. The Sheep Mountain population is estimated at approximately 350.

Mountain goat

Mountain goat, as with sheep, are well distributed throughout the green zone, but principally in the southern region. Most of the Yukon population is in the park. Hunting of goat is significant outside the park. The most studied population is on Goatherd Mtn. next to Lowell Lake with an



Map 5: Wildlife trans-boundary movement corridors

average population of 107. Total park population is estimated at 700 to 800. Some goat movements have been observed between KNPR and B.C. and Alaska.

Moose

The park offers only marginal moose habitat; the moose are concentrated in the southern park region, especially along Alder Creek, The park population is estimated at 400 to 500, while territorial populations are estimated at 50,000. However, populations in the Aishihik region are declining, perhaps due to grizzly and wolf predation and human hunting.

Moose are the hunted species of choice by Aboriginals, and hunting pressure may increase both inside and outside the park.

Golden eagle

Eagle populations are suspected as high in the park and region. Eagles in the park are concentrated in the Slims River valley, where nests are commonly found. Most eagles are transients in the park.

Table 8: Wildlife status

Grizzly bear

KNPR	
Population sizes	Park total: 300-400 in 1980 (Grey, 1987), 250 (Hoefs, 1973) based on available habitat and Pearson's Alsek densities, 150-400 (Ray Breneman, pers. comm.), 40-400 (Wielgus, R. *et al.* 1992.) based on estimate of minimum viable population size Based on 18% available habitat (3963 km^2) (Grey, 1987) and an average bear density of 25/km^2 (Pearson, 1975), park population is 159 bears (only 39% of the highest aforementioned estimates) Specific areas: Alsek 41-49 (Pearson, 1975), as many as 22 bears seen on a single raft trip on Alsek (John Mikes, pers. comm.), Slims 23 (Grey, 1987)
Densities	highest densities in Grizzly Bear Protection Zone (in Kaskawulsh-Alsek River Valleys), specifically at Dezadeash-Alsek confluence (Peepre, 1991), Alsek densities at 1/(23-27) km^2 or 40/1000km^2 (Pearson, 1975) Slims Valley 1/(15-20) km^2, more dense in Sheep Mtn area, 1/10km^2 in "more productive southern areas" (Leonard, Breneman and Frey, 1988, p. 34)
Distribution and trans-boundary movement	largest known home range of 1341 km^2 for an adult male and 217 km^2 for adult female (McCann, 1994), average ranges: male 287 km^2, females 86 km^2 (Grey, 1987), minimum range of 70 km^2 (RCP, 1982) observed 145 km movement in one period, 20 km/month (Grey, 1987), observed home ranges >297 km^2 (Wielgus, R. *et al.* 1992, p. 14) from 1992 to 1993, 12 collared bears made out of park movements (McCann, 1994); in 1992, 8 out of 22 tagged bears (36%) went outside of park: 5 into Kluane Wildlife Sanctuary and beyond, 2 into the Sanctuary, and 1 directly into Yukon (McCann, 1992), in 1993, 7 out of 33 bears (21%) had movements outside the park (McCann, 1994) Alsek bears known to be shot up to 100 km from park (e.g. Carmacks) (Barney Smith, pers. comm.), Alaskan grizzlies have been observed in Alsek and Tatshenshini River Valleys (Theberge, date unk.)

Table 8: Wildlife status (cont.)

Critical habitat	18% (3963 km^2) of 22,015 km^2 park is useful bear habitat (Wielgus, R. *et al.* 1992, p. 11) habitat in Dezadeash-Alsek floodplains, Klukshu River, Sockeye Lake (Theberge, 1980), Mt. Hoge/Donjek (KNPR, 1988) six active GB denning sites known in Upper Alsek (KNPR, 1988) Haines Hwy. from B.C. border to Dezadeash Lake: critical grizzly bear summer habitat (Synergy West, 1974) Donjek River Valley to Alaska Highway (Synergy West, 1974) Marginal habitat: Slims River Valley (Lopoukhine, 1983), Alsek south of confluence (Douglas, 1974b)
Critical seasons	bears in lower elevations mid-June to mid-September in transition zone between forest and alluvial flats (NWF, 1987)
Movement corridors	narrows between Mush and Bates Lake (Herrero,1983) Alsek and Tatshenshini River valleys (KNPR, 1992b) little trans-boundary movement with Wrangell-St. Elias (KNPR, 1992b)
Mortality sources	from 1992 to 1993, 2 out of 12 collared bears with out of park movements died (McCann, 1994) one trans-boundary mortality in 1992 (McCann, 1992) 13 mortalities in park recorded from 1987-1993 (McCann, 1994) concern about high degree of female and sub-adult kills, and females not being replaced (Barney Smith, pers. comm.) only about 2 road kills on main highways since 1986 (Dan Drummond, pers. comm.), no road kills within park (Ray Breneman, pers. comm.) Mortalities of bears in and around the park (McCann, 1994, Table 4) in 1992/93 (of these, 4 were collared at the time, and 1 previously collared): Harvest 10, Control 9, Natural 4, Defense of life and property 3, Poaching 1 (Total (incl. 1 suspect) 27)
Viability	smallest litter size of all North American grizzly bears (Grey, 1987) and late maturation (Pearson, 1975) park population "appears to be healthy" (Ray Breneman, pers. comm.) "Alsek Valley is home of the largest stable population of grizzly bears in Canada" (KNPR, 1988, p. 19) no significant change expected in grizzly populations for all northern parks (Herrero, 1992)
Region	
Population size	Canada: 21-28,000 (Banci, 1990, p. 48) Yukon: 6-7000 (YRR, 1995) in 1995, down from almost 14,000 in 1975 (Pearson, 1975) 82-139 to immediate east of park (Larsen, and Markel, 1989) B.C.: 6000-12,500 (Hummel, 1990) widely distributed in Greater Kluane area (DRR, 1989b), which has 10% of Canada's grizzly bears (Yukon Government, 1991) most northern B.C. parks have moderate to plentiful densities (Herrero and McCrory, 1987), the Tatshenshini-Alsek Region has high quality habitat with an estimated 100 bears (Peepre, 1992)

Table 8: Wildlife status (cont.)

Mortality sources	in 1990, 12 garbage conditioned bears killed at Haines Junction (bears no longer in town site area after fence installed in 1992) (Herrero, 1992) 1987 peak kills, most due to attractants (garbage, livestock) along Alaska Highway (DRR, 1989b) poaching does occur along boundary (KNPR, 1992b) high likelihood of unreported mortality at placer mines (Banci, 1990)
Viability	population probably increasing in Greater Kluane Region (Yukon Government, 1991) populations very close to habitat capability (Banci, 1990) Tatshenshini area is a central hub connecting bear movements between Glacier Bay NPP, TNF, and WSE with KNPR and KWS: "this would be one of the largest protected park complexes in the world" (Herrero, 1993, p. iii)

Dall sheep

KNPR	
Population sizes	1985 population: 5400 (Hoefs, and Barichello, 1985), 1973 population: 4000 (Grey, 1987) Average area specific populations, 1977-88 (DRR, 1989b): Sheep Mtn 347, Vulcan Mtn. 360, Donjek 543, Auriol 326
Densities	Sheep Mtn. average summer: 1.5 sheep/km^2, winter 17.7/km^2 (Hoefs, 1981)
Range	most common large mammal in park, most in Slims and Donjek drainages (Grey, 1987) Dall sheep at southern limit of range (Lopoukhine, 1983) 165 km^2 range around Sheep Mtn. (Hoefs, 1981)
Critical habitat	Sheep Mountain, Mt. Hoge/Donjek, Steele Creek (KNPR, 1988) in general, almost every major peak with escape terrain in green zone is a candidate for summer habitat, and low elevation south facing wind blown slopes for winter habitat sheep displaced by goats in more southern areas in park (Hoefs, 1980)
Critical seasons	by mid-June all sheep/goats are on alpine (high elevation) summer ranges, start to move down Sep.-Oct., critical winter period Dec. to late May (Hoefs, 1973)
Movement	movement between Vulcan and Sheep Mtns. is possible (Lopoukhine, 1983) in summer, Sheep Mtn. sheep go high into alpine; Vulcan Sheep go to Outpost Mtn. outside of park (Lopoukhine, 1983) winter movements down Congden and Bullion creek (Grey, 1987) much of activity in Donjek may simply be migration from Sheep Mtn. (Grey, 1987)
Mortality sources	Sheep Mtn.: "poaching has been a problem" (CPS, 1990b, p .6) coyotes are main predator (Hoefs, 1981) poaching is not becoming more of a problem, some Aboriginal hunting in park (Dan Drummond, pers. comm.)

Table 8: Wildlife status (cont.)

Viability	availability of winter forage as limiting condition (Hoefs, 1981) sheep and goat winter range is very restricted in park (Grey, 1987) illegal hunting probably common from mining sites (Val Geist, pers. comm.) large sheep populations may be due to predator control outside of park (Hoefs, 1973) Vulcan Mtn. sheep doing better than those on Sheep Mtn. (Val Geist, pers. comm.) Sheep Mtn. population generally stable unless severe perturbations occur such as severe winter conditions (Hoefs, 1981) Current Sheep Mtn. population near stable 20 yr. average of 333 (Skjonsberg, 1993) and above estimated carrying capacity of 200 (Hoefs, 1981), population seen as healthy with a slow increase in size (Skjonsberg, 1993)
Region	
Population size	Yukon: 19,000-22,000 (Hoefs and Barichello, 1985), 20% are Stone Sheep Greater Kluane Area: 50% of Yukon's population (Yukon Government, 1991) areas of high densities (>30/100km^2) exist outside of park (e.g. north of Kluane Lake) (DRR, 1989b) Tatshenshini-Alsek Region: 200 dall sheep (half of BC' s population) (Peepre, 1992)
Mortality sources	current Yukon harvest seen as sustainable and stable (Hoefs and Barichello, 1985) Logan Nunatak: Alaska outfitters poaching dall sheep (KNPR, 1988) some road kill on Alaska Hwy. (Kevin McLaughlin, pers. comm.)
Viability	important mineral lick in Burwash Uplands, north of Wolverine Ck. (Theberge, Fitzsimmons and Stabb, 1986) sheep numerous on Alaska Hwy. in winter (DPWC, 1977) population relatively stable, but 20% fluctuations are possible due to winter mortalities (Hoefs and Barichello, 1985)

Mountain goat

KNPR	
Population sizes	1989 park population: 900 (Yukon Government, 1991), 1980 park population: 700-800 (Grey, 1987) West side Slims River: 50 (Observation Mtn., Bullion Ck.) (Lopoukhine, 1983) Goatherd Mtn.: 1994 population of 142 (highest ever), average is 107 (Skjonsberg, 1994)
Densities	Goatherd Mtn. probably has highest density in park (RCP, 1982) at 3/km^2 (Grey, 1987), followed by Bates Lake-Alsek Range (Theberge, 1980)
Range	fewer goat sightings on cliff face facing Alsek River (Skjonsberg, 1994) goats at north-west limit of range (Lopoukhine, 1983) at Mt. Hoge/Donjek (KNPR, 1988)
Critical habitat	most common on Auriol, Alsek Ranges, Goatherd Mtn. and Duke River region, some on Vulcan Mtn. only isolated populations in northern part of park (Theberge, 1980) Goatherd Mtn. has best goat habitat in park (Grey, 1987) Tatshenshini-Alsek Region mountain goats most common ungulate, about 400, most on northern part of Tatshenshini (Peepre, 1992)

Table 8: Wildlife status (cont.)

Movement	highest by late July, but return to lower elevations by late Aug., average elevation 4500 ft. (Skjonsberg, 1994) less seasonal migration than sheep (RCP, 1982) 100 trans-boundary goats with B.C. and Alaska (Grey, 1987) 100 goats migrate annually across southern and western Yukon borders (Theberge, 1980, p. 75)
Viability	since 1977, fairly steady, gradual increase at Goat Mtn. with one significant drop (Skjonsberg, 1994)
Region	
Population size	Yukon: population 1700, more than half in KNPR and KWS, stable or increasing numbers (YRR, 1995)
Mortality sources	overhunting eliminates most goats in Greater Kluane Region (DRR, 1989b) rarely cross Alaska/Haines Hwy., if do, they may get shot by Aboriginals (Dan Drummond, pers. comm.)

Moose

KNPR	
Population sizes	total park population 400-500, with 4500km^2 of habitat (Grey, 1987) total population: 300-350 (Douglas, 1974a) 24 moose in Dezadeash Lake to Alder Creek area (Hoefs, 1973) 1989: Auriol 178, Duke 109, Donjek 28 (DRR, 1989b) 1994: Auriol (includes Mush-Bates and Alder): 232, 12 yr avg. 206 (Kevin McLaughlin, pers. comm.)
Densities	1 moose/10 sq. mi. (Douglas, 1974a)
Critical habitat	marginal habitat in park (Hoefs, 1973) best moose habitat is Mush Lake-Alder Creek and upper Duke (Grey, 1987) other areas include Dezadeash, Sockeye, Kathleen, Klukshu and Tatshenshini (Theberge, 1980), Burwash Uplands, Donjek Valley (Theberge, Fitzsimmons and Stabb, 1986) East of Dezadeash lake and Klukshu River valley is important moose winter habitat; and in park, Sockeye Lake and Cottonwood Creek (Jingfors, 1990) critical moose winter range at Jarvis River north of Kloo Lake and Donjek floodplain (DPWC, 1977
Critical seasons	rut late Sep. - early Oct. (Theberge, 1980)
Movement	most moose move up into sub-alpine shrub in summer, but some stay low in Mush Lake area (Hoefs, 1973) some movements across Haines Highway to winter range east of KNPR (Grey, 1987) Haines Hwy. is a major corridor in winter and provides access for moose hunting (Jingfors, 1990)
Mortality sources	minimal road kill (maybe 2 a year) (Dan Drummond, pers. comm.)

Table 8: Wildlife status (cont.)

Region	
Population size	Yukon: 50,000 (YRR, 1995) Greater Kluane Region: 5,900 and decreasing (Yukon Government, 1991) Tatshenshini-Alsek Region moose in moderate concentrations (Peepre, 1992)
Mortality sources	along Auriol range and across Haines Hwy. in winter are popular hunting areas (Kevin McLaughlin, pers. comm.)
Viability	natural predation (by bears and wolves) as most significant issue (90% of mortalities) (YRR, 1995) because of low calf/cow ratios, population trends suspected as stable or declining (DRR, 1989b)

Golden eagle

KNPR	
Population sizes	1978 Slims study identified 17 golden eagle nests. Later studies found 86 nests, of which 14 were active (Lopoukhine, 1983, p. 28)
Densities	concentration of breeding eagles rated as high in Slims (Lopoukhine, 1983)
Range	most eagles do not overwinter (some have), and return as early as late March (Lopoukhine, 1983)
Critical habitat	Slims River valley raptor nesting on south face of Sheep Mtn. (DPWC, 1977) common in Slims and Duke (Grey, 1987) a few small known or potential nesting areas in south Burwash area (Theberge, Fitzsimmons and Stabb, 1986)
Critical seasons	nesting/hatching in May (Lopoukhine, 1983)
Viability	raptors have low productivity (Theberge, Fitzsimmons and Stabb, 1986) population may be tied to hare populations (Grey, 1987)
Region	
Population size	"most common cliff-nesting raptor in the Yukon" (DRR, 1989b, p. 103) area northeast of park rated as medium for nest densities, rated high southeast of park (DRR, 1989b) Greater Kluane Region: Golden eagle population among highest recorded in North America (Yukon Government, 1991)

4.4 Human use

Mining, tourism and the Alaska pipeline (if built) will be the major agents of economic growth in the Greater Kluane Region (Yukon Government, 1991). Tourism is currently the regions largest long-term employer (Village of Haines Junction, 1994) with its lucrative business opportunities. First Nations, local communities, private investors, Parks Canada and the Yukon Government are actively supporting or promoting tourism based initiatives. The human population in the Yukon Territory is also growing, thereby increasing local use of the park and territorial resources.

This section reviews visitor trends both in the park and regionally, and reviews changes in resident population and industry. Determination of such trends is important in defining the CEA scenarios, as trends describe visitor and resident growth rates and use patterns which are the driving forces of change in the park and surrounding region (see Table 9 for a summary).

4.4.1 Regional visitors

In 1988, 155,000 to 170,000 visitors (78,000 parties) visited the Greater Kluane Region (DPA Group, 1989, p. ii). Assuming no major involvement by the public sector (i.e. no major new infusion of government funding to support tourism infrastructure), this is expected to grow at a rate of 3% p.a. (DPA Group, p. 8-4). Such growth is predicated on further diversification and growth in the outfitting and visitor service industries. Recreational usage is heavily biased towards low impact activities as demonstrated by the following use ratings (DRR, 1989a, Table 7):

Low .... winter use, bicycling, rafting, hunting, backpacking, boating;

Medium .... trail riding, camping, events;

High .... viewing, museums, photography, visitor centres.

4.4.1.1 Highway traveller

Recreational businesses predominantly cater to the very large proportion of non-destination, highway based traveller (i.e. RVs with retired couples, tour buses) which pass through the region between the contiguous U.S. and Alaska. This market is slowly growing (Catherine Paish, pers. comm.) with a saturated supply of services for the current demand (Duane West, pers. comm.). Such travellers make use of interpretation facilities along the highway (such as the Park's Visitor Reception Centres).

A major thrust of the Yukon Territorial Government and KNPR is to capture some of that 'pass-through' market for longer than a day: an average of 50% of regional visitors do not use park facilities (DPA Group, 1989, p. 2-4). Projects such as the proposed Alsek Pass road are seen as contributing to a critical two-day threshold that will keep visitors overnight in the park or surrounding area.

This has resulted in an emphasis on roadside facilities (DRR, 1989a) along the Alaska and Haines highway corridor, with existing local facilities and communities providing 'development nodes', and Haines Junction as a central 'staging area'. Smaller outlying communities such as Burwash Landing and Destruction Bay offer vehicle servicing, accommodation, guiding, outfitting, hunting, fishing and trapping services. The only further development between these nodes may be two to three new destination lodges along the Haines Highway (DPA Group, 1989) in addition to the existing Burwash Landing Resort and Dalton Trail Lodge.

Many projects by local highway service operators are to facilitate RVs; most operators have no other future plans except for the limited use of boats for fishing and some hiking. Many operators have indicated that they are working at capacity during peak summer months, and that they do not anticipate major growth in the future (DPA Group, 1989).

Table 9: Human use

Driving Force	Impacts	Resources affected	Nature of change	Change
Tourism	Backcountry visitation ("Adventure traveller")	Wildlife (large ungulates and carnivores), sensitive landscapes, rare plants	"Adventure" tourism market expected to slowly increase, particularly rafting on Alsek. Growth partly coupled with average rate of tourism growth in YT	12% p.a. average increase between 1990 and 1994
	Front country visitation ("Highway traveller")	Local wildlife, fish, waterbodies, local camping areas	Slow but steady increase in vehicle supported travellers	Estimated at 3% p.a.
	Hunting	Game species	Four types: 1) non-aboriginal YT residents hunting under quotas, 2) non-residents hunting with local guides, 3) aboriginal subsistence harvesting and 4) poaching	1) controlled through YT Game Management Areas 2) a few local outfitters have long history of using region, no indication of major growth 3) minimal harvest in KNPR so far; may change given land claims settlements 4) poaching suspected as minimal in park
	Fishing	Sport fish	Allowed in all lakes but Sockeye Lake	Probably increasing, especially due to local resident's fishing
Resource Extraction	Mining and mining access roads	Terrain, vegetation, waterbodies, wildlife (poaching and alienation)	Some current activity, some landclaims may be worked, possible large hardrock project in Burwash Uplands	Growth minimal
	Forestry	Vegetation, waterbodies, wildlife	None in park, logging generally limited in region	May be some logging by First Nation's Peoples of spruce beetle infested areas
Land claims	Hunting	Game species	Aboriginals have exercised their right for subsistence harvesting only to a limited extent in park, much more outside park (moose is species of choice)	Unknown implications to future moose and other species harvest in park
	Tourism development	Wildlife (large ungulates and carnivores), sensitive landscapes, rare plants	"Adventure" tourism market expected to slowly increase.	Champagne-Aishihik have rights to 25% of Alsek River rafting licenses. Unknown to what degree they may wish to pursue other ventures.
Local community development	Habitat loss, wildlife alienation, direct mortality (garbage dumps, highway, defense of life and property)	Wildlife	Haines Junction: Dump fenced off now, but new housing development and other projects are expanding	Expected 2.6% p.a. population growth
	River contamination	Water quality of Alsek/Dezadeash River	Level of problem unknown, but Heritage River water quality tests on Alsek reveal no problems yet	Expected 2.6% p.a. population growth

4.4.1.2 Destination traveller

Of much greater potential for growth is the destination market, of which adventure travel is the most significant type, albeit in much smaller numbers than the highway traveller: only 1000 in 1988 (DPA Group, 1989, p. ii). This is expected to increase to 3300 by 1994, predicated on new lodge units and overnight wilderness tour development (DPA Group, 1989, p. 8-6). Such developments would cater to a market split between consumptive activities (38% fishing and 12% hunting) and non-consumptive (26% outdoor tours (especially hiking) and 24% rafting) (DPA Group, 1989, p. 2-7).

Despite the potential for what could be the fastest growing market sector in the Yukon, the tourism industry is "faced with uncertainties in resource use and access which need to be resolved before major growth can take place" (DPA Group, 1989, p. 8-5). Even with KNPR as the only road accessible national park in the Yukon, limited access and interpretation facilities remain as significant constraints to tourism growth.

4.4.1.3 Adventure traveller

Adventure travel has the greatest potential for tourism growth in the Yukon; however, the demand would have to be met by a corresponding increase in outfitting tour operators. Wilderness operators form less than 10% of current destination expenditures (DPA Group, 1989, p. 8-5); less than 1% of visitors who stopped in the region went on a flightseeing or river tour (p. 2-4).

The Yukon government has placed considerable emphasis on adventure travel. However, aforementioned constraints may limit the probability of a high increase in adventure type tourism (Yvonne Harris, pers. comm.). Adventure travel is increasing in adjoining areas: 10-15% in B.C. (DRR, 1989a, p. 28) and 15-20% in Western Canada (DPA Group, 1989, p. ii). Visitation by European travellers has recently increased by 7% (Catherine Paish, pers. comm.). In general, KNPR offers an increasingly attractive travel destination as the number of rugged wilderness areas decreases elsewhere (DRR, 1989a).

4.4.1.4 Residents

Regional residents principally engage in fishing, RV use and tent camping (DPA Group, 1989). Other recreational use is insignificant. Usage by residents is expected to grow at 10% p.a. by the mid-nineties (DPA Group, 1989, p. 8-6).

4.4.2 Park visitors

The projects proposed in Kluane's PMP demonstrate a desire by the park to better facilitate the growing number of visitors in the region and the growing number interested in experiencing what the park has to offer. KNPR is "under pressure to develop its marketing image as one of North America's best wilderness recreation parks" (Herrero, 1992), a pressure perceived to be alleviated through increased visitor access into the park, and efforts by the park to enhance "private sector opportunities" (Duane West, pers. comm.). For example, a 1986 park visitor survey determined that the most popular trip suggestion for the bus tour traveller was a one day boat ride (jet boat or hovercraft) to Lowell Lake; and for the independent highway traveller, a 3 to 4 hour overland tour to Kaskawulsh Glacier.

4.4.2.1 Frontcountry usage

The majority of park visitors remain in the frontcountry along the Alaska/Haines Highway corridor. Use is concentrated at the park Visitor Reception Centres (VRCs) at Sheep River and Haines Junction, and at Kathleen lake, the only car campsite in the park. The Sheep Mountain area, the most road accessible portion of the park, has some of the highest visitor use (KNPR, 1992c). In 1989, the Kathleen lake campsite was used by 9% of park visitors (TECS, 1989).

In 1988, of the approximately 163,000 regional visitors (DPA Group, 1989), 70,000 (43%) (TECS, 1989, p. 13) visited the park. Such visitation has increased nearly 10 fold during the 1980s (Slocombe, 1991). Peak season is June to August; winter use is negligible.

Assuming that change in park visitation parallels the projected 3% p.a. increase in regional tourism, total park visitation would be 86,000 in 1995. Assuming this same rate continues, the park would experience its first doubling of visitation 18 years later in the year 2019.

4.4.2.2 Backcountry usage

Backcountry (overnight) usage, measured in person-days (the number of days spent in the park by a person), increased from 3780 in 1988 to 9245 in 1994 (KNPR, 1994), representing an increase of 145% or more than two fold in 6 years. Assuming that total visitation (largely dictated by the highway traveller) is predominantly one day or less per visitor (thereby allowing an approximate comparison between number of visitors and person-days), then backcountry use in 1995 would be 12% of total park visitation. This rapid rate of growth (averaging 12% p.a. between 1990 and 1994) may be attenuated by various control (i.e. quota) mechanisms (see Table 10). Otherwise, at the current rate, backcountry visitation will experience a doubling of 1995 levels by the year 2002 (at 21,000 person-days).

Figure 4 shows visitation for various groups until the year 2020 based on known growth rates. Figure 5 shows destinations for overnight backcountry registrations in 1994. If backcountry visitation (the destination traveller) is assumed to grow independently of the frontcountry or highway traveller with little crossover, backcountry visitation would eventually become a major portion of park visitation. The graph, by indicating the eventual "takeover" of park visitation by backcountry users, shows only a hypothetical outcome — travel restrictions would probably attenuate this growth before it reached such high levels and result in a more realistic proportion between frontcountry and backcountry users. However, the graph makes clear the point that backcountry trends are increasing significantly.

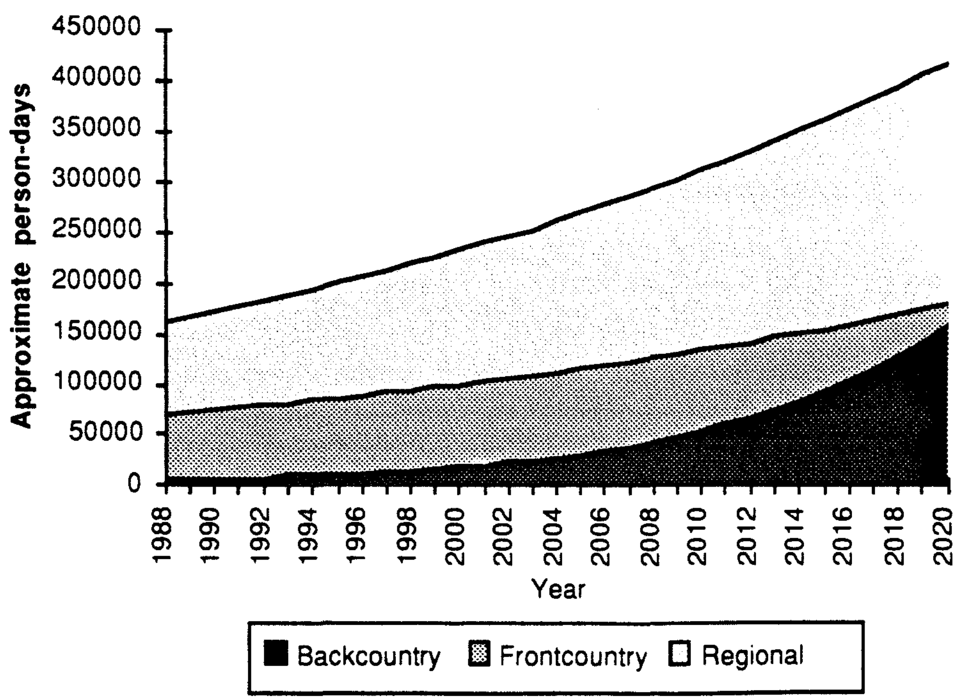


Figure 4: Visitation trends

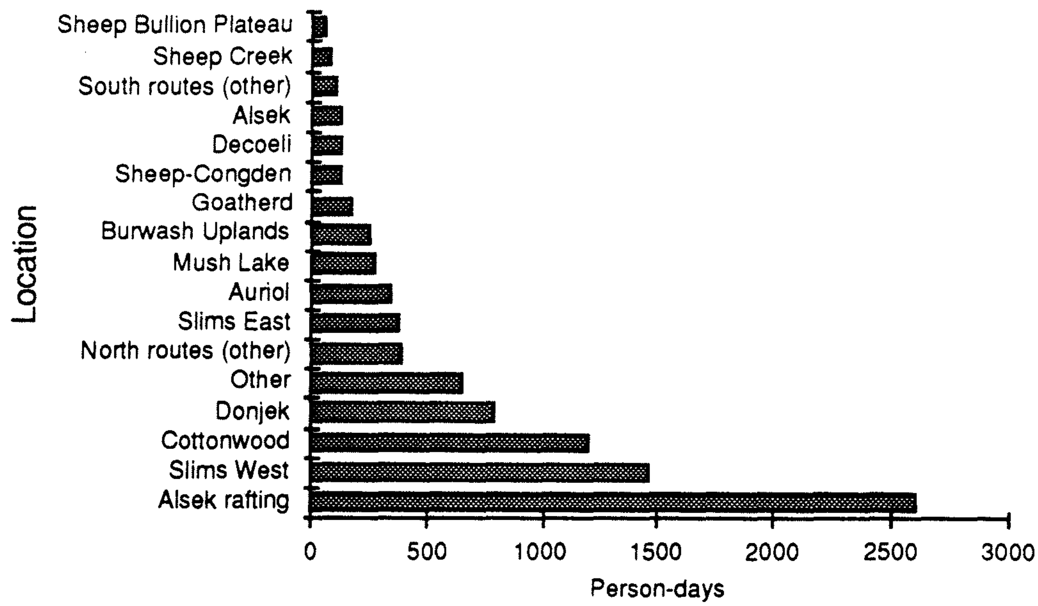


Figure 5: Overnight backcountry visitation, 1994

Table 10: Backcountry use restrictions

Activity	Restrictions	Status of implementation
Aircraft	Outside of icefields, landings restricted to only three lakes: Lowell (both lake and gravel flats), Bighorn and Onion (permits required). Special permits required for use anywhere else on case by case basis (KNPR, 1995a).	In place. Aircraft practice guidelines (e.g. for minimum cruising elevation) in preparation.
Rafting	One rafting party per day, parties limited to 25 individuals for commercial and 15 individuals for private trips (KNPR, 1995b). B.C. parks has put a limit for 1995 at 1993 levels for rafting parties crossing the border; however, this limit may not yet be reached (John Mikes, pers. comm.). Party sizes can range from 18 to 25 people (more for longer trips).	Starting 1995 season.
Backcountry hiking	Quota in Slims River valley based on availability of bearproof food containers. Limit of one night camping for rafting parties along Alsek River in Zone 1 Park Management Zone. Hiking and camping may be restricted in Zone 1 areas (Kevin McLaughlin, pers. comm.).	In place.
Alsek Pass road	No restrictions yet to old mining road, used as 4WD road. If Alsek Pass project proceeds, access is to be controlled (e.g. by use of a gate).	Pending acceptance of Alsek Pass proposal.

Rafting and hiking

Table 11 shows usage patterns in 1993 and 1994 for selected areas and use types in the park. In both years, approximately 70% of usage occurred in the same four areas: rafting along the Alsek River, and hiking along the west shore of the Slims River, along the Cottonwood trail, and random hiking in the Donjek River valley. Usage decreases dramatically for remaining areas. Of particular interest is an average of 16% usage in the northern area of the park, an area with few designated trails and open terrain amenable to dispersed and random hiking along river valleys and passes.

User groups are predominantly non-commercial hikers and commercial rafters (approximately 85% of usage). The majority of camping sites are randomly selected (thus dispersing the effects of camping), although some sites along the Alsek River and in the Donjek area experience repeated use from rafters. Using the measure of person-days as an indicator of intensity of visitor use, rafting on the Alsek is the most intense use of park resources. In 1995, 41 trips[11] have been scheduled on the river (KNPR, 1988, p. 11), approximately the same number of trips in 1994. Only 24% of the trips remain entirely within KNPR along the Alsek's upper 90 km reach (Turnback Canyon is in the Tatshenshini-Alsek Wilderness Park), and 68% of the trips include a return air flight through the park (see Table 12).

Rafting use on the Alsek became significant by 1991, a usage that parallels the 200% increase between 1989 and 1992 of rafting on the nearby Tatshenshini River (tours start at Dalton Post, just outside the park's southern border) (Askey and Williams, 1992, p. iii). Alsek River use could be approximated by visitation to the Goatherd Mountain SPA next to Lowell Lake, which experienced an increase from 163 visitors in 1989 to 2559 visitors in 1993 (KNPR, 1988), an increase of almost 16 fold in 4 years.

Peak use is in July and August, although June to September represents the full season (Askey and Williams, 1992), with August as the peak month. Visitor surveys on the Tatshenshini River (with conditions similar to those on the Alsek) revealed that the most important quality of the river experience was the feeling of undeveloped wilderness, scenery, and wildlife (Askey and Williams, 1992).

Rafting trips on the Alsek, all air supported, typically include a one day layover hike up Goatherd Mountain with camping at Lowell Lake. Camping between Lowell Lake and the Kaskawulsh-Dezadeash river junction is limited to one night per rafting party (Lloyd Freese, pers. comm.).

Aircraft

Aircraft access is often the only reasonable means of gaining access into the park backcountry (Jamie Tate, pers. comm.). Aircraft use in the park includes warden flights, commercial backcountry support (i.e. ferrying of visitors and equipment in support of backcountry trips) and commercial flightseeing trips. Aircraft landings in the park's 'green zone' are generally for: 1) warden flights (e.g. for wildlife surveys, search and rescue, monitoring, backcountry operations support); and 2) to provide trip support if no reasonable overland or water route is available (KNPR, 1987). Permits are required for aircraft landings, not for overflights. In 1994 (see Table 13), 161 fixed wing landings occurred in the park, the single largest use being icefields support (45%) followed by tripping support from Lowell Lake (Staley, 1994).

Of note is the considerable amount of warden flight time that constitutes "much of the aircraft activity" (Staley, 1994) in the park. This activity is widely distributed throughout the park and not scheduled on certain routes as occurs with commercial operators. This makes it difficult to predict effects. However, helicopters often fly at much lower altitudes that fixed wing aircraft (e.g. down to 500 ft or 150 m, Ray Breneman, pers. comm.) while tracking wildlife. Commercial pilots have observed a substantial amount of warden helicopter use in the park (Jamie Tate, pers. comm.).

River rafting on the Alsek is done with air support. Each rafting trip to Lowell Lake involves a lake landing and overflight shuttles between the lake and Haines Junction. Each rafting trip to Turnback Canyon involves shuttles between the canyon and Haines Junction. Float planes typically follow the Alsek River, while wheeled aircraft fly along the Mush/Bates Lake corridor

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[11] The B.C. government has licensed 44 commercial operators to raft B.C.'s Tatshenshini River.

(John Mikes, pers. comm.), although this use pattern can vary (Jamie Tate, pers. comm.). Each rafting party shuttle may take from three flights (for a fixed wing aircraft) to six flights (for float planes) or more, depending on group size, water levels and weather conditions (John Mikes, pers. comm.). Frequency of flights can be up to one per 40 minutes over the Alsek during peak periods (John Mikes, pers. comm.).

There are currently about three active flightseeing operators in the area: two helicopter and one fixed wing (Jamie Tate, pers. comm.), although at one time up to five operators were in business (Juri Peepre, pers. comm.) in the Kluane region offering tours over the park. Flightseeing involves both helicopter and fixed wing aircraft. A few popular routes are commonly followed (e.g. to Lowell Lake, Mt. Logan and Kaskawulsh Glacier); however, "custom" flights may also occur anywhere over the park. Heli-hiking (Juri Peepre, pers. comm.) and heli-skiing (Darryl White, pers. comm.) are also being considered for expansion beyond the designated landing areas, the latter activity being sought by two operators in Haines Junction.

4.4.3 Communities and resident population

Population growth in the 66,000 km^2 Greater Kluane Region is predicted at 2.6% p.a., resulting in a resident population of 1500 by the year 2000 (Yukon Government, 1989a, p. 35) in the three main communities along the Alaska/Haines Highway (Haines Junction, Destruction Bay and Burwash Landing). This does not include almost 775 members (Read and Associates, 1990, p. 32) of the Champagne-Aishihik Band, who along with the Kluane Tribal Council in the northern part of the region, form 45% of the regional population (Village of Haines Junction, 1994, p. 6). This figure has important future implications as native land claim agreements are ratified and implemented.

Most of the non-native population (57%) is in Haines Junction (Yukon Government, 1989a, p. 35), the fastest growing community in the Yukon. The population in 1993 was 780 (Village of Haines Junction, 1994). The community expects an ideal population size of 1000 (Darryl White, pers. comm.). In response to growing tourism demand, Haines Junction plans to expand its services to accommodate more visitors and to upgrade the airstrip. The town also plans to offer other services to encourage more mining activity (HLA Consultants, 1990). The town site also proposes to build two new subdivisions in addition to the new Bear Creek sub-division near the Dezadeash flats.

Most park day visitors, winter users, and boaters are local residents; however, they are a small fraction of the total visitation (DRR, 1990).

4.4.4 Mining

Surrounded by the "largest protected area in the world", tourism represents the only significant existing 'resource base' (Darryl White, pers. comm.) in the region. Mining remains the only other active industry and the industry with the greatest potential for growth. Forestry is negligible, with perhaps some future logging in Spruce Beetle infested forest near Kloo Lake. The Alaska pipeline (also referred to as the 'Foothills' pipeline) may never be built unless significant changes occur in gas markets. It is unknown if the region's remaining hydroelectric potential will be utilized given the recent construction of the Aishihik dam.

The general region, and specifically the Kluane Wildlife Sanctuary, have significant potential for mineral deposits (Yukon Government, 1989a). Active mining, and staked claims, exist along the KNPR boundary in the Sanctuary: placer mining at Wade Creek (Burwash Landing), Edith/Koidern Creek, Jarvis River (Mt. Decoeli) and Dalton Post (along Tatshenshini); quartz and placer claims on the North slopes of Vulcan and Archibald Mountain; and a potential large-scale quartz mine at upper Quill Creek. The Quill Creek mine, referred to as the 'Wellgreen' site, could have significant environmental effects in the Burwash Uplands area (Slocombe, 1991); however, it is unknown when or if ever this project may proceed.

Mining impacts include degradation of riparian and bottomland habitat (Banci, 1990) and increased hunting pressures due to improved road access. Significant loss of critical wildlife habitat in the Burwash Uplands area has occurred (Jingfors, 1990; Yukon Government, 1989a).

Table 11: Registered overnight visitor use

1993			1994		
	Person-days	%	Route	Person-days	%
By route					
Alsek rafting	2373	25.7	Alsek rafting	2616	28.3
Donjek	1736	18.8	Slims West	1476	16.0
Slims West	1355	14.7	Cottonwood	1215	13.1
Cottonwood	1336	14.5	Donjek	801	8.7
Other	649	7.0	Other	653	7.1
Sheep Bullion Plateau	308	3.3	North routes (other)	391	4.2
Slims East	288	3.1	Slims East	379	4.1
Mush Lake	250	2.7	Auriol	353	3.8
Auriol	204	2.2	Mush Lake	280	3.0
Alsek	186	2.0	Burwash Uplands	256	2.8
Burwash Uplands	170	1.8	Goatherd	174	1.9
Decoeli	159	1.7	Sheep-Congden	132	1.4
South routes (other)	128	1.4	Decoeli	130	1.4
Sheep-Congden	112	1.2	Alsek	129	1.4
Goatherd	74	0.8	South routes (other)	107	1.2
Sheep Creek	35	0.4	Sheep Creek	87	0.9
North routes (other)	24	0.3	Sheep Bullion Plateau	66	0.7
Total	*9387*	*100*	*Total*	*9245*	*100*
By user group					
Non-commercial hikers	5743	63.9	Non-commercial hikers	5575	57.0
Commercial rafters	2142	23.9	Commercial rafters	2526	25.8
Commercial hikers	481	5.4	Commercial hikers	916	9.4
Canoeing	269	3.0	Non-commercial rafters	365	3.7
Non-commercial rafters	231	2.6	Canoeing	337	3.4
Commercial horseback	115	1.3	Commercial horseback	70	0.7

Source: KNPR, 1993; Staley, 1994

Table 12: 1994 Alsek Rafting Trips

Destination	Trips	%
Lowell Glacier (KNPR)	10	24
Turnback Canyon (B.C.)	18	44
Dry Bay (Alaska)	13	32
Total	*41*	*100*

Source: Parks Canada, 1994

Table 13: 1994 Aircraft landings

Landing area/activity	# trips
Mountaineering	72
Lowell Lake	44
Research	16
Filming	13
Salvage	8
Bighorn Lake	6
Water surveys	2
Onion Lake	0
Total	*161*

Source: Staley, 1994

4.4.5 Aboriginal peoples

Recent Council of Yukon Indians land claim agreements have potentially important implications for the region and the park. Two Bands are in the immediate park area: the Champagne-Aishihik Band (CAB) to the south and east of the park, and the Kluane Tribal Council to the north of the Slims River valley. Only the Champagne-Aishihik currently have a settlement.

The CAB are targetting tourism in their pursuit of economic growth (Read and Associates, 1990; Yukon Government, 1989a). Specific initiatives in the park include guided horsetrips (for which CAB has exclusive rights) from Dalton Post to Onion Lake and beyond, and horsetrips in the Donjek area. The CAB are proposing to build the Matatana Resort (Read and Associates, 1990) on a 26 km^2 parcel of land, north of Kathleen Lake, that has been given to the CAB under the land claims agreement (this is the only land removed from KNPR as a result of the land claims settlement). This would serve as a central staging area and hotel for visitors. Other proposals include a gondola on Paint Mountain, north of Haines Junction, and a park entry facility at Jarvis Creek (Read and Associates, 1990).

The CAB hold first rights of refusal for trails or roads, motorboat services, vehicle shuttles, retail permits, and Alsek rafting licenses (they receive 25% of available licenses), and the right to establish cabins, camps, caches and trails to support subsistence harvesting, provided the location conforms with Kluane's PMP (Government of Canada, 1994). In general, CAB have rights to pursue actions for subsistence use (their agreement has precedence over the National Parks Act), but the rights to manage and plan the park must be done through Parks Canada under the *Park Management Plan* (Duane West, pers. comm.). Management is practiced through a new co-management Board.

A great deal of uncertainty however surrounds the implications of the land claims agreement to the region and park. There is general agreement that developments will be slowly introduced over a considerable period of time, and that subsistence use may remain minimal at current levels. This uncertainty has resulted in delays in initiatives by non-native investors until the new 'operating rules' are established (Hepple *et al.*, 1982).

4.4.6 Road proliferation

The proliferation of roads around KNPR, most due to mining, and the upgrading of roads from the Alaska/Haines highway corridor into the park, have been identified as one of the most significant regional impacts on wildlife and other park resources (Juri Peepre, pers. comm.; Yvonne Harris, pers. comm.). Road development on mineral claims or for mining exploration are largely unregulated and unlimited in the Yukon (Yukon Government, 1989a; Jingfors, 1990).

Four-wheel-drive vehicle roads are fanning out from the Alaska/Haines highway into the Kluane Wildlife Sanctuary (all directed towards KNPR), principally in the Burwash Uplands, and along the Duke River, Jarvis and Quill Creeks. Existing roads entering the park include low grade access into Alder Creek, Slims Valley west and east, and to Alsek Pass, all proposed for some form of upgrade under the 1990 PMP. The YTG has investigated the development of an access road along Quill Creek to support front and backcountry guided tours (Yukon Tourism, 1995).

4.4.7 Hunting

Game species of primary interest for hunting in the Yukon are moose, sheep and grizzly bear (see Table 14 for a summary) (DRR, 1989a; Yukon Government, 1991). Grizzly bear hunting is economically a significant part of the southern Yukon outfitting industry (Banci, 1990). Sheep hunting is the single largest hunting draw (Hoefs and Barichello, 1985). Moose and caribou hunting is currently minimal due to low regional populations, a situation that has precipitated the YTG wolf cull.

Hunting is prohibited in certain areas: in the Kluane Wildlife Sanctuary, along a no-hunting corridor (for big game) within 1 km of the Alaska Highway from the Slims River to the U.S. border, and no harvesting zones for natives (non-natives may not hunt in KNPR) within KNPR (Bates Lake, entire Slims River valley, and an area between the Auriol range, Alsek River, Goatherd Mtn., Kathleen Lake and the Haines Highway).

The CAB final agreement signed in 1992 provides the CAB with "exclusive rights to harvest, for subsistence, all species of fish and wildlife" (Government of Canada, 1994, p. 6). Native hunting in the park has, since the creation of KNPR, been negligible (Jingfors, 1990). However, hunting may increase in some areas, principally for moose, the game species of choice by aboriginals (Duane West, pers. comm.). Hunting by aboriginals outside the park may be considerable (HLA Consultants, 1990). The CAB will decide on harvest allocation through the park co-management Board (Government of Canada, 1994).

Overhunting of some species is considered a problem in the region, and poaching, to an unknown extent, is suspected to occur in the park (KNPR, 1987). Grizzly bear in particular are suspected of being overharvested (Barney Smith, pers. comm.; Banci, 1990), especially a "severe overharvest" of female grizzlies in bordering game management zones to the park. Fifty bears were killed between 1981 and 1990, but the extent of 'park bears' in this total is unknown (Wielgus, McCann and Bunnell, 1992). Furthermore, "Unreported kills could account for a substantial portion of bear mortality" (DRR, 1989a; Yukon Government, 1991, p. 138).

Table 14: Hunting statistics for principal game species

Species	1987 GKR harvest	1987 Population trends	1995 harvest limits: Zone 7 (SW of park)	1995 harvest limits: Zone 5 (N and NE of park)
Moose	82	Significant decline	Permit	Closed
Sheep	127	Stable	Permit or bag limit of 1*	Bag limit of 1**
Grizzly bear	30	Stable	Bag limit of 1	Bag limit of 1

*depends on sub-zone

** Bag limits: maximum one animal per hunter, no limit on number of hunters

Source: DRR, 1989a; Yukon Government, 1991; YRR, 1995

5.0 Screening

This section describes the steps performed in the second stage of the CEA framework. The screening stage focusses the CEA effort onto only the most significant areas and concerns.

5.1 Effects on environmental components

A case could be made that any project could potentially affect anything. For example, one could argue that a new road could affect hydrology in the area due to eroding embankments, etc. (an immediate and local effect), and that some wildlife would be disturbed (possibly a delayed, longer-term and cumulative effect with other projects). However, it is not the job of this study to point out every possible effect, only the important ones. For example, in the case of the Alsek Pass road, there are only a few animals with range in the area (e.g. it is known that moose use the lower Dezadeash river flats; grizzly bears have been observed on the nearby mountain slopes, and Trumpeter Swans have been observed nesting by the river), and it is doubtful that hydrology would be greatly affected with good construction practice. Nonetheless, there must be an early attempt to understand what is important, a separation of the 'need to know' from the 'nice to know'.

Table 15 lists projects and identifies if a significant effect may result from project operation and maintenance (as opposed to construction) on any of seven chemical and physical 'environmental components' (air, water soil, biota, habitat, terrain and wildlife).[12] The table answers the question: what is producing an effect on what? Each highlighted cell in the table represents the effect of that one project on an environmental component, and does not take into account synergies with other projects (synergies are dealt with in the next framework step; there are too many projects at this stage to allow for a practical examination of synergies, and more importantly, many of the synergies may not be significant). Very localized effects are not considered significant unless use is expected to grow substantially (e.g. horses degrading trails, campers trampling campsite vegetation).

Effects in the table are ranked on a two-point scale of risk assessment that assesses the significance of an effect: it is either trivial or non-trivial.[13] This approach is based on examining the probability that there will be a significant adverse interaction between a project (impact) and an environmental component. The two screening ranks are:

- Trivial effect (i.e. insignificant)— A low probability of occurrence or acceptable magnitude (includes case of no effect). For wildlife, this would imply that the project will not change reproductive capacity of the species or productive capacity of habitat.
- Non-trivial effect (i.e. significant) — A high probability of occurrence or unacceptable magnitude. For wildlife, this would imply that population recovery may never occur or may occur in the long-term.

In the face of limited data, and before more detailed analysis is performed in step 9, the screening remains based on best professional judgement and best available information at the time of screening. Any effects ranking may change later (reflecting an adaptive process) depending on results of further investigation, perhaps for example in a workshop format. Two biological conservation principles assist this and later decision making. The "safe minimum standard of

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[12] The following types of effects are beyond the scope of this report: visual, recreational carrying capacity, social, economic, and historical/archeological.

[13] The earlier the decision is made as to significance of effect, and the larger the scale at which cause-effects are examined, the coarser the rankings should be (i.e. it would be inappropriate at this stage to rank with a four point scale as commonly used in many EIAs: none, low, moderate and high). The effects at this point must only be known as important or not; hence there is no ranking 'in between' the two selected here.

conservation" states that it is prudent, when faced with possible environmental degradation, to "safeguard the resource provided those measures do not impose unacceptable costs on society" (Myers, 1993, p. 79). The "precautionary principle of biodiversity" states that one should apply a cautious and conservative approach when faced with lack of information or the potential for significant effects (Myers, 1993).

In summary, the matrix ranks in Table 15 were determined by the author asking, for each project, the following questions in succession (adopted from Duval and Vonk, 1991). One moves on to the next question if the answer is yes. The "threshold" from non-trivial to trivial (based on the explanation above of what constitutes a non-trivial and trivial effect) occurs if one proceeds beyond question 3.

1. Will project change reproductive capacity or productive capacity of habitat? If no, insignificant effect. (Table value is then ranked as trivial.)
2. Is change in question 1 unacceptable? If no, probably insignificant effect. (Table value is then ranked as trivial.)
3. Are the biological conservation principles being compromised? (e.g. do the effects impose significant societal cost, or; do data gaps make significant the uncertainty of effect's prediction?) If no, insignificant effect. (Table value is then ranked as trivial.)
4. Will recovery of population or habitat occur? If no, very significant effect. (Table value is then ranked as non-trivial.)
5. Is a short-term recovery expected? If no, probably significant effect. (Table value is then ranked as non-trivial.)

The screening step is the last framework step in which all impacts and effects are examined. After this, only the selected VECs and projects (typically as represented by disturbance nodes) will be considered. The screening step focusses the remaining CEA effort, and indicates that in Scenario A most significant effects are on wildlife, thus substantiating the focus for a first CEA in the park on wildlife related issues. This conclusion is similar to that reached in previous screening reports done for the park (Mathers, 1979; CPS, 1990a; CPS, 1991).

Two natural agents of change, fire and the spruce beetle, were not included in the screening. Both may modify the successional stage of the park vegetation and so affect wildlife; however, they are not purposefully man induced and so do not qualify as 'projects'; and, they are of low significance. Fire rarely occurs in the park due to lightning strikes, and only eight human caused fires (due to recreational activity) occurred in a period of 19 years (Hawkes, 1983). Regarding spruce beetle, the park policy of natural regulation is not to interfere, and the recent outbreak is not yet considered a serious threat in the park (Ray Breneman, pers. comm.), although continued infestation may precipitate a response (e.g. logging of infested areas) outside the park (Kevin McLaughlin, pers. comm.).

Table 15: Project environmental effects screening

Impacts (Projects)					Effects						
Type	Class	1990 PMP	Projects	Location	Chemical				Physical		
					Air	Water	Soil	Biota	Habitat	Terrain	Wildlife
PARK (within park boundaries)											
Facility	Road	■	Alsek Pass Road	Alsek Pass						■	■
		■	Sugden Creek Road maintenance	Dezadeash River							■
		■	Sheep Creek road maintenance	Slims Valley							■
		■	Mush Lake road maintenance	Alder Creek							■
		■	Alaska Highway pulloffs	Kluane Wildlife Sanctuary							
		■	Vulcan Creek Road maintenance	Slims Valley							■
			Kaskawulsh loop highway	Slims-Kaskawulsh-Dezadeash	■	■	■	■	■	■	■
			Slims River Valley West Road	Slims Valley		■	■		■	■	■
	Trails	■	Goatherd Mtn. (from Lowell Lake)	Lowell Lake, Goatherd Mtn.							■
		■	Observation Mtn. (from Slims Day Use area)	Slims Valley						■	■
		■	Kaskawulsh Glacier (from Vulcan Creek)	Slims Valley						■	■
		■	Sheep Mtn. Sheep Interpretation	Slims Valley							■
		■	Mush to Bates Lake portage upgrade	Mush-Bates							
		■	Mush-Bates link to Goatherd Mtn.	Mush-Bates							■
		■	Kathleen Lake day use	Kathleen Lake							
		■	Kathleen to Louise Lake portage	Kathleen Lake							
		■	Integrated trail system	Anywhere							■
	Day Use	■	Alsek Pass	Alsek Pass (at end of road)					■	■	■
		■	Mush Lake (includes campground)	Alder Creek (at end of road)					■		■
		■	Sheep Creek	Slims Valley						■	■
	Campsites	■	Rafting campsites	Alsek River							■
			Designated backcountry	Designated sites on trails		■		■	■	■	■
			Random backcountry	Anywhere							■
			Kathleen Lake car camping	Kathleen Lake							
			Icefields	Icefield Ranges							
	Buildings	■	Cottage removals	Kathleen Lake							
			Sheep Mountain VRC	Slims Valley							
			Sheep Mountain VRC relocation	Slims Valley						■	

Table 15: Project environmental effects screening (cont.)

Zoning	SPA (zone 1)		Expand Alsek Grizzly Bear Protection Area	Kaskawulsh Valley							
			Add archeological site	Unknown							
			Delete Bates Lake Island and Shaft Creek	Mush-Bates							
			Reduce Donjek Valley	Donjek Valley							
			Expand Sheep Mountain	Slims River Valley							
Activity	Air travel		Helihiking/skiing	Unknown							
			Flightseeing	Anywhere							
			Research (incl. random helicoper landings)	Anywhere							
			Photo/film support (incl. random landings)	Anywhere							
			Warden operations	Anywhere							
			Rafting support (Lowell Lake)	Alsek River							
			Rafting support (return from Turnback Canyon)	Alsek River							
			Backcountry tripping support	Onion, Bighorn and Lowell Lakes							
			Backcountry tripping support	Duke/Donjek area							
			Backcountry day use hiking support	Lowell Lake							
			Icefields support	Icefield Ranges							
	Water travel		Rafting	Alsek River							
			Shuttle to Bear Camp	Dezadeash/Alsek River							
			Shuttle to Lowell Lake (Jetboat, hovercraft)	Dezadeash/Alsek River							
			Canoe rentals	Louise, Mush-Bates Lakes							
			Canoeing	Various lakes							
			Motorboat access	Kathleen, Mush Lake							
			Motroboat shuttle	Bates Lake							
			Serpentine Creek Launch (Sugden Creek Road)	Alsek River							
	Land travel		Backcountry (overnight) hiking	Designated trails/bushwacking							
			Frontcountry (day) hiking	Designated trails							
			Cross country skiing	Designated trails/anywhere							
			Ski touring	Icefield Ranges							
			Snowmobiling	Kathleen Lake							
			Mountaineering (icefields)	Icefield Ranges							
			Horseback riding	Designated trails							
			Mountain Biking	Designated trails							
	Consumptive		Fishing	Various lakes							
			Hunting: aboriginal subsistence	Hunting zones							
			Hunting: poaching	Anywhere							

REGION (surrounding park)											
Facility	Mining		Access Roads	Kluane Wildlife Sanctuary						■	■
			Hardrock mine pits	Burwash Uplands					■	■	■
			Placer mines	Kluane Wildlife Sanctuary		■				■	■
			Gravel pits	Kluane Wildlife Sanctuary						■	
	Linear infrastructure		Foothills Pipeline	Kluane Wildlife Sanctuary							
			Alaska/Haines Highway	YT							■
			Shakwak project (highway upgrading)	YT							
	Communities		Haines Junction growth	YT		■					■
			Burwash Landing	YT							■
			Destruction Bay	YT							■
	Building		Matatana Resort	Kathleen Lake					■		
			Paint Mtn. Tram	Paint Mtn. (Pine Lake)							
			Vulcan Mtn. tram	Vulcan Mtn.					■		■
Activity	Consumptive		Land staking for mining	Kluane Wildlife Sanctuary							
			YT wolf cull	YT (Aishihik)							■
			Hunting: aboriginal subsistence	CA traditional lands							■
			Hunting: legal (regulated by YT)	YT							■
			Hunting: poaching	Anywhere							■
			Forestry	Kluane Wildlife Sanctuary		■	■		■		
			Trapping	Kluane Wildlife Sanctuary							■
			Grazing (horse)	YT					■		
	Non-consumptive		Rafting (Tatshenshini)	YT/KNPR (Bridge River)							
			Horseback riding	Trails							

"1990 PMP" column ■ = projects listed in 1990 Park Management Plan

"Effects" columns ■ = non-trivial effects (high probability of occurrence or unacceptable magnitude)
(blank) =trivial effect (low probability of occurrence or acceptable magnitude, or no effect)

CA = Champagne-Aishihik
YT = Yukon Territory
SPA = Special Protected Area

5.2 Project synergies

Synergies, or project interactions, are based on examination of interactions between disturbance nodes. Map 6 illustrates disturbances and disturbance nodes in the park and along its boundary. Step 6 in the CEA framework includes a preliminary determination (see Tables 16, 17 and 18) of significant interaction between projects because of spatial overlap (e.g. aircraft landings and trail hiking at Lowell Lake) and/or temporal overlap (e.g. concurrent rafting and aircraft use in the summer months).

The first two tables present information on disturbances and disturbance nodes to assist in the determination of synergies. Table 16 lists 13 nodes identified in and around the park and 12 disturbances to wildlife, and shows the 'intensity' of the activity occurring in the node. The table also shows which species may be affected at that disturbance node. Relationship intensity is rated by frequency of use (frequent or occasional) and use pattern (regular or irregular), attributes of activities that may influence a species' response to disturbances. Ratings for seasonally dependent activities (e.g. hiking) are given for high use seasons.

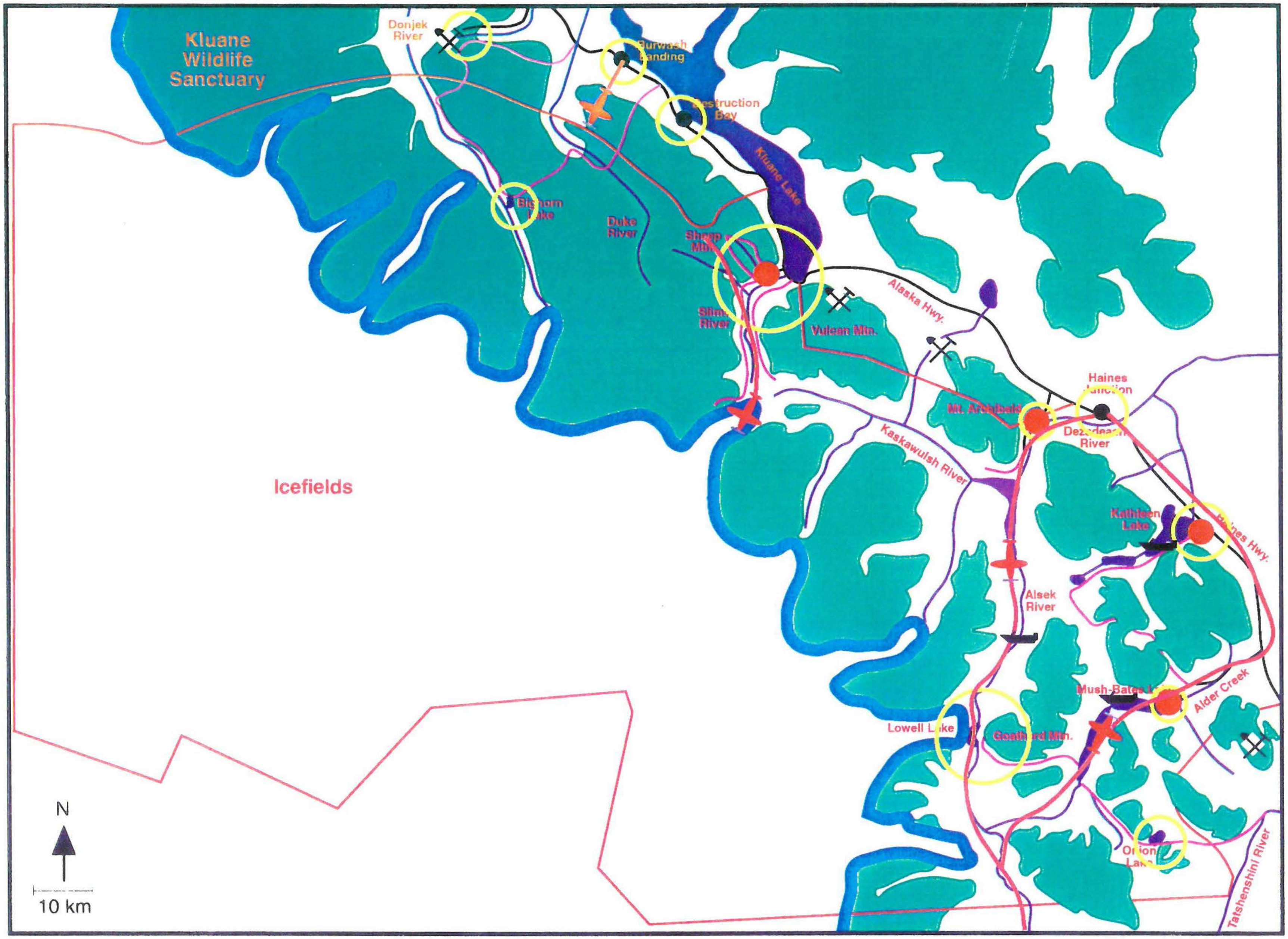
Table 17 identifies peak occurrences of various activities carried out in the park throughout the year, and periods when the wildlife VECs are active in the park. A temporal overlap of disturbance activities and species occurrence may indicate potential for a synergistic effect (e.g. hikers and bears at the Kaskawulsh-Dezadeash gravel flats). Note that some wildlife are annual residents (particularly sheep and goat), while some may be transient (particularly bear and moose) and use the park only part of the year. Wildlife activities also reflect critical months (e.g. lambing, calving, winter range). Human activities are rated according to peak use months.

Table 18 cross-references the disturbance nodes, ranking the strength of the synergistic relationship as weak, moderate or strong. The stronger the synergy, the greater the long-term significance of effects produced by the relationship on wildlife. Ranking decisions reflect relationships as they exist now (i.e. Scenario A conditions). The implications of future changes will be dealt with in step 9, Hypotheses analysis.

In summary, the matrix ranks in Table 18 were determined by the author asking, for each disturbance node, the following questions in succession:

1. Do activities in each node rarely or never occur at same time, and do activities originating in one node (e.g. hikers on trails, aircraft flights) rarely or never continue on to other node? If yes, table value is ranked as weak.
2. Do activities in each node sometimes occur at same time, and do activities originating in one node sometimes continue on to other node? If yes, table value is ranked as moderate.
3. Do activities in each node often occur at same time, and do activities originating in one node often continue on to other node? If yes, table value is ranked as strong.

Table 18 provides a visual 'map' that highlights major and minor interactions. This approach is useful in organizing and presenting complex conditions for review during an environmental assessment. The table reveals for example that significant overlap of activities and wildlife are occurring in the Slims River valley, Alsek River at Lowell Lake and Mush-Bates Lakes.



Map 6: Disturbances

KNPR border
Limit of Icefields
Lakes/Rivers/Creeks
4000 ft (1600m) elevation
Roads
Trails
Daysites
Disturbance Nodes
Mining
Aircraft
Boats/rafts

Table 16: Intensity of disturbances to wildlife at disturbance nodes

Disturbance Nodes	Intensity of disturbance												Wildlife affected				
	Aircraft, landings/takeoffs (P)	Aircraft, overflights (D)	Boating (L)	Day use area (P)	Hiking/camping, backcountry random (D)	Hiking/camping, backcountry trail (L)	Hunting (D)	Mining (P)	Rafting (L)	Roads, off-road (L)	Roads, paved (L)	Townsites (P)	Grizzly bear	Dall sheep	Mountain goat	Moose	Golden eagle
Aishihik region (A)							frequent and regular	occasional and regular		frequent and irregular	frequent and irregular		common			common	
Alaska Highway (L)							occasional and irregular				frequent and irregular	frequent and regular	common			common	
Alsek Pass (P)		frequent and regular	occasional and irregular	occasional and regular		occasional and irregular				occasional and regular			common	common		common	
Alsek-Kaskawulsh River Valleys (L)		frequent and regular	occasional and irregular						frequent and regular				common			common	
Hiking trail network (L)		occasional and irregular			occasional and irregular	frequent and irregular							common			common	
Kathleen Lake (P)			frequent and irregular	frequent and regular		occasional and regular							common			common	
Kluane Wildlife Sanctuary (A)					frequent and irregular	occasional and irregular	occasional and irregular	frequent and regular		frequent and irregular			common	common	common	common	
Lowell Lake/Goatherd Mtn. (P)	frequent and regular	frequent and regular	frequent and regular			frequent and regular			frequent and regular				common		common		
Mush-Bates Lakes/Alder Creek (L)		occasional and irregular	frequent and regular	frequent and irregular		occasional and regular	occasional and irregular			occasional and regular					common	common	
Onion/Bighorn Lake (P)	occasional and irregular	frequent and regular				occasional and irregular							common	common	common	common	
Sheep Mtn. (P)		occasional and irregular		frequent and regular		frequent and regular								common			common
Slims River Valley (L)		occasional and irregular				frequent and regular							common	common	common		common
Townsites (P)	frequent and regular	occasional and irregular		frequent and regular								frequent and irregular	common				

Shapes A = area, D = dispersed, L = linear and P= point

Wildlife affected (hatched) = common occurence of that species at disturbance node

Intensity of disturbance
- (black) = frequent (occurence) and regular (use pattern)
- (dark shading) = frequent and irregular
- (medium shading) = occasional and regular
- (light shading) = occasional and irregular
- ( ) = no action of significance

Table 17: Temporal overlap of disturbances

Activity		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Human	Aircraft landings						■	■	■				
	Aircraft overflights						■	■	■				
	Backcountry hiking/camping						■	■	■				
	Biking						■	■	■				
	Extractive industries						■	■	■				
	Frontcountry day use areas						■	■	■				
	Highway traffic					■	■	■	■	■	■		
	Communities	■	■	■	■	■	■	■	■	■	■	■	■
	Horse riding						■	■	■				
	Hunting								■	■	■		
	Hunting (aboriginal)	■	■	■	■	■	■	■	■	■	■	■	■
	Motorboating						■	■	■	■	■		
	Predator control	■	■	■									■
	Rafting						■	■	■				
	Snowmobiling	■	■	■									■
	Vehicle access roads					■	■	■	■	■			
Wildlife	Grizzly Bear				▨	▨	▨	▨	▨	▨			
	Dall Sheep	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	Mountain Goat	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	Moose	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	Golden Eagle				▨	▨	▨	▨	▨				

■ = peak activity periods
▨ = species active in park

Table 18: Synergies between disturbance nodes

Disturbance nodes	Aishihik region	Alaska Highway	Alsek Pass	Alsek-Kaskawulsh River Valleys	Hiking trail network	Kathleen Lake	Kluane Wildlife Sanctuary	Lowell Lake/Goatherd Mtn.	Mush-Bates Lakes/Alder Creek	Onion/Bighorn Lake	Sheep Mtn.	Slims River Valley	Townsites
Aishihik region		weak	weak	weak	weak	weak	moderate	weak	moderate	moderate	weak	weak	strong
Alaska Highway			strong	moderate	weak	moderate	moderate	weak	moderate		moderate	weak	strong
Alsek Pass				strong	moderate	weak	moderate	weak	weak	weak	weak	weak	weak
Alsek-Kaskawulsh River Valleys					moderate	weak	moderate	strong	weak	weak	weak	moderate	weak
Hiking trail network						moderate	moderate	strong	moderate	weak	strong	strong	
Kathleen Lake							weak	weak	weak	weak	weak	weak	moderate
Kluane Wildlife Sanctuary								weak	moderate	moderate	moderate	moderate	moderate
Lowell Lake/Goatherd Mtn.									moderate	weak	weak	weak	weak
Mush-Bates Lakes/Alder Creek										weak	weak	weak	moderate
Onion/Bighorn Lake											weak	weak	weak
Sheep Mtn.												strong	weak
Slims River Valley													weak
Townsites													

= weak synergy
= moderate synergy
= strong synergy

5.3 Effects on wildlife

Step 7 is the last and most detailed screening before the hypotheses analysis stage of the CEA framework. A screening is done for each wildlife VEC (see Table 19), as many specific effects can only be properly dealt with at a species specific level. As the cause/effect relationship is now between a specific impact and VEC, the screening can be more specific than the more general screening in step 5. Hence, step 7 uses four instead of two ranking levels as follows:

- None — no effect;
- Low — low probability of occurrence or magnitude of effect (on reproductive capacity of species or productive capacity of habitat) probably acceptable;
- Moderate — possibly significant effect;
- High — high probability of occurrence or magnitude of effect probably unacceptable (e.g. population recovery may never occur or may occur in the long-term).

The projects are short-listed from the previous screening as ones which have the potential for causing significant effects on wildlife (i.e. projects ranked in Table 15 as having non-trivial effects, and frequent and regular use). The strength of synergies between disturbance nodes (Table 18) was considered as another attribute (e.g. indicative of frequency of activity).

Table 19 correlates impacts with six effects types that, if significant, may result or will result in adverse effects on wildlife. The effects types are:

- Loss of habitat: changes due to habitat loss and alteration;
- Habitat fragmentation: separation of quality habitat into smaller patches;
- Alienation of habitat: increased stress, flight, and range abandonment due to sensorial disturbance;
- Obstruction to movement: physical objects or human activity that may result in reduction of animal movements between habitats;
- Direct mortality: death due to vehicle collision, defense of life and property, poaching, legal hunting, and aboriginal subsistence harvesting;
- Removals: management removal and/or destruction of animal by park wardens due to human safety concerns.

Finally, an overall significance is provided for each project, indicating the suspected contribution of that project to total cumulative effects (from all projects) on that species.

Table 19: Effects on wildlife

Grizzly bear

Impacts: Scenario	Project	Effects: Habitat loss	Fragmentation	Alienation	Obstruction	Mortality	Removals	Overall
PARK (within park boundaries)								
Current	Backcounty camping	low		moderate	low	high	moderate	moderate
	Backcountry hiking			moderate		moderate	moderate	moderate
	Flightseeing			high				high
	Warden survey flights			moderate				moderate
	Aircraft tripping support/Lowell Lake			high				high
	Aircraft tripping support/Turnback			moderate				moderate
	Aircraft tripping support/Onion, Bighorn, Duke			moderate				moderate
	Rafting campsites	low		moderate		high	moderate	moderate
	Snowmobiling			low				moderate
	Horseback riding			moderate		moderate	moderate	moderate
	Mountain Biking			low		moderate	moderate	moderate
	Hunting: aboriginal subsistence					high		moderate
	Hunting: poaching					moderate		moderate
Build-out	Alsek Pass/Sugden Creek Road	moderate	moderate	high	moderate	moderate	moderate	high
	Slims Valley Roads/Day Use	low	moderate	high	moderate	high	moderate	high
	Sheep Mtn. Sheep Interpretation							
	Mush Lake Road/Day Use	low	low	moderate	low	moderate	moderate	moderate
	Goatherd Mtn. Trail			low		moderate	moderate	moderate
	Slims Valley Trails			moderate	moderate	high	moderate	moderate
	Shuttle to Bear Camp			high		moderate	moderate	moderate
	Shuttle to Lowell Lake (Jetboat, hovercraft)			high				high
	Motorboat use			moderate				moderate
Long-term	Helihiking			high				high
REGION (surrounding park)								
Current	Mining roads	low	moderate	moderate	low	high		moderate
	Mining sites	moderate	moderate	high	moderate	moderate	moderate	moderate
	Alaska/Haines Highway	low	low	high	moderate	moderate	low	moderate
	Haines Junction	high	moderate	high	moderate	high	moderate	moderate
	Other communities	low	low	moderate	low	high	moderate	moderate
	YT Wolf cull					moderate		
	Hunting: aboriginal subsistence					low		low
	Hunting: legal (regulated by YT)					high		high
	Hunting: poaching					high		high
	Forestry	low	low	low	low	low	low	low
	Trapping							
	Grazing (horse)	low	low	low	moderate	low	low	low
Long-term	Matatana Lodge	low	low	moderate	low	moderate	moderate	moderate

[black] = high
[dark shading] = moderate
[light shading] = low
( ) = none
\+ = positive effect

Table 19: Effects on wildlife (cont.)

Dall sheep

Impacts		Effects						
Scenario	**Project**	**Habitat loss**	**Fragmentation**	**Alienation**	**Obstruction**	**Mortality**	**Removals**	**Overall**
PARK (within park boundaries)								
Current	Backcounty camping			light shade				light shade
	Backcountry hiking	light shade		dark shade				dark shade
	Flightseeing			black				black
	Warden survey flights			light shade				light shade
	Aircraft tripping support/Lowell Lake			dark shade				dark shade
	Aircraft tripping support/Turnback			dark shade				dark shade
	Aircraft tripping support/Onion, Bighorn, Duke			dark shade				dark shade
	Rafting campsites							
	Snowmobiling			light shade				light shade
	Horseback riding							
	Mountain Biking							
	Hunting: aboriginal subsistence					light shade		light shade
	Hunting: poaching					dark shade		dark shade
Build-out	Alsek Pass/Sugden Creek Road			light shade				light shade
	Slims Valley Roads/Day Use	light shade		dark shade	dark shade			dark shade
	Sheep Mtn. Sheep Interpretation			black				black
	Mush Lake Road/Day Use							
	Goatherd Mtn. Trail							
	Slims Valley Trails			dark shade				dark shade
	Shuttle to Bear Camp							
	Shuttle to Lowell Lake (Jetboat, hovercraft)							
Long-term	Helihiking			black				black
REGION (surrounding park)								
Current	Motorboat use							
	Mining roads	light shade	light shade	dark shade	light shade	dark shade		dark shade
	Mining sites	dark shade	light shade	dark shade	light shade	black		dark shade
	Alaska/Haines Highway				dark shade	dark shade		dark shade
	Haines Junction							
	Other communities							
	YT Wolf cull					+		
	Hunting: aboriginal subsistence					light shade		light shade
	Hunting: legal (regulated by YT)					black		dark shade
	Hunting: poaching					black		dark shade
	Forestry							
	Trapping							
	Grazing (horse)							
Long-term	Matatana Lodge			light shade		light shade		light shade

Table 19: Effects on wildlife (cont.)

Mountain goat

Impacts		Effects						
Scenario	Project	Habitat loss	Fragmentation	Alienation	Obstruction	Mortality	Removals	Overall
PARK (within park boundaries)								
Current	Backcounty camping							
	Backcountry hiking							
	Flightseeing							
	Warden survey flights							
	Aircraft tripping support/Lowell Lake							
	Aircraft tripping support/Turnback							
	Aircraft tripping support/Onion, Bighorn, Duke							
	Rafting campsites							
	Snowmobiling							
	Horseback riding							
	Mountain Biking							
	Hunting: aboriginal subsistence							
	Hunting: poaching							
Build-out	Alsek Pass/Sugden Creek Road							
	Slims Valley Roads/Day Use							
	Sheep Mtn. Sheep Interpretation							
	Mush Lake Road/Day Use							
	Goatherd Mtn. Trail							
	Slims Valley Trails							
	Shuttle to Bear Camp							
	Shuttle to Lowell Lake (Jetboat, hovercraft)							
	Motorboat use							
Long-term	Helihiking							
REGION (surrounding park)								
Current	Mining roads							
	Mining sites							
	Alaska/Haines Highway							
	Haines Junction							
	Other communities							
	YT Wolf cull					+		
	Hunting: aboriginal subsistence							
	Hunting: legal (regulated by YT)							
	Hunting: poaching							
	Forestry							
	Trapping							
	Grazing (horse)							
Long-term	Matatana Lodge							

Table 19: Effects on wildlife (cont.)

Moose

Impacts		Effects						
Scenario	**Project**	**Habitat loss**	**Fragmentation**	**Alienation**	**Obstruction**	**Mortality**	**Removals**	**Overall**
PARK (within park boundaries)								
Current	Backcounty camping							
	Backcountry hiking							
	Flightseeing							
	Warden survey flights							
	Aircraft tripping support/Lowell Lake							
	Aircraft tripping support/Turnback							
	Aircraft tripping support/Onion, Bighorn, Duke							
	Rafting campsites							
	Snowmobiling							
	Horseback riding							
	Mountain Biking							
	Hunting: aboriginal subsistence							
	Hunting: poaching							
Build-out	Alsek Pass/Sugden Creek Road							
	Slims Valley Roads/Day Use							
	Sheep Mtn. Sheep Interpretation							
	Mush Lake Road/Day Use							
	Goatherd Mtn. Trail							
	Slims Valley Trails							
	Shuttle to Bear Camp							
	Shuttle to Lowell Lake (Jetboat, hovercraft)							
	Motorboat use							
Long-term	Helihiking							
REGION (surrounding park)								
Current	Mining roads							
	Mining sites							
	Alaska/Haines Highway							
	Haines Junction							
	Other communities							
	YT Wolf cull					+		
	Hunting: aboriginal subsistence							
	Hunting: legal (regulated by YT)							
	Hunting: poaching							
	Forestry							
	Trapping							
	Grazing (horse)							
Long-term	Matatana Lodge							

Table 19: Effects on wildlife (cont.)

Golden eagle

Impacts		Effects						
Scenario	Project	Habitat loss	Fragmentation	Alienation	Obstruction	Mortality	Removals	Overall
PARK (within park boundaries)								
Current	Backcounty camping							
	Backcountry hiking							
	Flightseeing							
	Warden survey flights							
	Aircraft tripping support/Lowell Lake							
	Aircraft tripping support/Turnback							
	Aircraft tripping support/Onion, Bighorn, Duke							
	Rafting campsites							
	Snowmobiling							
	Horseback riding							
	Mountain Biking							
	Hunting: aboriginal subsistence							
	Hunting: poaching							
Build-out	Alsek Pass/Sugden Creek Road							
	Slims Valley Roads/Day Use							
	Sheep Mtn. Sheep Interpretation							
	Mush Lake Road/Day Use							
	Goatherd Mtn. Trail							
	Slims Valley Trails							
	Shuttle to Bear Camp							
	Shuttle to Lowell Lake (Jetboat, hovercraft)							
	Motorboat use							
Long-term	Helihiking							
REGION (surrounding park)								
Current	Mining roads							
	Mining sites							
	Alaska/Haines Highway							
	Haines Junction							
	Other communities							
	YT Wolf cull							
	Hunting: aboriginal subsistence							
	Hunting: legal (regulated by YT)							
	Hunting: poaching							
	Forestry							
	Trapping							
	Grazing (horse)							
Long-term	Matatana Lodge							

6.0 Analysis

This section, steps 8 and 9 of the CEA framework, define and analyze the impact hypotheses. The analysis depends on four fundamental 'inputs': 1) knowledge of current and proposed impacts (projects); 2) knowledge of status of wildlife VECs (including population trends) and their habitat; 3) the nature of wildlife response to human disturbances; and 4) the rate and direction of change of human use in the park and region. These inputs provide the information necessary to allow the (cumulative) assessment in the hypotheses of current conditions affecting VECs and the prediction of effects on VECs from many projects. The assessor's ability to confidently make an evaluation of effects will in part be based on the availability and usefulness of information describing these inputs. All four inputs involve varying degrees of uncertainty: any can change unpredictably in the future given changing human use and natural conditions.

The assessment process must rely on subjective evaluation, risk assessment, and fundamental ecological principles (discussed later) to compensate for information deficiencies and uncertainties in park and regional project projections. It is therefore incumbent on the assessor to collect and evaluate all relevant information that may have bearing on the assessment, after screening out trivial issues, so as to be best prepared to 'weigh the evidence' during the hypotheses analysis (described in detail in Section 6.4).

Section 6, in summary, includes the following:

- Definition of hypotheses that will be analyzed.
- Summary of scenarios. This establishes the most important human use trends.
- A discussion of wildlife response to disturbances. This establishes the fundamental knowledge, assumptions and models (e.g. zones of disturbance) on which responses will be dealt with in the hypotheses analysis.
- Evaluation of hypotheses through the discussion and weighing of evidence.

6.1 Hypotheses formulation

Step eight introduces the hypotheses which provide the context for further analytical work. Use of hypotheses is critical to the CEA framework: it defines the 'lines of inquiry' which will be followed, thereby routing the research in appropriate directions. These directions reflect the focussing work accomplished so far regarding significant areas of concern and cause-effect relationships.

Selection of hypotheses was based on a qualitative review of results from the wildlife effects screening (Table 19).[14] The selection was based on examination, for each species, of where the most significant effects where (i.e. matrix ranking of high). Review of the tables revealed a "picture" of how the animal was being affected by human activity from which trends could be discerned. The results of this review are then summarized in Table 20 which lists 13 hypotheses. Table 20 also outlines information requirements, and assesses quality of data (poor, fair or good) to determine if adequate information or theory was available to allow a reasonable chance of meaningful analysis.

In summary, the hypotheses were determined by:

1. Determining trends of significant effects, for each VEC, by reviewing occurrences of "high" values in the wildlife effects table (Table 19);

---

[14] Qualitative implies here that no further ranking or totalling of values was done. It is perhaps at this point that, given the complexity of the interactions amongst VECs and human activities, attempts at ranking to "weed out" the most instructive hypotheses may not be possible or reasonable.

2. Establishing what the specific impact types and supposed effects are for the strongest (i.e. most common and significant) trends; and
3. Summarizing the results in Table 20.

The hypotheses are grouped to ensure the review of increasingly broader issues, thus ensuring a 'cumulative effects' approach by successively examining more interactions. Each of the first eight hypotheses are specific to one species and one area in the park. Three of these are for grizzly bear, two for dall sheep, and one each for mountain goat, moose and golden eagle. The next four hypotheses consider effects on all wildlife VECs from a specific impact. The last hypothesis considers the effects of all impacts on all wildlife VECs.

6.2 Scenario summaries

6.2.1 Scenario A: Existing

Scenario A is characterized by a small but steady growth in regional tourist visitation, continuing emphasis on front country use by the majority of park visitors, and significant backcountry use in a few areas within the park (Slims, Alsek and Donjek River valleys). Backcountry use focusses on rafting on the Alsek, hiking along the Slims River, and random hiking in the northern reaches of the park. Aircraft support for backcountry trips is also localized to a few areas, with perhaps numerous overflights for flightseeing and icefields support. Access into the park remains limited for many travellers except those willing to pursue 'adventure' type travel conditions. Such use has grown significantly over the last few years, especially rafting.

With little change in resource extraction or hunting patterns (except for moose in the Aishihik region), the local economies and population will also grow slowly, but with no significant impact on the park. Local businesses continue to cater largely to the highway traveller market. Mining remains an important but small part of the regional economy. Aboriginal hunting remains insignificant.

6.2.2 Scenario B: Build-out

Scenario B is characterized by significant attempts to increase visitor access into the park through the upgrading or building of new roads and trails, building of day use areas, and the licensing of new commercial activities for land and water based access. Entry points follow routes already established in Scenario A; there is no new access into previously 'undisturbed' territory.

These changes will increase both overnight and day use visitation. Implementation of backcountry registration and commercial licensing (for rafting, aircraft landings, hiking and guiding) and adherence to park guidelines may slow down the rapid growth in visitation, and therefore the effects of such growth. The exceptions to this are day users and the highway traveller who visits new or upgraded day use areas and makes short day-trips, perhaps by mechanized craft, into areas of the park previously not so readily accessible.

More highway based facilities may be built to cater to the growing highway traveller market. There will probably be no significant change in mining, forestry and pipeline related activities. Road access outside the park may threaten regional wildlife populations through increased legal and illegal hunting.

The Champagne-Aishihik Band and Kluane First Nation will gradually exercise their options under their land claims agreements. Hunting may increase in the park (for moose and perhaps a few other species), new commercial ventures may evolve (such as horse trips and lodges), and the management of the park itself may significantly change depending on the direction taken by the new co-management Boards.

Table 20: Hypotheses formulation

#	VEC	Impact type	Area	Effect supposition due to impacts	Information required	Data quality	Research focus
Species specific							
1	Grizzly bear	Road and trail use	Deazdeash, Kaskawulsh and Slims River valleys	Adversely affect survival in the park	Status of VEC in area, rate and nature of growth of human use, nature of VEC response to disturbance	Good	Response to vehicular and foot traffic, viability of current population
2		Aircraft and watercraft use	Alsek River Valley	Adversely affect survival through behavioural changes and habitat alienation	Nature of VEC response to disturbance, use of traditional range	Fair	Response to aircraft
3		Hunting and encounters	Region outside of park	Adversely affect survival through behavioural changes and direct mortality	VEC movements, range, human activity outside of park	Fair	Large regional movements, mortality statistics
4	Dall sheep	Road and trail use	Sheep Mountain	Adversely affect survival through behavioural changes and habitat alienation	Status of VEC in area, rate and nature of growth of human use, nature of VEC response to disturbance	Fair	Response to vehicular and foot traffic, viability of current population
5		Aircraft use	Sheep Mountain	Adversely affect survival through behavioural changes and habitat alienation	Status of VEC in area, nature of VEC response to disturbance	Poor	Response to aircraft
6	Mountain goat	Trail and aircraft use	Goatherd Mountain	Adversely affect survival through behavioural changes and habitat alienation	Status of VEC in area, rate and nature of growth of human use, nature of VEC response to disturbance	Fair	Response to aircraft and foot traffic, viability of current population
7	Moose	Recreational use and hunting	Alder Creek/Mush-Bates Lakes	Adversely affect Moose survival through behavioural changes, habitat alienation and direct mortality	Status of VEC in area, nature of VEC response to disturbance	Fair	Response to vehicular traffic, viability of current population
8	Golden eagle	Human activities	Slims River Valley	Adversely affect species survival through behavioural changes and habitat alienation	Status of VEC in area, rate and nature of growth of human use, nature of VEC response to disturbance	Poor	Response to aircraft, viability of current population
Impact specific							
9	All wildlife VECs	Aircraft use	Park 'green' zone	Adversely affect the long-term viability of wildlife VECs	Response to aircraft	Fair	Project synergisms
10		Road and trail use	Park 'green' zone	Adversely affect the long-term viability of wildlife VECs	Response to hikers	Fair	Project synergisms
11		River rafting	Alsek River	Adversely affect the long-term viability of wildlife VECs	Response to rafters	Good	Project synergisms
12		Causes of direct mortality	Inside and outside park	Adversely affect the long-term viability of wildlife VECs	Hunting pressures, management control	Fair	Project synergisms
13		All park and regional activities	Park and region	Result in reduced populations or extirpation of some or all wildlife VECs in the park	All impacts and effects	Poor	Project synergisms

6.2.3 Scenario C: Long-term

Scenario C is characterized by a number of major projects that may significantly increase the local tourism and industrial based economy. The probability of any of these projects occurring is low unless major private and public investment is made, or significant changes occur in international resource based markets. Resource based industrial projects (mining and pipelines) may proceed with significant impact on local community growth, changes that may result in further capitalization to support tourism initiatives.

Many of the tourism based projects involve significant infrastructure to facilitate mechanized access into the park, and may have significant local environmental impact. Increased helicopter use may occur over the green zone.

6.3 Wildlife response to disturbances

The manner in which wildlife respond to disturbances (e.g. sheep running from passing helicopters), and the ultimate implications to the viability of wildlife population in the park, is fundamental to establishing the nature of cause-effect relationships in the park and to estimating the eventual cumulative effect of many projects on many VECs.

This section reviews some important ecological principles, the uncertainty and difficulty associated with realistically portraying wildlife response, and describes an attempt to quantify wildlife response.

6.3.1 Establishing cause/effect relationships

An animal, in response to a disturbance, may move away from the disturbance (i.e. displacement), may alter its behaviour (e.g. habituation or attraction leading to a direct conflict with humans, or avoidance leading to inefficient use — or alienation — of habitat), or it may experience a physiological response (e.g. increased heart rate). The implications of this to wildlife includes less energy for maintenance, growth and reproduction needs; death or illness, trampling, and abortions; and reduction in range and access to resources (e.g. food, escape terrain, cover) and increased predation (Geist, 1978). Most field research on wildlife response has assessed the degree of immediate response to a disturbance (e.g. flight); often such studies are very specific to a certain species, environment, disturbance type and pattern of activity.

Any of these responses may ultimately lead to induced mortality. In a National Park, direct mortality (typically for bear) results from management efforts to ensure human safety. The degree to which this occurs may depend on the habituation of the animal (or avoidance or attraction) to the disturbance.

The degree to which a response ultimately translates into adverse effects on a larger population (if at all) has not been precisely determined. Such an effect would appear as reduced reproductive fitness and habitat utilization, perhaps reducing the population size and the health or reproductive capability of individuals to levels below those needed to maintain a viable population.[15]

It is only with great difficulty that one can establish a cause and effect relationship at an individual or population level based on the knowledge obtained in the general literature and the habitat and wildlife data available. For example, the literature is replete with examples of different studies showing opposite results for the same species and disturbance (e.g. dall sheep and helicopters). Predicting a specie's response to disturbance is also made more difficult as

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[15] Species 'health' has also been referred to as 'vigor' or 'integrity' (Stringham, 1990; Westman, 1985).

innate and learned responses have great "intra and inter-specific variation" (Knight, and Cole, 1991, p. 243; Val Geist, pers. comm.).

6.3.1.1 Ecological principles

Certain 'rules of thumb' or principles nonetheless do exist and can aid in an effect's assessment. Such concepts must be considered failing the availability of adequate population data specific to the park. These concepts, combined with species specific responses, form the basis of the 'working material' for the cumulative effects assessment.

These principles, based on a review of literature, may generally be described as follows:

- An animal may more readily adapt to a disturbance, particularly noise, if the activity pattern is regular, predictable and not associated with any danger.
- Habituation may increase the potential for direct conflict due to less avoidance of humans.
- Habituation becomes more likely as the activity becomes longer in duration (e.g. no rapid outbursts).
- Topography may have a significant influence on response by amplifying (e.g. river valleys commonly used by humans and wildlife) or attenuating (e.g. mountain ridge lines block noise of an aircraft) sensory disturbance (i.e. noise, visual sighting, smell).
- Topography of connected patches of habitat may have a significant influence on genetic exchange.
- Displacement may cause an animal to move to sub-optimal habitat — assuming that such habitat is still available and not already occupied by a fully dispersed population (i.e. that the habitat is below ecological carrying capacity for that species) (see Orians, 1986).
- An increase in the number of individuals and areas of suitable occupied habitat increases the security of a population from threats to viability; therefore, a "broad geographic distribution" (Salwasser, 1988, p. 90) reduces the risk of population loss in the park.
- Increased human access into previously inaccessible areas has consistently led to decreases in certain wildlife populations (broadly, post-European settlement history); however, the exact cause and effect relationship may not always be easily determined (Shank, 1979).
- The "safe minimum standard of conservation" and the "precautionary principle of biodiversity" (as explained in 5.1) describe the need to make conservative assumptions about the significance of effects on VECs when data is limited and the potential for continuing human encroachment is high.
- The effects resulting from trans-boundary movements on wildlife increases as the effective park size (quality habitat) becomes smaller and as the park shape becomes more narrow than circular (i.e. Kluane's green zone is a long and relatively thin strip of protected habitat, so dispersal will result in a greater probability of wildlife moving outside the park).
- In the absence of specific population targets in the park (e.g. 95% probability of population survival in 100 years, 250 sheep on Sheep Mountain), and uncertainty regarding future project development and the effects of such projects on wildlife, the guiding principles of Parks Canada regarding ecosystem protection should be referred to when evaluating the potential significance of effects and when objectives are sought. The Parks Canada "Guiding Principles and Operational Policies" (Parks Canada, 1994) states that "National park ecosystems will be given the highest degree of protection to ensure the perpetuation of natural environments essentially unaltered by human activity. Human activities within a national park that threaten the integrity of park ecosystems will not be permitted" (Parks Canada, 1994, p. 33).[16]

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[16] The notion of ecosystem integrity however is too ill defined to be of practical use in guiding park management policy. What is required to reduce risk to the viability of park wildlife is the determination and investigation of specific cause-effect relationships where there are suspected

The issue of displacement from desired habitat requires further attention for Kluane. It is possible that no more habitat, for the selected wildlife species exists within the park boundaries. Vegetation mapping in the park is limited, and habitat correlation is not available. The green zone is only a coarse view of habitat in the park, but should suffice for this study by indicating the largest area of potential habitat. All the available habitat in the park may already be used, including marginal habitat (Val Geist, pers. comm.); therefore, alienation may not necessarily result in animals just moving on to another area (i.e. wildlife in the park has already expanded fully into all available range). Instead, animals may remain in their traditional range, but experience increased physiological stress. Territorial species may be driven away from all suitable habitat by the existing occupants when they are displaced from their original territories. Such a situation may indicate very little overall tolerance in the park for further activities, unless a learned response (e.g. habituation) mitigates the effects of disturbance.

This has dire consequences if it is shown that the most significant and common response of wildlife in the park to roads, hikers and aircraft etc. is movement away from the disturbance. The critical question is: are populations already distributed for optimum fitness, and would flight adversely disrupt this balance and send them to less quality habitat?

Evidence from research in Banff National Park (BNP) may be instructive. Studies indicate that habitat fragmentation is a major contributor to wildlife displacement from critical wildlife habitat (Purves, White and Paquet, 1992). Although the impacts are not directly comparable to those in Kluane (Banff experiences more direct habitat loss and a substantially greater number of visitors), lessons could be learned from what is happening in Banff. Studies have postulated that a certain level of overall visitation could be used to represent a threshold effect regarding effects on wildlife (Purves, White and Paquet, 1992). Human disturbance modelling, based on road and trail, and settlement or camp use, has determined that more than 10% of available habitat in BNP, Yoho and Kootenay National Parks is alienated to wildlife due to human use.

The state of affairs in BNP (and a practical cumulative effects view) is best summarized by Paquet (1993, p. 8):

> "The natural landscape of the central Rocky Mountains is changing rapidly. In many areas alterations and reductions of essential habitat components have diminished biological diversity and ecological function. At present, the extent of protected wilderness in the Rocky Mountains is too limited, too fragmented and insufficiently connected to permanently sustain populations of large carnivores. Moreover, the incremental erosion of unprotected wilderness and loss of habitat adjacent to nature reserves in the Rocky Mountains is rapidly increasing the number of insular pockets of wilderness and wildlife. Habitat loss, insularization and degradation are major contemporary causes of species endangerment. Fragmentation of continuous, natural landscapes is one of the most important factors contributing to the ever increasing loss of biological diversity."

6.3.1.2 Cause and effect linkages

Figure 6 illustrates cause (impact) and effects relationships typical for wildlife of concern in the park (adopted from LGL, 1985). These relationships or 'linkages' break down a hypothesis into basic relationships that, all together or one at a time, may cause changes in the wildlife populations.

The linkages, aside of direct mortality, are based on three principal suppositions: 1) that flight or behavioural change resulting in increased stress leads to increased energy use; 2) that energy

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problems, making decisions based on current available knowledge and best professional judgement, pointing out data gaps and relationship uncertainties, making conservative assumptions in the face of uncertainty, and defining further monitoring and research needs.

intake for growth, reproduction and maintenance are reduced owing to spatial and temporal displacement from high quality food and habitat, and 3) that the net energy balance, if negative (a loss), results in reduction in animal vigour (ability to maintain population despite influence of stresses (Stringham, 1992)), reproductive fitness, and energy reserves. This may then affect the abundance, distribution, and demographics of the population, ultimately leading to a decline in population due to emigration or mortality.

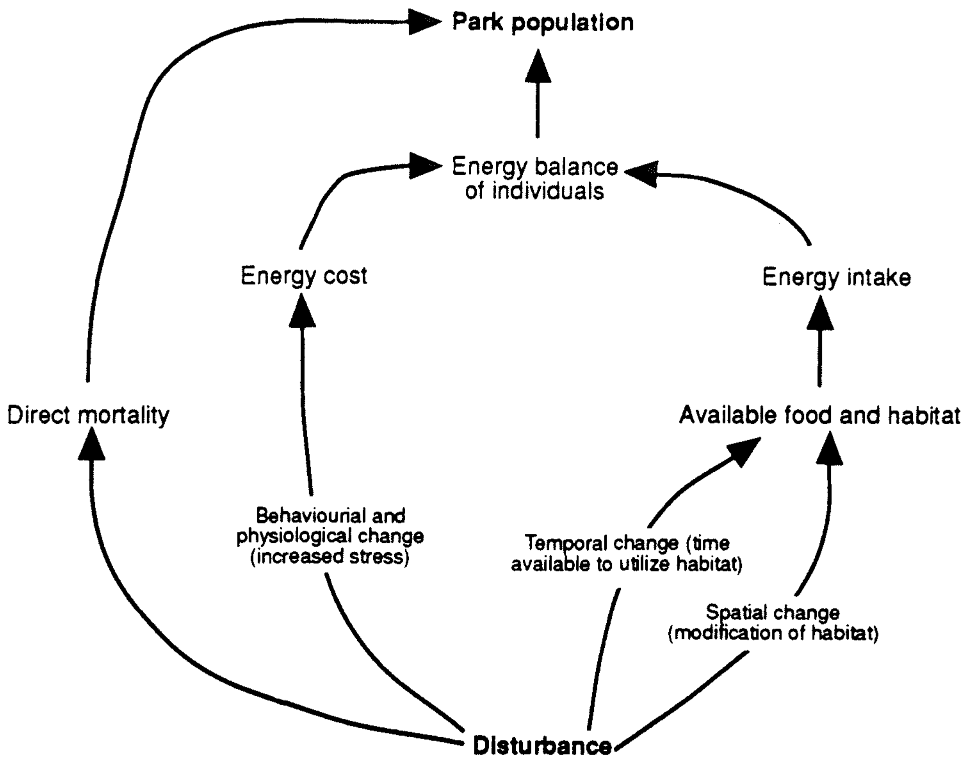


Figure 6: Wildlife effects linkages

6.3.2 Wildlife Zones of Influence and Disturbance Factors

Very few projects in KNPR cause direct habitat loss and fragmentation. The fragmentation effect in Kluane is mostly indirect: the sensory nature of the activity associated with the disturbance is usually the more important impact (e.g. noise from an aircraft). The Zone of Influence (ZOI) represents a form of fragmentation as the habitat within the ZOI may be less desirable and under used, and hence less available (as if 'lost') to an animal. Most activity areas and corridors in the park are fairly distant from one another; there is often minimal physical overlap between disturbance nodes, and the direct project effects (e.g. habitat loss or water contamination) are very localized and in most cases negligible.

Table 21 lists the ZOI and Disturbance Factors for wildlife VECs for four activities: aircraft, trails, roads and settlements. The values were obtained from the literature (see Table 21) on observed effects of one activity on one species within certain environmental conditions (e.g. mountainous or prairie terrain) for certain activity patterns (e.g. frequency of traffic flow). The table lists average zones and factors that reflect typical immediate responses (as opposed to long term population implications), thus limiting the ability to generalize their appropriateness in other areas under different conditions. Hence these values can provide only one type of input into the analysis, and cannot be relied on alone.

Map 7 shows the ZOI for grizzly bear in the park's southern green zone (the area of the park with the most human activity). The zones for road and aircraft are drawn to scale; the zone for trails is no wider at that scale than the normal map line (this map will be referred to later in a grizzly bear hypothesis).

Table 21: Wildlife Zones of Influence and Disturbance Factors

Species		Aircraft	Trails	Roads	Settlements[4]
Grizzly bear	ZOI[1]	1	0.1	3	3
	DF[2]	H	L	H	M
Dall sheep	ZOI	0.5	0.1*	0.2	NA
	DF	M	L	L	NA
Mountain goat	ZOI[3]	1*	0.2*	0.4*	NA
	DF	H	H	H	NA
Moose	ZOI	0.2	0.1*	.1*	.5*
	DF	M	L	L	M
Golden eagle	ZOI	0.5	0.3	0.5*	NA
	DF	M	L	L	NA

[1] ZOI = Zone of Influence in km

[2] DF = Disturbance Factor rankings: L = low, M = moderate, H = high, NA = not applicable (i.e. activity not expected to occur)

[3] values assumed as double that of sheep (no direct evidence available, except that goat considerably more sensitive than sheep)

[4] "Settlements" includes any point sources of human disturbance

* inferred (no direct quantitative evidence from literature)

Sources:[17]

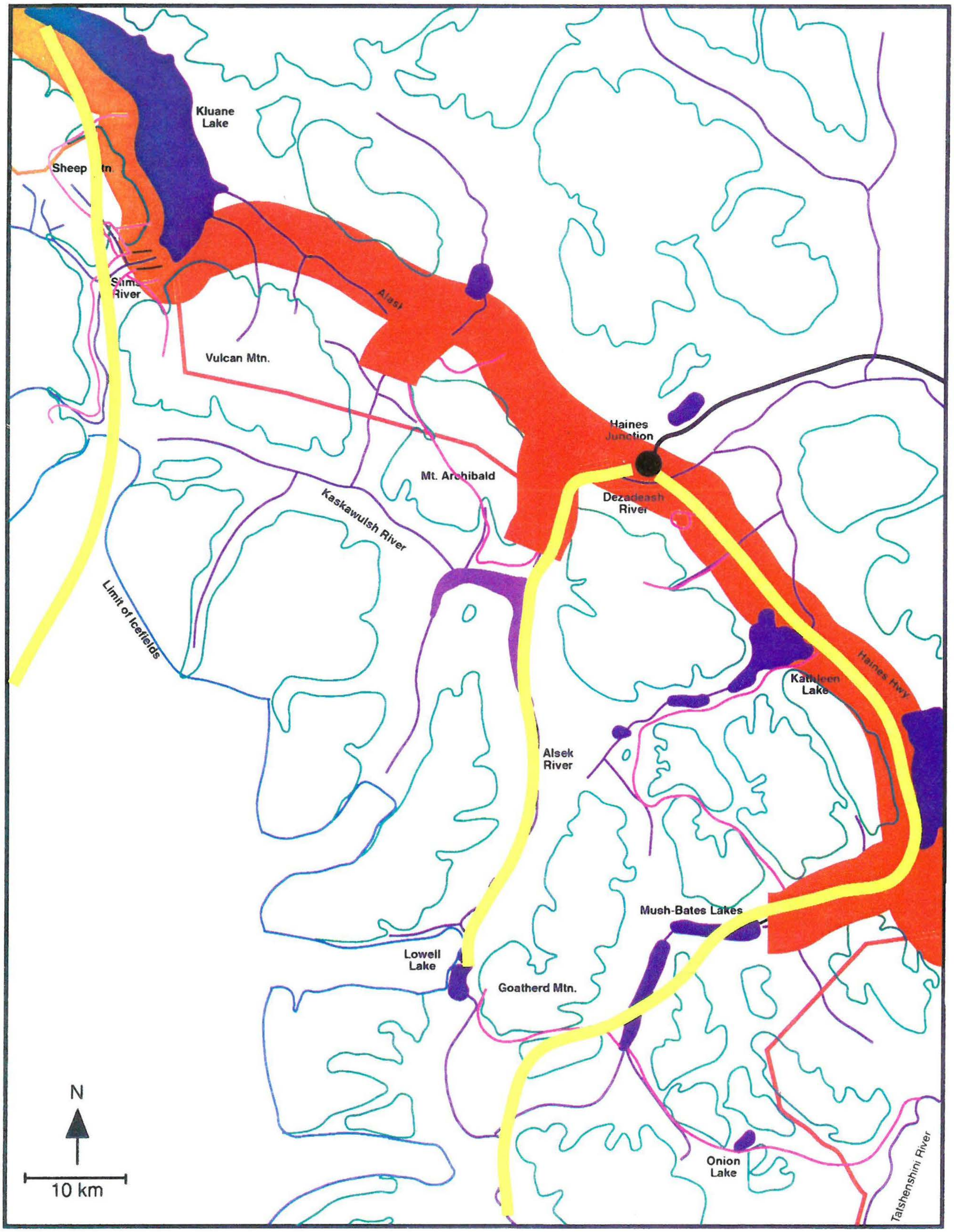
Grizzly bear............. Mattson *et al.*, 1995; McKechnie and Gladwin, 1993; Albert *et al.*, 1991; Mattson, 1989; Wetering and Smith, 1989; McLellan and Shackleton, 1988c; NWF, 1987; Shank, 1979; McCourt *et al.*, 1974

Dall sheep .... Komex, 1995; McKechnie and Gladwin, 1993; Stockwell and Bateman, 1991; Singer and Beattie, 1986; MacArthur *et al.*, 1982; Prism, 1982

Moose .... Komex, 1995; McKechnie and Gladwin, 1993; Singer and Beattie, 1986; Shank, 1979; McCourt *et al.*, 1974

Golden eagle............ Watson, 1993; Lopoukhine, 1983

[17] These sources provided quantitative results based on conjecture or observation. To develop the table values, these sources were used along with other literature (as cited in the hypotheses analysis, see section 6.4) that provided information on species' response.



Map 7: Zones of Influence in southern Green Zone for Grizzly Bears

KNPR border
Lakes/Rivers/Creeks
Roads
Road ZOI
Limit of Icefields
4000 ft (1600m) elevation
Trails
Aircraft ZOI

6.4 Evaluation of hypotheses

Each hypothesis introduced in Table 20 is evaluated in this section. Analysis includes consideration of the following cumulative effects assessment issues (as described in Figure 1):

1. Effects on viability of local and regional populations;
2. Effects on ecological processes;
3. Effects projected to future activity levels;
4. Combined effect of more activity throughout the region.

Each hypothesis analysis reviews certain effects types. Table 22 lists these for Grizzly bear; the types are similar for the other species. Such a breakdown of effects are used to guide the effects hypotheses for all VECs.

The overall effect stated in Table 22, "Adversely affect [VEC] survival", begs the question: what is an unacceptable effect on a VEC, and when if ever will an impact cause this? An unacceptable (i.e. significant) effect is one with an adverse effect on species survival. An effect is considered adverse, for the purposes of this study, if population numbers are not recoverable in the long-term (e.g. +20 years). This is to satisfy Parks Canada's mandate of representativeness; that is, species currently residing in the park are to be protected and populations maintained to ensure survival.

It is not necessarily implied (unless stated otherwise) in the hypotheses that a significant effect in a local area on a local population may have an adverse effect on overall *Park* populations for a particular species. It is suggested, however, that this may be likely more often than not given the critical nature of the habitat areas and populations examined in the hypotheses. No evidence to better substantiate effects at the park level can be made from available data and population theory.

An interpretation of the cause-effect relationships for hypothesis one is illustrated in Figure 7 (this is a more detailed interpretation of Figure 6). Such 'network' diagrams are useful in organizing the relationships in preparation of hypotheses analysis. Note that certain impacts on Grizzly Bears are explicitly dealt with in other hypotheses, each examining a slightly different but related cause and effect relationship.

Considerable attention is given to hypothesis 1 analysis due to both its complexity and the introduction of concepts that are used in later hypotheses.

Table 22: Breakdown of effects for Grizzly bear hypotheses

Impacts for Grizzly Bears	H1: Road/trail use in park	H2: Air/watercraft use in park	H3: Hunting/ encounters outside park
Overall effect	Adversely affect bear survival	Adversely affect bear survival	Adversely affect bear survival
Effect type	Loss of habitat Habitat fragmentation Alienation of habitat Obstruction to movements Direct mortality Removals	Alienation of habitat	Direct Mortality
Effect mechanisms	Habituation (and/or food-conditioning) Abandonment Increased stress Sensory obstruction to movement Physical obstruction to movement Reduced reproduction Habitat under-use Genetic alteration 'Extinction vortex' phenomenon	Habituation Abandonment Increased stress Sensory obstruction to movement Reduced reproduction Habitat under-use 'Extinction vortex' phenomenon	Hunting Poaching Defense of Life and Property (DLP) Road kills Genetic alteration 'Mortality sink' phenomenon 'Extinction vortex' phenomenon

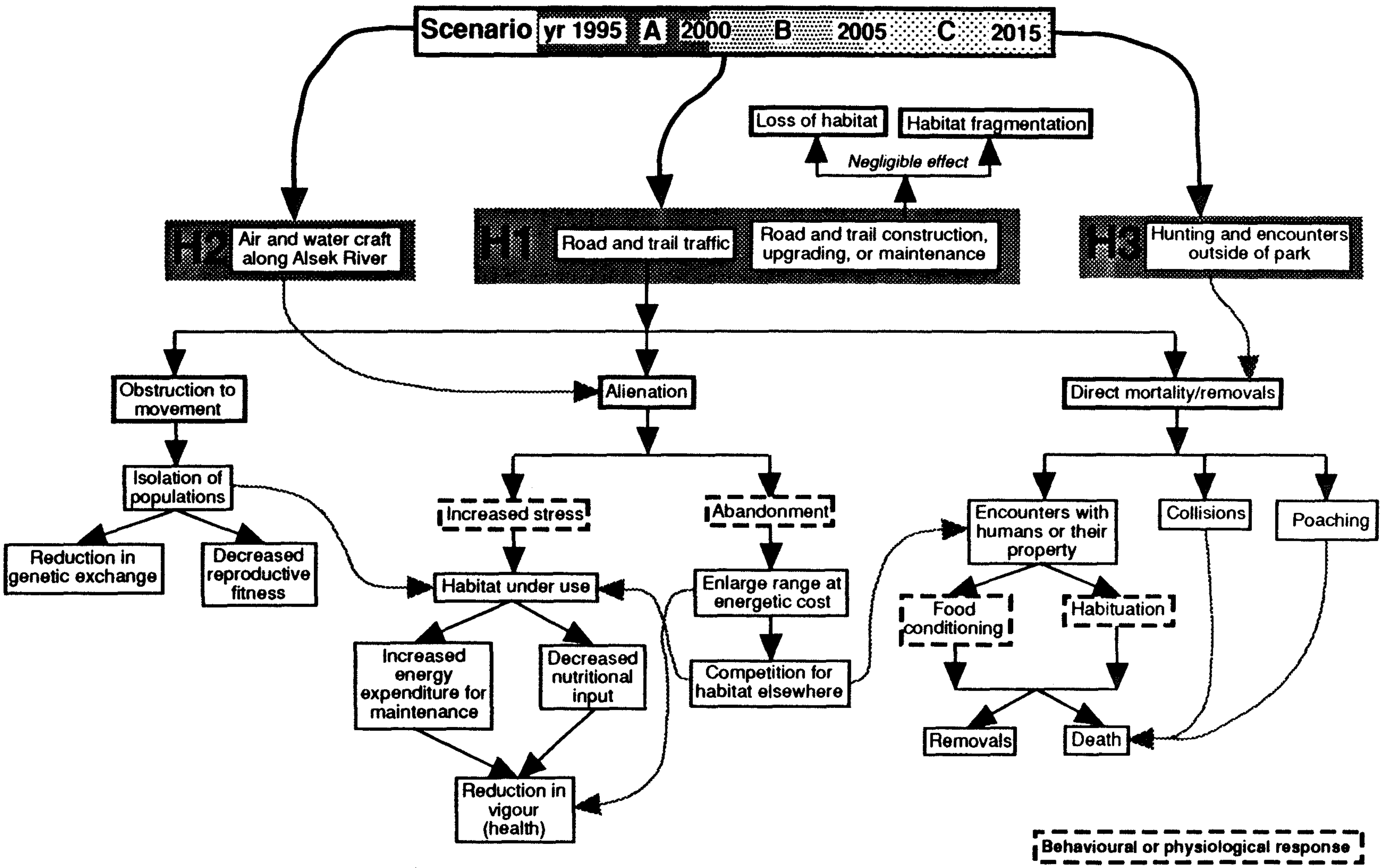


Figure 7: Effects linkages for Grizzly bear hypothesis 1

6.4.1 H1. Road and trail use in the Dezadeash, Kaskawulsh and Slims River valleys will adversely affect grizzly bear survival in the park.

6.4.1.1 Scenario A: Existing

Impacts. Land-based access into this area is currently by a road along the Dezadeash River through Alsek Pass, a hiking trail/road along Jarvis Creek, and trails from the Slims River valley access road trailheads. No designated trails link the Slims to the Dezadeash-Alsek areas. The Cottonwood trail from Kathleen and Mush-Bates Lakes passes by Sockeye Lake, located in a wildlife corridor linking the Dezadeash-Alsek to more southern areas in the park. Other existing activities of significance (see the introduction to Section 6.4 for a definition of significance as used in these hypotheses) that may also affect bears include rafting on the Alsek River, aircraft overflights due to tripping support or flightseeing (see Hypothesis 2), and hunting outside the park (see Hypothesis 3).

Current visitor day use levels at Alsek Pass are unknown. However, usage is suspected to be an average of 50 user nights per year (DRR, 1989a, p. 38). Relative to other hiking areas in the park, registered visitation is negligible; however, there is day use by local residents. Backcountry hiking is by registration only with no access limitations. Usage is infrequent and irregular; nonetheless, the Alsek pass area was closed for 7 days in 1993 (Peepre, 1991) because of concern about human encounters with bears. Local residents may also hike or drive part-way up Quill Creek from the Alaska highway for access into the Auriol Range; usage in the park is suspected as negligible.

The Slims River valley experiences some of the highest levels of backcountry visitation in the park. Much of this use probably remains within the Slims area, the lack of prepared trails along the Kaskawulsh River demanding random hiking (bushwhacking). Overnight hiking from the Slims is registered and limited by available bear-proof food containers.

Population status. Current estimates of the park's grizzly bear population are in the range of 150 to 400. Bears in the park are perceived to have a stable population; however, population numbers are suspect and trends, based on interpretation of field based data, are unknown.

Loss of habitat. Current road and trail 'footprint' is along narrow vehicle and foot traffic corridors. Only these existing travel routes will be upgraded, so further loss of habitat is probably trivial.

Habitat fragmentation. The degree of existing trail and road network in the area is probably not yet extensive enough to separate patches of quality habitat and to create travel corridors. As explained above, alteration of habitat is minimal. Fragmentation could be important indirectly if alienation of habitat is significant; otherwise, fragmentation is not an important effect given the very local nature of the projects relative to remaining available habitat.

Alienation of habitat. In general (see below for details) the response of bears to trails are either habituation or flight, and the response to roads are habituation or remaining in the vicinity but under increased stress, resulting in habitat under-use and possible abandonment. Habitat under-use leads to decrease in nutritional input, and may occur due to selective harvesting of habituated bears (Dave Mattson, pers. comm.). Increased stress may lead to reduced reproduction and less energy for maintenance (i.e. reduced vigor). Park bears are known to have low reproduction rate (relative to grizzlies in other regions), and so are particularly susceptible to loss of females.

There is considerable evidence that habituated bears will tolerate humans on a consistent basis to within a few metres (Dave Mattson, pers. comm.). Habituation to trails may result in aggressive or passive responses to hikers; it remains unclear if habituation consistently increases or decreases the risk of injurious encounter with humans (Herrero and Jope, 1991 as cited by Albert and Bowyer, 1991). This uncertainty implies that use patterns (i.e. regularity and frequency) may not assist in indicating if problems will occur.

In Denali National Park, frontcountry activities displaced bears into the backcountry, increasing the chances of interaction. However, the result of encounters was usually flight from hikers (Albert 1991; Mattson, 1989). In Glacier National Park, in heavily used areas, bears exhibited neutral responses, returning to feeding. In general, habituated bears showed less response (McArthur Jope, 1982; Mattson, 1989) and appeared to avoid backcountry hikers, while responding more strongly (i.e. adversely) to campsites (Mattson, 1989).

Many studies have indicated that roads have a significant adverse influence on bear populations and use of habitat (Banci, 1990 citing seven studies). Evidence from research in Yellowstone National Park has indicated consistent under-use of habitat near roads and other areas of human activities, and a significant increase in overall mortality risk even when compared to areas where firearms are allowed (NWF, 1987; Mattson, 1995). The construction of the Wonder Lake road in Denali National Park led to high habituation of bears to the road, and an increase in encounters (NWF, 1987; Albert, 1991). Avoidance by bears of roads in the Flathead region of B.C. has been found to be independent of traffic volume (McLellan, 1988); on the other hand, rarely used roads have been used by bears as travel corridors (Wetering, 1989).

Abandonment of foraging sites may ultimately result if the stress on bears exceeds some level of tolerance (Gilbert, 1994). Bear movements are strongly governed by feeding habits, so human activities may result in bear movement upslope to lower quality habitat (e.g. subalpine) for the season or movement away from the immediate river valley area into areas currently used by other bears or into unused habitat. Despite the view that more highly stressed bears (in terms of disturbance in accessing food) may be willing to tolerate greater presence of humans (and other bears) to ensure food intake (Mattson, 1989; McArthur Jope, 1982), the combination of sensory disturbance from various activities will eventually reduce any tolerance to the point of abandonment of range. This may be occurring in Denali National Park where seasonal bear movements and peak visitor activities result in a high number of interactions along river flats (Albert, 1991), a situation similar to that in Kluane at the Alsek confluence.

Increased stress may result in less energy for maintenance and reproduction. Kluane's bears, compared to other North American bears, have smaller body mass, smaller litter sizes, longer reproductive intervals, and later maturation (Pearson, 1985 as cited in Gray, 1987). Litter size is affected by the vigor of the sow, which is "directly related to habitat quality and food supply" (Falquez, 1987, p. 8). Therefore, if Kluane's bear population is already experiencing slow growth, increased stress from trail and road use (particularly the latter) may adversely affect the reproductive capacity of the park's bear population. Significant impacts on female reproduction rate are anticipated due to increased human access into bear habitat (Stephen Stringham, pers. comm.).

Table 21 shows that on average, based on a variety of field observations, bears significantly under use habitat within 100 m of trails and up to 3 km from roads. The areal result of this is illustrated in Map 7. The significance of response (disturbance factor) to trails however is low due to the uncertainty of habituation effects, and high for roads due to the certainty of habitat under-use. As bears tend to forage in the summer at the same elevations as that of human activity, and in their movements tend to use paths of least resistance (Komex, 1995), the probability of encounters and alienation is high.

Obstruction to movements. Effects of disturbance may be worse where the terrain results in 'bottlenecks' to bear movements such as at Alsek Pass and Lowell Lake, or where linear obstructions such as roads may affect bear dispersal outside of the park and to more remote areas in the park. Such movements may be driven by a search for undisturbed habitat (by humans) and personal space (distance from other bears). Reduction in bear movements can lead (Allendorf and Servheen, 1986) to reduction in fitness due to inbreeding (reduced genetic exchange). Along with other effects that reduce fitness, continuing lack of population recovery creates the 'extinction vortex' phenomenon whereby a combination of effects leads to an unrecoverable decline in a species population. These effects are discussed below in more detail

Relatively little total Park area falls within the project's zone of influence for bears (see Map 7), although all of it in the Dezadeash-Alsek-Kaskawulsh River Valleys provides prime bear habitat in the park. For this reason, the area was designated as a Special Preservation Area and is the study area for the current Grizzly Bear Research Project in the park.[18] Habitat is not as good in the Slims valley.

Further south in the park, Sockeye Lake, Mush-Bates and the Dalton Post area provide other areas of prime habitat; and further north, the Donjek River valley does so. All of these areas are linked by mountain passes and river valleys within the park and to areas outside. Park bears have been located outside the park: broader movements exist to the east (Aishihik), north (Kluane Wildlife Sanctuary) and south (Tatshenshini-Alsek Wilderness Park). Many subadults may be moving to areas outside of the park (Barney Smith, pers. comm.), suggesting dispersal pressures due to competition for habitat, or lack of quality habitat, in the park. Adult grizzlies will move to areas they find more appealing, being areas with little human disturbance or providing richer food sources such as salmon along the Klukshu and Tatshenshini Rivers (Stephen Stringham, pers. comm.).

The availability of unoccupied or not fully utilized habitat outside the park for emigrating park bears is unknown. Bear populations are large and suspected as increasing in the Greater Kluane Region, and suspected as large in the Tatshenshini region due to high quality habitat. It has been suggested however that bears in the region outside the park are nearing full habitat capability (Banci, 1990).

The Alaska/Haines highway represents a potentially serious obstruction to east-west movements due to sensory disturbance; however, bears are known to cross the highway into the Aishihik, and road kills have been reported by local authorities as negligible. It is uncertain as to what extent the highway reduces the number of bear movements, if at all, from what they would have been had the road not been there.

Direct mortality and removals. As discussed earlier, field observation as indicated in the literature shows that response of bears to trails are either habituation or flight. Habituation may lead to aggressive encounters with hikers on trails or at campsites, resulting in removals or management kills. The need for management response will depend on the nature of human activity and degree of bear habituation/food-conditioning (see Alienation of habitat discussion).

If habituated or food-conditioned bears pose a greater risk, then they are the first to be removed or killed as a result of bear management actions. This has already occurred in the Slims River area, where between 1981 and 1987 five bears were killed and five relocated (Leonard, Breneman and Frey, 1988). The Slims River valley has been the worst area in the park for bear conflicts (Rick Staley, pers. comm.), although improving in the last six years due to the use of bear-proof food containers. This suggests that despite current large numbers of users (the Slims was the second highest use area at 20% overnight registrations in 1994), management actions may be significant in reducing effects in the Slims or other areas in the park (all currently with much less use) if various mitigation measures are successfully implemented (e.g. visitation quotas, food storage practices, visitor education, area closures).

Mortality due to road collisions, poaching, use of garbage dumps and defense of life and property are discussed in hypothesis 3.

6.4.1.2 Scenario B: Build out

Future activities in the Alsek region that may influence bears include upgrading of the Alsek Pass road, building a day use area at the park border along the road, a land shuttle to Bear Camp and

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[18] This six year study is being conducted by the Centre for Applied Conservation Biology, University of British Columbia.

a boat tour to Lowell Lake. Activities of consequence in the Slims valley region include upgraded access roads and trails along the Slims River.

The cumulative long-term implication of these developments is the impacts of increased visitation on bear habituation and alienation. The high rate of backcountry visitation in the Slims valley is not expected to continue for long if quota measures are implemented. Although the Alsek region currently has a very low proportion of park visitation, this may change dramatically if the Alsek Road is upgraded.[19] Projects are especially significant in terms of increasing the chances of bear-human interactions if they ease access into the backcountry for the very large proportion of highway travellers who otherwise would have remained in the frontcountry.

Non-mechanized use will increase (e.g. hiking, biking) and become more frequent and regular. Mechanized use may remain the same or increase; a vehicle control gate would only allow park staff or commercial tours through (creating more frequent and regular traffic). The degree to which this greater predictability of activity may ameliorate effects on bears is questionable when compared with evidence indicating a direct adverse relationship between increased road access and bear habitat use.

The implications to bears from Scenario B activities are:

- increase of trail use, both day and overnight, along the Slims and Alsek Rivers;
- increase of traffic along the Alaska/Haines Highway;
- stable intensity of vehicular traffic along the Alsek road;
- increased boating and rafting activity on the Alsek;[20]
- increased aircraft activity along the Alsek (see Hypothesis 2).

The combined effects of these activities suggest a significant intensification of impacts and disturbances relative to Scenario A. This may be sufficient to either: 1) permanently alienate bears from the existing or larger zone of influence (assuming overlap of various activities in the same area creates an increased zone size with a greater disturbance factor); or 2) result in adverse behavioural responses of individual bears remaining in the area: avoidance in some individuals, and aggressive encounters from others resulting in management responses.

6.4.1.3 Scenario C: Long-term

Future long-term activities in the region (>10 years away) that may influence bears include the Kaskawulsh Loop Highway, Slims River Valley West Road and major increases in local community populations due to increased industrial activity.

The probability that the Kaskawulsh Loop Highway or the Slims River Valley West Road would proceed is quite low due to the continuing difficulties faced in acquiring the considerable capitalization required, and the significant environmental effects that would probably be assessed. Of more consequence will be the incremental growth in visitation, both day and overnight, supported by more highway corridor facilities (e.g. Matatana Lodge) and gradual upgrading of access roads radiating from the highways towards the park.

Regional bear populations in the Aishihik and Kluane Wildlife Sanctuary may be adversely affected by increased road densities resulting in increased hunting. Disturbances along the Alsek River in Kluane, a major north-south movement corridor for bears, may reduce bear exchange with outlying areas. The Tatshenshini-Alsek Wilderness Park and Glacier Bay National Park may

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[19] It is of interest to note that the 1980 Kluane PMP specifically recommended that the existing Alsek Pass road be maintained only for controlled interpretive tours to minimize environmental impacts, principally adverse effects on grizzly bears (KNPR, 1988).

[20] No studies in the literature were found describing response of large mammals to water based activities (such information was only found for waterfowl).

then provide a future for regional populations by becoming the new 'core refugia' for bears in the region. Although not satisfying Parks Canada's mandate for representativeness, loss of park bears may not be significant in the maintenance of bear populations in the larger southwest Yukon, northern B.C. and Alaska panhandle region.

The implication for bears from Scenario C projects and timeframes is then the loss of bear movements to surrounding protected and semi-protected wilderness areas.

6.4.1.4 Discussion

The following summarizes the relevant effects:

- Alienation is probably the most important effect, although it is uncertain as to the most probable bear response and effect mechanism at work. Nonetheless, evidence from other parks and field observations of bear response suggest that habitat under-use due to alienation may be significant, especially as it reduces nutritional input, an effect which may place at high risk the most susceptible members of the population (i.e. females of reproductive age). Low reproduction means slow population recovery due to random natural changes in habitat condition and incremental effects of many human projects.
- Roads and trails in and outside the park represent a sensory obstruction to bear movements. If bear movements are substantially reduced, the park bear population may be adversely affected through less genetic exchange causing reduced bear fitness for future reproduction and maintenance.
- Behavioural response of habituation could lead to encounters with humans leading to removals or management kills. Incidents resulting in direct mortality or removals are expected to increase as human visitation increases. There remains a risk that what happened in the Slims River Valley 10 years ago will be repeated elsewhere if mitigation through the use of bear-proof food containers is not conducted.

No explicit method exists to determine if any one or all of the projects may eventually result in a significant reduction or loss of the park's resident grizzly bear population. However, evidence presented indicates a reasonable probability of concern that current bear populations, although considered numerically stable, may in the long-term (e.g. 100 years) decline due to continual dispersal out of the park, random fluctuations in forage condition, removals and human induced stress. The effects are especially significant on the nutrient input of female bears already reproducing at unusually low rates. Such conclusions are corroborated by long-term general trends experienced in other protected areas subject to increases in human access (Stephen Herrero, pers. comm.). Examples of bear responses and direct losses in other parks indicate general relationship between increased human presence and reduction in size of bear population, regardless of the detailed mechanisms involved.

In summary, no evidence is available in Scenario A (existing situation) of adverse effects on bears. Reproductive rates of bears are low. Population is unknown but a range is suspected. Rate of exchange with other areas is unknown, but some extra-park movements are known and larger regional movements are suspected. The effects listed above have been observed in the field in other parks (albeit with different levels and types of human activities), often with adverse results. The major significant changes in Scenario B are increases in visitation and improved access into the backcountry. Historical precedence suggests adverse affect on bears under such circumstances of increased intrusion into bear habitat. Major significant changes in Scenario C include further growth in frontcountry facilities along the highway and continuing increase in backcountry visitation, exacerbating the situation in Scenario B.

A possible course of events resulting from this scenario progression is as follows:

1. Park bear population is stable;
2. Roads are built or upgraded;
3. Rate of visitor usage substantially increases;

4. Bear-human encounters increase;
5. Movements of bears become more constrained;
6. Vigor of individuals decreases due to habitat under-use or abandonment;
7. Reproduction rate decreases;
8. Loss of bears through management controls increase;
9. Bears abandon park range and explore new territory inside and outside park where they are subject to further adverse effects;
10. New territory may be occupied by other bears or have sub-optimal habitat;
11. Vigor of individuals continues to decrease, fewer bears return to park;
12. Resident park population declines.

Of importance to determine is at what point along this progression will there be a problem. The answer to that will require further research in the park (see below). It is suggested that effects may begin to be significant by at least step 6. If the population is on a downward trend, a first goal would be to maintain a stable population at or near current levels.

Uncertainty about park bear population and trends make predictions difficult. The degree to which the bear population may already be affected is unknown. A more certain conclusion is then not possible until some data gaps are filled through further research. The following identifies some areas of research needs:

- park bear population and trends;
- extent of bear dispersal from and within park;
- extent of use of movement corridors in park;
- extent of immigration into park;
- threshold of habitat alienation at which bear vigor is irreversibly affected;
- degree of availability of uncontested and undisturbed habitat within and outside park;
- quality (capability) of habitat within park;
- growth in backcountry use with and without visitation controls.

The research could be focussed by the answering of sub-hypotheses to H1, such as: Habitat alienation will cause abandonment of historical range leading to reduced nutritional input and reduced vigor in KNPR; Loss of bears due to management kills or removals will seriously threaten park bear populations; and the Alaska/Haines highway is a significant obstruction to bear movements between the park and the Aishihik region.

6.4.1.5 Conclusion

H1 is probably true in scenario B.[21] This conclusion is based on the risk of under-use or abandonment of habitat along roads and trails, reduction in bear movements and removal of bears due to safety measures by park staff. This would lead to less energy for maintenance, dispersal and reproduction. The risk is considered low in Scenario A, and moderate in Scenario B and C.

The conclusion is also made based on a conservative approach given data gaps and uncertainties of bear population and trends. The risk rating is moderated by the considerable uncertainty associated with bear activity.

The following summarizes the assessment according to various impact categories (adopted from Komex, 1995). The ratings, based on a qualitative review of the material presented here by the author, are only meant to indicate general trends. The option concluded is bolded:

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[21] If a hypothesis conclusion states that it is true in Scenario A or B, it also means that it is true in the remaining future scenarios.

Attribute	Options
Duration (of impact)	None, Brief, Long-term, **Permanent**
Magnitude (of impact)	None, Low, **Moderate**, High
Scale (spatial extent involved)	Local, **Regional**
Direction (of change in VEC condition)	Positive, **Negative**, Neutral
Probability (likelihood of impact)	None, Low, Moderate, **High**
Frequency (of project activities)	**Continuous**, Sporadic
Confidence (of prediction and data)	Low, **Moderate**, High
Impact significance (Overall risk)	None, Low, Moderate, **High**

6.4.2 H2. Aircraft and watercraft use along the Alsek River Valley will adversely affect grizzly bear survival through behavioural changes and habitat alienation.

6.4.2.1 Scenario A: Existing

Impacts. Alsek River use includes rafting and canoeing. Trips usually begin shortly downstream of Alsek Pass along the Dezadeash River, and conclude at Lowell Lake in the park, Turnback Canyon in B.C. or Dry Bay in Alaska. In 1994, commercial rafting was the predominant user group (78%) on the river; non-commercial rafting and canoeing formed the balance at 22%.

Fixed-wing aircraft are used as return shuttles for rafters, flightseeing trips, warden patrols and biological research. Flightseeing also occurs. Warden survey flights use both fixed aircraft and helicopters; usage patterns are irregular throughout the park.

Aircraft landings are restricted to Lowell Lake, either on the water or on a gravel beach. Each rafting party generates an average 4.5 aircraft round-trips.[22] Based on 1994 figures, this would result in 90 flyovers each way per year between Lowell Lake and Haines Junction, and 162 flyovers between Turnback Canyon and Haines Junction. Assuming that half of the Turnback flights fly over or near some portion of the upper Alsek (above Lowell Lake), the Alsek experiences 171 flyovers per year or 57 per month during a three month rafting season, peaking at 6 to 12 overflights per day.

No or negligible motorized boating activity currently exists on the Alsek.

Loss of habitat and habitat fragmentation. These effects do not directly occur as a result of the principal impacts being examined.

Alienation of habitat. The associated aircraft activity however may result in alienation of habitat and behavioural changes due to the noise generated. The effects are of particular concern at Lowell Lake where aircraft landings and takeoffs occur (Rick Staley, pers. comm.). Along the Alsek, fixed wing aircraft fly at cruising altitudes of about 4500 to 5000 ft (1370 to 1520m),[23] or lower during inclement weather (Jamie Tate, pers. comm.), and helicopters fly at about 1000 ft (300 m) (Paul Pigchelaas, pers. comm.) during flightseeing trips. A fully loaded fixed wing aircraft however may take 8 to 16 km to ascend from Lowell lake (Jamie Tate, pers. comm.). This usage pattern suggests that, with the implementation of aircraft use guidelines requiring

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[22] There were 10 rafting trips to Lowell Lake and 44 aircraft landings at the lake in 1994. That ratio of aircraft to rafting trips is almost identical to the average of 3 to 6 trips as suggested by a rafting operator.

[23] This is equivalent to 6500 to 7000 ft (1980 to 2310 m) above sea level (the Alsek is approximately at 2000 ft (610m) above sea level). Furthermore, in crossing mountain ranges, fixed wing aircraft may only be 300 to 500 ft (90 to 150 m) above the mountain tops (Erick Olef, pers. comm.).

minimum cruising altitudes, cumulative effects on bears along the Alsek due to aircraft activity may be localized to Lowell Lake.

Much evidence exists of direct effects on bears due to aircraft activity. The immediate response is running until cover is reached, with stronger responses for open terrain (McKechnie and Gladwin, 1993). Grizzly bears are considered one of the most responsive large mammals to aircraft (Shank, 1979), especially helicopters. For example, regular scenic flights by helicopters in Glacier National Park did not result in habituation by the majority of bears encountered (NWF, 1987). In general, frequency of flights seems to result in sensitization as opposed to increased tolerance (McKechnie and Gladwin, 1993; NWF, 1987). Correlation between aircraft altitude and strength of reaction is poor (McCourt *et al.*, 1974). Such evidence suggests that peak aircraft activity in a single day at Lowell Lake has non-trivial effects on bears.

No information was found in the literature on effects from non-motorized or motorized boating (although a conservative assumption might be made that motorboats may at least produce the same effects as road traffic due to noise disturbance).

The more important implication of the bear's immediate response to species viability is unclear. There appears to be general agreement that continuous aircraft flights results in sustained levels of stress (McKechnie and Gladwin, 1993). Some sources indicate subsequent disruption of normal activity and abandonment of historical range by low-altitude flights (McCourt as cited in McKechnie and Gladwin, 1993), a response that would suggest reduction of nutrient input due to use of sub-optimal habitat elsewhere and competition with other bears. However, other sources suggest no evidence exists that aircraft activity affects long-term survival due to range abandonment and change in population demographics (Prism, 1982; Shank, 1979).

In Kluane, open terrain along the Alsek is found on the river flats, with cover provided by the forested slopes nearby, thus offering escape routes from aircraft overflights. Flights are most frequent during the time of year when bears may be found along the river in search of high quality forage such as *Equisetum*, *Heracleum*, *Hedysarum* and *Shepherdia* (Grey, 1987). Aircraft overflights during this time are frequent and regular on a daily basis; however, evidence indicates that this activity pattern, normally mitigated through wildlife habituation, may not result in the same effect on bears. Therefore, despite readily available cover, physiological stress on bears may increase, possibly resulting in behavioural changes or range abandonment. If abandonment does occur, it is uncertain if uncontested habitat exists elsewhere in the park — bears may have to move outside the park, assuming those corridors are not blocked.

Obstruction to movement. At Lowell Lake, aircraft landings occur, and rafters use a campsite at the base of Goatherd Mountain. Bears have been observed to move past the campsites. It is suspected that bears use the river corridor en route to the Tatshenshini (Ray Breneman, pers. comm.). Evidence presented in hypothesis one indicates that bears respond more strongly to backcountry campsites than to backcountry hikers. Evidence presented earlier suggests that an area of combined low level flights (i.e. with landings and takeoffs) and overflights may exceed an already poor tolerance of bears to aircraft activity. If this occurs at Lowell Lake, a movement corridor 'bottleneck', the opportunity may be reduced for genetic exchange of park bears with bears in other regions. Significant loss of genetic variation may lead to reduction in fitness (Westman, 1985) in park bears, assuming that such movements are occurring and that restrictions to movements would be a contributing factor to such a loss in Kluane. No direct evidence to support this was found.

The relatively long and narrow shape of the park's green zone and the blockage of movements westward due to the icefields suggests dispersion and search for forage north, south and east of the park. River valleys act as movement corridors through mountain and icefield barriers to connect Kluane to coastal and interior areas (Herrero, 1993). These movements would be more common the greater the disturbances in the park. Such movements would also increase with greater need to obtain a diversity of foods to satisfy annual nutritional requirements if the habitat mosaic in the park was inadequate. No proof exists however of the latter condition being true.

Alienation of habitat due to aircraft flights north of Lowell Lake along the Alsek would further reduce the chances of such bear movements. This in combination with the effects of the Alsek Pass road creates a 'bottleneck', effectively decreasing the probability of bear movements eastwards.

Watercraft activities probably have negligible effect on bears except with associated campsite activity if in critical habitat or narrow movement corridors. No direct evidence is available however to support this conclusion.

Direct mortality and removals. Air and water craft activity may indirectly lead to direct mortality and removals by, as with roads, transporting people into bear habitat. The discussion of this effect in H1 is also relevant here. Potential areas of conflict however are limited to a few points along the river (as opposed to along the entire travel route), including random takeout points by rafters along the river, and campsites, particularly at Lowell Lake.

6.4.2.2 Scenario B: Build out

Future projects and activities of possible significance include motorized tour boats to Lowell Lake, increased rafting and aircraft flights along the Alsek due to rapid growth in the adventure travel tourism market, and more flightseeing. It is doubtful if the upgraded Goatherd Mountain trail will mean a significant increase in hikers or trailriders in the Lowell Lake area.

Efforts are already underway to limit the number of rafting parties and party sizes that may launch on any given day. If these measures are implemented, they would place an end to the rapid increase in rafting trips unless more trips occurred in shoulder seasons. Such quotas however may already allow unacceptably high levels of activity; research has not been done to determine this.

The tour boat proposal, using a jetboat or hovercraft to allow one day return trips, could be conservatively considered to have the equivalent effect of a continuous road down the length of the Alsek to Lowell Lake. This would imply a zone of influence that would extend along the river shores and alienate bears from the currently available high quality forage. As bears continue to seek forest cover in escape from boating and aircraft activity, habitat may be incrementally alienated and long-range movements reduced. This combination of effects would threaten three fundamental requirements for viable bear populations: undisturbed movement corridors, seasonal foraging habitat and sanctuaries for females and cubs (Gilbert, 1994).

6.4.2.3 Scenario C: Long-term

No specific projects in the long-term may directly affect bears in the Alsek region. Bears would be affected by a gradual alienation from habitat and disturbance to movement corridors throughout the park due to the combined affects of various activities under the pressure of increased front and backcountry visitation. Projects and activities include increased usage in the Slims and Donjek areas, rafting and boat activities on the Alsek, and aircraft flightseeing and tripping support.

6.4.2.4 Discussion

There is no direct evidence that current levels of aircraft and watercraft use along the Alsek River valley are adversely affecting the park grizzly bear population. However, the risk of habitat alienation and increased stress that may result from increased levels and more types of human activity is considered significant, particularly at Lowell Lake where use of a movement corridor may be affected (the arguments on cause-effects as presented in H1 are equally applicable here). The most significant impact is aircraft use, the most significant effect alienation due to such activities (to which bears are quite sensitive), followed by obstruction of movements.

As with hypothesis 1, the effect's conclusion reached must be qualified due to lack of information. Further data on bear movements, habitat use and a more thorough accounting of aircraft activity (e.g. maximum number of flights per day) would assist in refining this effect's analysis. The uncertain current status of bears in the park makes long-term population level predictions difficult. What is known is that human use levels are expected to increase in terms of frequency of trips and diversify in terms of types of mechanized transport. What is also known is that bear mortality risk increases as human access, use of facilities and overall park visitation increases (Mattson, 1993).

6.4.2.5 Conclusion

H2 is probably true in scenario B. This conclusion is based on the risk of under-use or abandonment of habitat along the Alsek River, reduction in bear movements and removal of bears due to safety measures by park staff. This would lead to less energy for maintenance, dispersal and reproduction. The risk is considered low in Scenario A, and moderate in Scenario B and C.

The following summarizes the assessment according to various impact categories.

Attribute	**Options**
Duration (of impact)	None, Brief, **Long-term**, Permanent
Magnitude (of impact)	None, Low, Moderate, **High**
Scale (spatial extent involved)	Local, **Regional**
Direction (of change in VEC condition)	Positive, **Negative**, Neutral
Probability (likelihood of impact)	None, Low, Moderate, **High**
Frequency (of project activities)	**Continuous**, Sporadic
Confidence (of prediction and data)	Low, **Moderate**, High
Impact significance (Overall risk)	None, Low, Moderate, **High**

6.4.3 H3. Hunting and encounters outside the park will adversely affect grizzly bear survival through behavioural changes and direct mortality.

6.4.3.1 Scenario A: Existing

Impacts. Activities outside the park that may affect grizzly bears are hunting, poaching, vehicle access into bear habitat, collisions with vehicles, community growth and garbage control. Hunting, poaching and collisions result in direct mortality. Increased vehicle access into hinterland areas increases the chances of hunting and poaching kills and collisions with vehicles. Defense of life and property (DLP) by community residents may result in direct mortality. Bears attracted to garbage dumps increase the chances of DLP incidents and direct management response by local authorities.

Loss of habitat and habitat fragmentation. These effects are not significant on a regional basis as a result of the principal impacts being examined.

Alienation of habitat. Alienation of habitat would be suspected along the roads and highways (see H1) outside the park, and around human settlements unless food conditioning occurs (see below).

Obstruction to movement. This effect is not significant on a regional basis as a direct result of the principal impacts being examined.

Direct mortality. Management control and DLP were the largest sources of regional bear mortality in 1992-93 (see Table 8), mostly attributable to pursuit of foods at agricultural operations and community garbage dumps (Banci, 1990) and placer mining camps (HLA, 1990). Such losses appear to be increasing (Banci, 1990). Elsewhere, evidence of this effect suggests significant implications to bear viability. In the Canadian Rocky Mountain National Parks and Yellowstone National Park, "a large percentage of bears, far too many for populations to be viable, are being killed needlessly by armed people who feel threatened" (Gilbert, 1994, p. 8).

The construction of a fence around the Haines Junction garbage dump in 1992, combined with the use of bear-proof food containers within the park, may have contributed more to safeguarding the viability of bear populations in the park by reducing direct mortality than any beneficial results due to mitigation of indirect effects from recreationally based disturbances (e.g. alienation, stress). Although information (e.g. bear age, home range, degree of habituation) on bear mortality and causes is sketchy, an indication of general trends and identification of possible problem areas of concern could be deduced from available information.

Eighteen bears are known to have been killed or have died of natural causes between 1981 and 1993 in the park (see Table 8). Twelve bears were killed at the Haines Junction dump in 1990 before the fence was built; the number of park bears in that total is unknown, although suspected as significant (Dan Drummond, pers. comm.). Assuming 30% of those bears (the average number of trans-boundary bears from the park) were park bears, at least 22 park bears were killed between 1981 and 1993. If the park population is stable and numbers at the lower range of estimates (250), then the mortality rate is 9%. This figure is above the recommended annual harvest rates for bears (2% for females and 6% for males (Banci, 1990)) to ensure long-term stability in harvested populations. Concerns have already been raised about harvest underestimation, excessively high female (as opposed to male) harvest and local overharvesting in the Greater Kluane Region, especially the Ruby range (Banci, 1990; Barney Smith, pers. comm.) near Haines Junction. Bear harvests, largely driven by non-residents hunting through local outfitters, have increased in the Greater Kluane Region from 30 in 1987 (DRR, 1987) to 71 in 1991 (YRR, 1995), an increase of more than two-fold in five years. The latter figure is close to the maximum allowable harvest for the region as prescribed by the Yukon government.

Increase in road access into the Aishihik region may increase hunter success. No limits exist on annual harvest (bag limits only limit the harvest per hunter, not the total number of hunters). Grizzly hunting by non-residents is a major part of the Yukon's four million dollar big game outfitting industry, especially in the southern Yukon (Banci, 1990). The extent of poaching in the park is unknown, but it is not suspected to be significant (Ray Breneman, pers. comm.).

Regional bear populations have been considered by the Yukon Government as stable and increasing, with populations very close to habitat capability (Banci, 1990). If so, this suggests that park bears may experience increased difficulty in ranging outside the park as a result of intra-species competition and learned avoidance of hunted areas. Settled areas provide attractions resulting in food conditioning which may overcome the bear's inherent avoidance of settled areas (up to 3 km, see Table 21).

Road kills in the park and surrounding region are negligible or non-existent in some areas (Dan Drummond, pers. comm.; Ray Breneman, pers, comm.). Therefore, despite known and suspected bear movements outside the park, collisions do not seem to be a significant effect.

6.4.3.2 Scenario B: Build out

The evidence presented in Scenario A suggests that increased road densities, growing local human populations and expansion of settlements, increased tourist visitation and continuation of mining activities will lead to increased bear mortality. As to whether the mortality rate of park bears is acceptable will depend on the current total population and effects on viability due to disturbances. Knowledge of current populations is very limited, and knowledge of response to various recreational activities is uncertain (although evidence described in H1 and H2 suggest worsening alienation effects).

However, it is fairly clear as to direct mortality sources. Although local community population growth is small now, that could change if various Scenario B projects proceed. This would increase the probability of DLP and hunting kills.

6.4.3.3 Scenario C: Long-term

The long-term implications of continued human use in the region suggests a result similar to what is already being suspected in the Rocky Mountain parks. Hunting pressures may exceed recruitment rate and fragmented populations may be separated by distances greater than normal dispersal distances (Dueck, 1990). Even the combined area of all four core mountain parks (20,160 km^2, slightly less than the total area of Kluane and five times Kluane's green zone size) may be inadequate to ensure long-term bear viability if habitat in regions surrounding the park is not maintained (Herrero, 1992). In Canadian and U.S. mountain parks, "90% of known grizzly bear mortality is man-induced" (Herrero 1993, p. 1).

It is suggested that Yukon grizzly populations are currently healthy only because of the small human population base (Shank, 1979). If major industrial projects take place, and facilitation of tourism and big game hunting continues to increase at or greater than rates described in Scenario A, then Kluane's bear population may experience the same risk to viability as now being perceived in the Rockies.

6.4.3.4 Discussion

Hunting and encounters outside the park already result in the removal of bears. Mortality of bears outside the park is of concern to KNPR if all or some of those bears are 'park' bears; that is, if most of the bears' home range and denning occurs within the national park boundaries. What is not known is the significance of this loss relative to bear demographics in the park (i.e. positive or negative trends resulting from difference between birth and immigration versus death and emigration). Such information would be required before a conclusion to H3 could be made with more confidence.

Some evidence is available however which, based on direct observation, suggests that perhaps 20% to 40% of park bears include in their ranges areas outside the park (see Table 8). Park bears may spend as much as 50% of their time out of the park (McCann, 1992).[24] Many males may spend greater time outside the park due to far home ranges and dispersal of sub-adults (Barney Smith, pers. comm.). Other evidence indicates that movements of greater than 100 km are occurring. General knowledge of bear movements in North America (see Table 8) suggests that typical ranges of bears, particularly adult bears, would allow incursions into areas outside the park. Since bears are moving outside the park one may assume that disturbance pressures there are equivalent or less than in the park, and that habitat availability is equivalent or greater than in the park (otherwise, areas outside the park would not be attractive to bears).

In summary, the effect on bears from direct mortality and behavioural changes induced by human frontcountry activity are the creation of 'mortality sinks' in which bears are killed. The long-term population consequences of such sinks are self evident, and are most significant if there is too great a loss of females. The effect of the Aishihik region mortality sink on park bear populations may be increasing, despite garbage control efforts, due to increased human prescence in the area.

Some direct evidence suggests that park bears may be included in regional mortality, and subject to intra-specific competition for resources outside the park. Hunting success has increased as a result of a burgeoning local hunting industry and increased hinterland access. Kills are skewed towards female mortality, a threat to bear population growth. Regional mortalities are within harvesting limits; however, there is a risk that if some of those bears would have otherwise returned to the park, the effects on the park population would represent a harvest above those

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[24] Any interpretation of recently obtained data such as this from the Grizzly Bear Research Project must be qualified due to the small sample size of tracked bears. The figures used here do not imply precise known values, but are only used to indicate possible magnitudes for the purposes of this preliminary assessment.

limits. H3 therefore may be true in Scenario A, but without adequate data, such a conclusion could not be reasonably defended.

Given the evidence of current mortalities, future trends in tourism growth and hunting, and precedents at other parks, regional activities may in the future have a significant adverse effect on park bear populations. A conservative conclusion could be made at this time in consideration of the risk these changes may pose to the park bears.

6.4.3.5 Conclusion

H3 is probably true in scenario B. This conclusion is based on the risk that loss of park bears outside the park will reduce the reproductive capability of bears with historical range in the park. The risk is considered low in Scenario A, and moderate in Scenario B and high in Scenario C.

The following summarizes the assessment according to various impact categories.

Attribute	**Options**
Duration (of impact)	None, Brief, Long-term, **Permanent**
Magnitude (of impact)	None, Low, Moderate, **High**
Scale (spatial extent involved)	Local, **Regional**
Direction (of change in VEC condition)	Positive, **Negative**, Neutral
Probability (likelihood of impact)	None, Low, Moderate, **High**
Frequency (of project activities)	Continuous, **Sporadic**
Confidence (of prediction and data)	Low, Moderate, **High**
Impact significance (Overall risk)	None, Low, Moderate, **High**

6.4.4 H4. Road and trail use on and near Sheep Mountain will adversely affect dall sheep survival through behavioural changes and habitat alienation.

6.4.4.1 Scenario A: Existing

Impacts. Land-based activities in the immediate Sheep Mountain area include use of the Sheep Mountain Visitor Reception Centre (VRC) along the Alaska Highway, day-hiking along four designated trails up Sheep Mountain, a hiking trail up Vulcan Mountain, hiking along both sides of the Slims River, and short access roads to trailheads along both sides of the Slims River from the Alaska Highway. Regional activities include growth of nearby communities (Destruction Bay and Burwash Landing), traffic along the Alaska highway, and mining and traffic on mining access roads in the Kluane Wildlife Sanctuary. The Sheep Mountain area is zoned as a Special Preservation Area (SPA); therefore, no facilities or motorized access are allowed (the access roads are just outside the SPA).

The Sheep Mountain VRC is the starting point of the park's most accessible trails from the frontcountry, also offering the best opportunity for highway travellers to experience a wildlife sighting. The majority of the park's current visitors (about 86,000 person-days) will stop at the Sheep Mountain or Haines Junction VRC. Backcountry hiking along the Slims is the most popular hiking activity in the park.

Population status. Park and Territorial sheep populations are stable and increasing (see Table 8). Of approximately 20,000 sheep in the Yukon, 10,000 are in the Greater Kluane Region, half of which are in the park. Some movements may exist across the Alaska Highway, to B.C. and to Wrangell-St. Elias National Park. Populations are well distributed in the park, thereby reducing the chances of collapse of park populations due to intense localized disturbances.

The Sheep Mountain population is currently above the long-term average based on recent survey estimates (Skjonsberg, 1993), and almost twice the estimate based on earlier habitat carrying capacity (Hoefs, 1982).[25] Lamb to nursery ratios suggest a healthy population with a slow increase in size (Skjonsberg, 1993, citing ratios from Geist, 1971). Populations on Sheep Mountain have historically fluctuated significantly due to severe winter conditions affecting forage condition and availability (Hoefs, 1981). Another limiting factor for dall sheep in the park is predators (Grey, 1987); however, predation is limited, especially with the recent wolf cull (which may explain in part the above average sheep population). Sheep dispersion in general is limited by learned traits causing continued use of the same high quality and stable forage by successive sheep generations (Geist, 1978). Escape terrain on Sheep Mountain is readily available.

Loss of habitat and habitat fragmentation. These effects are not significant as a result of the principal impacts being examined. Existing trails and roads represent only a very small portion of the available habitat.

Alienation of habitat. Road and trail use on and near Sheep Mountain (response to aircraft is examined in H5) will adversely affect dall sheep survival if behavioural changes and habitat alienation cause increased stress and range abandonment. This will result in reduced vigor through reduced nutritional input and excessive energy expenditure.

In general, sheep can be very sensitive to human disturbances and run great distances in alarm towards escape terrain, especially in response to very loud and short noises (Geist, 1978). However, such immediate responses, possibly leading to range abandonment, may not occur if sheep are in a "known and largely predictable environment" (MacArthur, Geist and Johnston, 1982), if hunting does not also occur (Prism, 1982; Val Geist, pers. comm.) and if the disturbances are regular and predictable, not short and infrequent (Prism, 1982) (Sheep have been known to live near active quarries and airstrips (Geist, 1978)). Under such conditions, sheep may learn quickly that there is no threat, and so habituate to human activity.

Hiking on trails up Sheep Mountain is a very popular tourist activity. Although there appears to be general agreement that large mammals may be displaced very close to trails (resulting in a very small zone of influence, see Table 21), the effects for habituated animals is minor and does not result in large movements away (Boyle and Samson, 1985). The high day-usage of the Sheep Mountain area during peak tourist season should result in regular and frequent use of trails, providing predictable disturbances, and hence less threatening, to sheep. However, as wildlife viewing and photography is sought by hikers, the 'stalking' of sheep may be more disturbing to them. This may be aggravated by possible random (dispersed) hiking along the open slopes of Sheep Mountain, and the approach of sheep from above by hikers, an action certain to result in panic flight (Val Geist, pers. comm.). Restriction of visitor access to specific viewing sites would mitigate this effect (Val Geist, pers. comm.).

Obstruction to movements. These effects are not significant as a result of the principal impacts being examined. Existing trails and roads represent only a very small portion of the available habitat.

Direct mortality. Road access on mining roads in the Kluane Wildlife Sanctuary, and the mine sites, may be responsible for some sheep mortality due to poaching (Val Geist, pers. comm.) along the northern periphery of the park (particularly along the Burwash Uplands). Sheep are known to migrate in the winter down Congden Creek (Gray, 1987), which descends into the Sanctuary. This mortality source would be combined with known poaching on Sheep Mountain and occasional aboriginal harvest.

Slims River valley road activity in the Sheep Mountain area probably has an insignificant effect on sheep. Sheep were once reported as numerous on the Alaska highway in winter (DPWC, 1977); however, low winter traffic volumes suggest that the risk of collision mortality is low. The

[25] Suggesting either an imminent population crash or under-estimated capacity; the latter is suggested as more likely given the apparently stable population numbers.

access roads along the Slims River would experience significant traffic only during the peak summer tourist season. However, sheep at that time are in alpine meadows.

6.4.4.2 Scenario B: Build out

Future projects include the VRC relocation, Shakwak Project (re-paving and realignment of the Alaska highway), construction of the Sheep Creek day use area, maintenance of trailhead access roads, upgrading of trails along the Slims River, upgrading of trails up Sheep Mountain to an interpretation site, and increased mining activity.

The implication of these combined activities is increased visitor use of trails and poaching. If learned neutral responses by sheep continue to strengthen, visitor increase may have little effect assuming hiking remains along designated routes. There is no evidence to suggest that winter use will increase; hence critical winter range will remain largely undisturbed. Poaching may increase if more placer and hardrock mines become operational on claims in the Sanctuary.

More activity at the base of Sheep and Vulcan Mountains may not interfere with suspected movements of sheep between the mountains across the Slims River valley, as sheep are at lower elevations only during non-peak visitor periods.

6.4.4.3 Scenario C: Long-term

Long-term projects include heli-hiking (see H5), the Slims River Valley West Road, increase of random hiking in the Donjek and expansion of mining activities in the adjoining Sanctuary, particularly the Wellgreen project.

If Wellgreen proceeds, a major increase in human activity will occur in the Burwash area, with possible increase in use of off-road vehicle access roads in the Sanctuary for recreational use by workers and new community members. If it is true that much of the sheep population in the Donjek area consist of migrants from Sheep Mountain as suspected by Gray (1987), then it is possible that this linkage could be interrupted by the combination of hiking and poaching activities in northern areas of the park. These further disturbances may be significant if stress from activities in the Sheep Mountain area results in attempts by sheep to migrate permanently to new range in less disturbed and available habitat in the park.

The Slims Road would probably have low impact on sheep if winter closure was in effect. If not, effects similar to those experienced in Denali's Wonder Lake road may occur, in which the road impeded migration movements of unhabituated sheep (Dalle-Molle and Van Horn, 1991).

6.4.4.4 Discussion

It is unknown if current levels of human use are causing significant adverse effects on sheep.[26] The health of the sheep population and its continuing use of the same habitat would suggest no adverse effects. Although evidence in other areas has indicated that a combination of disturbances (e.g. aircraft and point sources of noise) may drive sheep from historical range (Shank, 1979), there is no evidence to suggest that this is happening in KNPR.

Road and trail use on and near Sheep Mountain should probably not adversely affect dall sheep survival if reasonable measures are taken to control distribution of visitor access. Road use and mining impacts outside the park may result in increased mortality; however, the effect may not be significant given the current large, well distributed and thriving sheep population in the park. Sheep on Sheep Mountain should readily habituate to increased visitor use if the use patterns are frequent, regular and non-threatening. Except for hikers in the alpine region, there is little temporal overlap between sheep movements and human activities.

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[26] Trampling of vegetation may occur if visitors stray off designated trails, thereby directly affecting the sheep's habitat.

The possibility of disruption of major north-south migrations of sheep due to activity in the Burwash Uplands could have significant effects on the Sheep Mountain populations; however, the likelihood of these activities occurring is very uncertain. It is suggested that research should be done to determine the extent of such movements. Also, ongoing monitoring beyond the current annual census should be done to observe sheep response to hikers. This will become more important as human visitation increases.

In summary, current healthy populations are evidenced by long-term monitoring. Human disturbances, although potentially significant, can be relatively well controlled. Threats to sheep remain minimal, and sheep have demonstrated the ability to habituate to such disturbances. Therefore, available evidence does not seem to indicate serious threats to sheep viability.

6.4.4.5 Conclusion

H4 is therefore probably false. This conclusion is based on historical population stability in the face of increasing usage and the appropriate future application of visitor use controls to reduce visitor impacts. The risk is considered low in Scenario A and B and moderate in Scenario C.

The following summarizes the assessment according to various impact categories.

Attribute	**Options**
Duration (of impact)	None, Brief, Long-term, **Permanent**
Magnitude (of impact)	None, **Low**, Moderate, High
Scale (spatial extent involved)	**Local**, Regional
Direction (of change in VEC condition)	Positive, Negative, **Neutral**
Probability (likelihood of impact)	None, Low, Moderate, **High**
Frequency (of project activities)	**Continuous**, sporadic
Confidence (of prediction and data)	Low, **Moderate**, High
Impact significance (Overall risk)	None, Low, **Moderate**, High

6.4.5 H5. Aircraft use over Sheep Mountain will adversely affect dall sheep survival through behavioural changes and habitat alienation.

6.4.5.1 Scenario A: Existing

Impacts. Current aircraft use in the Sheep Mountain area is due to flightseeing, shuttles to the icefields for research or recreational activities, and warden survey flights. No landings occur immediately around Sheep Mountain. No records are available for the number of flightseeing trips. Trips to the icefields account for the majority of aircraft trips in the park; however, how many may have originated from the nearby Arctic Institute Field Station at Silver City, from Haines Junction and from Burwash Landing is unknown.

Alienation of habitat. With the increasing popularity of flightseeing and interest in mountaineering generating many flights during summer seasons, the frequency and regularity of these flights over Sheep Mountain may have resulted in habituation by sheep. In general, the more infrequent and irregular the aircraft traffic, the more likely the disruption and decreased tolerance of sheep (McKechnie and Gladwin, 1993; Hoefs, 1981 citing Geist). Response varies according to learning experience, but in general seems to occur even at (relatively for other species) high altitudes and approach distances (Shank, 1979). Dall sheep are considered to be among the most sensitive of animals to aircraft disturbance (Shank, 1979). Examples are known where habituation has not occurred in over two years of aircraft use (McKechnie and Gladwin, 1993).[27]

[27] The study on dall sheep in the Northwest Territories involved helicopters approaching sheep at elevations of up to 1500 ft. (460 m) at approaches of up to 1 mi. (1.6 km).

However, examples also exist of just the opposite response where survey flights did not cause abandonment of range (Prism, 1982), habituation occurred (Shank, 1979), no ill effects occurred on sheep during lambing (McKechnie and Gladwin, 1993), and where survey helicopters could hover above sheep with no running response (Val Geist, pers. comm.).

The magnitude of effect will also be influenced by the nature of animal activity during flyover. If the immediate response of sheep is panic running (if no escape terrain is immediately available), it typically is brief (in the order of minutes). Vertical rugged terrain substantially increases energy expenditure. It is unclear however if aircraft activity will cause movements away from preferred range.

6.4.5.2 Scenario B: Build out

The principal change of significance to Sheep Mountain sheep in Scenario B is an increase in all types of park visitation, especially flightseeing as local businesses slowly cater to the highway traveller and 'one-day' visitor experiences. If minimum cruising altitudes and 'no-fly-zones' or flight-corridor guidelines are adhered to, no significant adverse affect is expected for the population.

6.4.5.3 Scenario C: Long-term

Heli-hiking, if allowed within the park, could have significant effects on sheep if habituation does not occur. Helicopters consistently cause more severe flight response by large mammals than fixed-wing aircraft because of a more irregular 'noise signature'. Further use of helicopters would then present a new type of noise unfamiliar to the sheep. Current helicopter use is limited to annual sheep surveys by wardens during non-breeding seasons, creating only occasional interruption in behaviour that based on other evidence is not expected to have significant adverse affect (McKechnie and Gladwin, 1993).

6.4.5.4 Discussion

Evidence about the viability of the population suggests that significant adverse effects are not occurring. Aircraft use over Sheep Mountain will probably not adversely affect dall sheep survival through behavioural changes and habitat alienation unless fixed wing aircraft appear at lower elevations or helicopter use is increased.

6.4.5.5 Conclusion

H5 is therefore probably false. This conclusion is based on historical population stability in the face of increasing usage and the appropriate future application of visitor use controls to reduce visitor impacts. The risk is considered low in Scenario A and B and moderate in Scenario C.

The following summarizes the assessment according to various impact categories.

Attribute	**Options**
Duration (of impact)	None, **Brief**, Long-term, Permanent
Magnitude (of impact)	None, **Low**, Moderate, High
Scale (spatial extent involved)	**Local**, Regional
Direction (of change in VEC condition)	Positive, Negative, **Neutral**
Probability (likelihood of impact)	None, Low, **Moderate**, High
Frequency (of project activities)	Continuous, **Sporadic**
Confidence (of prediction and data)	Low, **Moderate**, High
Impact significance (Overall risk)	None, Low, **Moderate**, High

6.4.6 H6. Trail and aircraft use around Goatherd Mountain will adversely affect mountain goat survival through behavioural changes and habitat alienation.

6.4.6.1 Scenario A: Existing

Impacts. Current activities around Goatherd Mountain include hiking on a trail from Lowell Lake, hiking on a trail from Mush-Bates Lakes, rafting and aircraft shuttles along the Alsek River, and camping at the base of Goatherd Mountain on the shore of Lowell Lake. Hypothesis 2 reviewed the nature of aircraft and rafting activity along the Alsek River, Lowell Lake being one of the most intensely used areas in the park, and the area experiencing the most rapid growth in visitation. Although backcountry registration for Goatherd Mountain (assumedly largely hiking from Mush-Bates Lakes) was only 2% of backcountry usage in 1994 (see Table 11), visitation more than doubled from the year before.

Population status. Mountain goats in the park are well distributed, the total population increasing by 20% during the 1980s (see Table 8). The Goatherd Mountain population is at high levels and remains the area of highest density in the park. Goat seasonal movements are minimal, with goats at the highest elevations (1370 m) by late July (Skjonsberg, 1994), thus minimizing encounters with many visitors unless they hike to the mountain summit, but possibly maximizing exposure to aircraft activity.

Alienation of habitat. Although the focus of human activity is not Goatherd Mountain but the Alsek River, hikes from rafting parties and associated aircraft use may combine to cause an adverse effect on goats. Little direct information is available on goat response to human disturbances. In general, goats are more skittish than sheep, less likely to habituate, and more likely to disperse permanently (Val Geist, pers. comm.). Direct evidence of this is their sensitivity to human disturbance as evidenced by response to resource exploration activities (Grey, 1987). Goats may change habitats if foraging opportunities are diminished (McKechnie and Gladwin, 1993). Table 21 suggests a zone of influence twice that of sheep and high disturbance factors. In an area of such close proximity of activities, this zone of influence suggests a high probability that overlapping disturbances may have an adverse affect on goat viability on a population suspected as "very susceptible " (Val Geist, pers. comm.).

Compared to sheep, goats are far more flighty and less readily approached by hikers (Prism, 1982); however, they may readily habituate to humans on foot who are not perceived as a threat (Val Geist, pers. comm.). Responses to aircraft, particularly helicopters, are immediate and intense, resulting in running towards escape terrain (Parks Canada, 1994; Prism, 1982) and in some cases abandonment of traditional range. Responses are equally high even for goats "accustomed to overflights" (DRR, 1989a, p. 43).

6.4.6.2 Scenario B: Build out

Projects of possible consequence to the Goatherd Mountain goats include the boat shuttle to Lowell Lake, and upgrades to the trails from Lowell Lake and Mush-Bates Lakes. All of these suggest a substantial increase in foot travel on the mountain. Rafting quotas are expected to limit rafting related activities and their impacts on goats; however, motorized water-access along the Alsek and Mush-Bates Lakes will increase hiking activity by allowing easier and quicker access to the mountain.

6.4.6.3 Scenario C: Long-term

The only specific long-term project that may be of significance is heli-hiking. Goatherd Mountain would be an ideal location for tour operators, as the mountain offers wildlife viewing opportunities and a spectacular view of the Lowell Glacier. The use of helicopters would be a serious threat to goats, and probably result in range abandonment regardless of the regularity and frequency of flights.

6.4.6.4 Discussion

The evidence presented here suggests that park populations are secure, yet tenuously so in an area such as Goatherd Mountain in which many activities occur. Habituation may occur for hikers, but is less likely to occur for aircraft. If aircraft landings, takeoffs and overflights are routed away from the mountain, the risk of range abandonment will be lessened.

Visitation increases are sure to occur if proposed projects are implemented. It is possible that with such rapid increases of human use, adverse effects on goats may not be noticed by park staff until after the effects have become intolerable to goats and resulted in population decline on Goatherd Mountain. It is suggested that more frequent population monitoring be done if usage continues to increase at current rates. Too little is known about the long-term effects on goats due to sensory disturbances. A conservative management approach is advisable (see section 6.3.1 for a discussion of this).

Evidence presented in Scenario A suggests the possibility of disturbances in Scenario B and C exceeding tolerable levels by goats resulting in range abandonment. It is unknown if suitable habitat is available elsewhere in this event.

6.4.6.5 Conclusion

H6 is therefore probably true in scenario B. This conclusion is based on the risk of significant increases in stress or abandonment of range. The risk is considered low in Scenario A, moderate in Scenario B and high in Scenario C.

The following summarizes the assessment according to various impact categories.

Attribute	Options
Duration (of impact)	None, **Brief**, Long-term, **Permanent***
Magnitude (of impact)	None, Low, Moderate, **High**
Scale (spatial extent involved)	**Local**, Regional
Direction (of change in VEC condition)	Positive, **Negative**, Neutral
Probability (likelihood of impact)	None, Low, Moderate, **High**
Frequency (of project activities)	**Continuous**, Sporadic**
Confidence (of prediction and data)	Low, **Moderate**, High
Impact significance (Overall risk)	None, Low, Moderate, **High**

* Trails are permanent, overflights are brief.

** Continuous during peak visitor use season.

6.4.7 H7. Recreational use and hunting along Alder Creek and the Mush-Bates Lakes will adversely affect moose survival through behavioural changes, habitat alienation and direct mortality.

6.4.7.1 Scenario A: Existing

Impacts. Activities that may affect moose include motorboat use and fishing on the lakes, vehicle traffic on Alder Creek road, backcountry hiking on the Cottonwood trail and a trail west to Goatherd Mountain, overflights from Turnback Canyon shuttles, aboriginal hunting, regional hunting, and the Aishihik wolf cull.

Registered backcountry usage in the Alder-Mush vicinity was approximately 20% (see Table 11) of total park usage in 1994. The increase since 1993 was negligible. More than half of that use was hikers on the Cottonwood trail, the most popular single trail in the park with usage comparable to that in the Slims River valley (the trailhead is on the Alder Creek road). The Mush Lake campground is very popular with local residents as it provides easy access to fishing, the most popular local activity along with camping and RV use (DRR, 1990). The road is closed in the winter to all traffic.

Population status. Moose populations in the park and Alder-Mush vicinity have been increasing slowly (see Table 8); about half of the park moose are in that area. Moose commonly migrate eastward across the Alaska Highway to better winter habitat.

Alienation. In general, moose tolerate human presence well and adapt well to human disturbance (Shank, 1979). Habituated moose may allow quite close human approaches on foot (Shank, 1979), and exhibit avoidance not to roads but to vehicle traffic, particularly if occupants leave their vehicles (Prism, 1982; Komex, 1995). Moose in Denali National Park remained still as opposed to fleeing in response to traffic on the Wonder Lake Road, the degree of response diminishing if the moose could hide in roadside vegetation (Prism, 1982). Response to aircraft is consistently low (i.e. no running observed, and suspected low physiological stress) for relatively low fight altitudes (see Table 21) (McKechnie and Gladwin, 1993; Shank, 1979).

Road traffic to the trailhead and to the campsite are probably frequent and regular during peak summer use; suggesting a high probability of habituation. If motorboat use causes a response similar to that of road vehicles, then effects from motorboats should also not be significant.

Obstruction to movement. Although moose are fairly distributed in the park's green zone, the concentration at Alder-Mush may partly be due to lack of equivalent quality habitat elsewhere (Hoefs, 1973), and partly due to the view that moose will not disperse into hunted or exploited areas (i.e. Aishihik region), but will increase productivity in adjacent non-hunted areas (Prism, 1982). The winter road closures mean that traffic activities will probably not interfere with moose movements further east (the moose will probably make use of the road as a travel corridor) across the Haines Highway. The highway does not appear to be an obstruction to movements; habitat use east of the highway is well known.

Direct mortality. Aboriginal hunting is minimal in the park (Lawrence Joe, pers. comm.); however, predation and aboriginal harvesting has been suspect in contributing to population declines outside the park. Incidents of vehicle collisions with moose are negligible (Dan Drummond, pers. comm.; Ray Breneman, pers. comm.). Direct mortality in the park is therefore negligible.

6.4.7.2 Scenario B: Build out

Future projects that may affect moose include a motorboat shuttle on Bates Lake, Mush Lake campground and day use area upgrades, Alder Creek road maintenance, portage upgrade between the lakes and trail upgrade to Goatherd Mountain, aboriginal hunting and increased rafting on the Alsek River resulting in more aircraft flights.

Of special note are possible increases of aboriginal hunting of moose. There are differing perceptions as to whether harvest will increase — the implications of the Champagne-Aishihik land claims agreement to many park issues is very uncertain. It is suggested, based on evidence from the Band and Parks Canada, that aboriginals will place a higher value in facilitating non-consumptive tourism in the park in recognition of the value wildlife has in promoting a tourism industry. Furthermore, much of the prime moose habitat in the park lies within no harvest zones established during the land claims settlement, the closest in the Bates Lake area. A high harvest would place considerable stress on moose in the summer as, given hunting outside the park, moose may not have other available habitat to which to move. If the wolf cull achieves its goals outside the park, reduced predation may offset increased hunting in the park and surrounding region.

6.4.7.3 Scenario C: Long-term

Hunting pressures may increase due to construction of lodges along the Haines Highway and a growing local population that is expanding its tourist facilities (e.g. the Matatana Resort, proposed to be built by the Champagne-Aishihik north of Kathleen Lake).

If current rates of visitation continue, hunting increases, and quotas on use of the Cottonwood do not come into affect as elsewhere in the park, the impacts on moose could result in significant alienation. However, despite the uncertainty of prediction in such long time-frames, this is not expected to occur.

6.4.7.4 Discussion

Given the small zone of disturbance, low disturbance factors (see Table 21), attraction of high quality habitat, protection from much hunting, and apparent ready behavioural response of habituation, the effects from these activities may not be significant. Although overall park usage is increasing, the greatest increase is along a narrow corridor (Cottonwood trail) and concentrated in a small area (Mush Lake campsite). Aircraft overflights at cruising altitudes should not present a significant effect. Altogether, the evidence suggests that habitat alienation may be limited.

Recreational use and hunting along Alder Creek and the Mush-Bates Lakes will probably not adversely affect moose survival through behavioural changes, habitat alienation and direct mortality for an extended period of time. Moose appear to readily habituate to human disturbance, and aboriginal peoples are not expected to threaten this important resource through overhunting.

6.4.7.5 Conclusion

H7 is probably false. This conclusion is based on a low risk of adverse effect due to alienation and hunting. The risk is considered low in Scenario A and B and moderate in Scenario C. The following summarizes the assessment according to various impact categories.

Attribute	Options
Duration (of impact)	None, Brief, **Long-term**, Permanent
Magnitude (of impact)	None, **Low**, Moderate, High
Scale (spatial extent involved)	Local, **Regional**
Direction (of change in VEC condition)	Positive, Negative, **Neutral**
Probability (likelihood of impact)	None, Low, Moderate, **High**
Frequency (of project activities)	**Continuous**, Sporadic
Confidence (of prediction and data)	Low, **Moderate**, High
Impact significance (Overall risk)	None, **Low**, Moderate, High

6.4.8 H8. Human activities along the Slims River valley will adversely affect golden eagle survival through behavioural changes and habitat alienation.

6.4.8.1 Scenario A: Existing

Impacts. Projects and activities which may affect golden eagles include hiking along the Slims River and Sheep Mountain, and aircraft overflights to the icefields, flightseeing and warden survey flights.

Population status. Little information is available on golden eagle use in the park. Identification of nests indicates activity concentrated on cliff faces in the Duke and Slims River valleys. This evidence indicates extensive use in the Slims River valley (see Table 8), particularly on the southern portion of Sheep Mountain. Most eagles are summer residents or migrants passing through, return in March and nest in May. Golden eagles are common in the surrounding Greater Kluane Region and throughout the Yukon.

Alienation. In general, raptors are sensitive to human disturbance but not to the extent of habitat abandonment (McKechnie and Gladwin, 1993). Raptor sensitivity is greatest during nesting season (Lopoukhine, 1983), with occasional flushing of nests observed due to aircraft activity (McKechnie and Gladwin, 1993). Increased frequency of visitation (Knight and Cole, 1991) and steady approaches by aircraft (McKechnie and Gladwin, 1993) generally results in less stress;

however, close approaches by helicopters cause more response than fixed-wing aircraft (Watson, 1993).

6.4.8.2 Scenario B: Build out

Projects in this scenario probably will not result in worsening effects on eagles. Winter use in the park is negligible, and increases of use in the Slims River, although one of the most heavily used areas in the park, occur as hiking and flightseeing during a few summer months.

6.4.8.3 Scenario C: Long-term

This scenario may introduce increased helicopter use in the area. If this is the case, then only warden flights may occur at lower elevations. However, avoidance of such use during nesting periods considerably reduces the chances of disturbance. Furthermore, as in H5 regarding sheep, low level aircraft flight patterns should not include sudden appearances over mountain ridges.

6.4.8.4 Discussion

Effects on golden eagles are probably not significant. Critical nesting periods occur during a period of no land-based visitor activity. Although hikers during the remainder of the year may expose eagles at their nests, effects may not extend beyond flushing. This continuous physiological stress could result in abandonment of nests; however, the evidence suggests otherwise. Aircraft flights along the Slims River valley are at cruising altitudes and probably will have no significant effect, with the possible exception of warden flights. The information on raptor responses suggests that if these flights do not abruptly cross over mountain ridges into the valley, and maintain distances outside the zone of influence (see Table 21), the effects should not be significant.

Although determining the effects on eagles is hampered by little data on eagle use of the valley, the disturbances are largely predictable and probably do not pose a serious threat.

6.4.8.5 Conclusion

H8 is therefore probably false. This conclusion is based on a low risk of adverse effect due to alienation and effective control of aircraft use. The risk is considered low in Scenario A and B and moderate in Scenario C.

The following summarizes the assessment according to various impact categories.

Attribute	**Options**
Duration (of impact)	None, Brief, **Long-term**, Permanent
Magnitude (of impact)	None, **Low**, Moderate, High
Scale (spatial extent involved)	**Local**, Regional
Direction (of change in VEC condition)	Positive, Negative, **Neutral**
Probability (likelihood of impact)	None, Low, **Moderate**, High
Frequency (of project activities)	Continuous, **Sporadic**
Confidence (of prediction and data)	Low, **Moderate**, High
Impact significance (Overall risk)	None, **Low**, Moderate, High

6.4.9 H9. Aircraft use in the park's green zone will adversely affect the long-term viability of wildlife VECs.

The wildlife species examined generally exhibit physiological stress and possible range abandonment only if aircraft flights are within their respective zones of influence. Some species are more sensitive under certain conditions, particularly if flights are irregular, infrequent and appear abruptly (especially for helicopters suddenly appearing over a ridge). These conditions generally only occur at landing/take-off sites within the park; otherwise flights are at cruising altitudes above species' zones of influence, altitudes that can be dictated by park or industry in the park. The second reason population collapse is doubtful is that Kluane has recently begun the process of implementing visitor use guidelines and quotas. This will reduce impacts if these measures are effectively implemented. The third reason is that the park continues to act as a core refugium for wildlife that, despite experiencing growing levels of disturbance, still offers relatively protected and quality habitat compared to significantly disturbed habitat (especially due to hunting) just outside the park in the Yukon. Furthermore, this core refugium extends further than Kluane's borders: the adjoining parks in B.C. and the U.S. provide potential alternative habitat sites in the eventuality that disturbances in one park are too high, effectively creating some measure of habitat based 'redundancy' for wildlife.

This study cannot answer hypothesis 13 with much confidence. No cumulative effects technique, when faced with this degree of uncertainty of wildlife status, wildlife response, and future project trends, can provide a definitive answer and so proceed any further in the analysis. Review of available information and precedent must be used as input to a subjective evaluation of risk of significant adverse effect occurring (for further discussion on this matter see section 7.3).

The prudent course of action to take is to make conservative assumptions about the probability of adverse effects until such assumptions can be shown as incorrect. Regarding hypothesis 13, although in the short-term the hypothesis is probably false, it cannot be assumed so in the long-term.

H13 is therefore probably true for Scenario C.

7.0 Summary and Conclusions

7.1 Hypotheses conclusions

Table 23 lists the hypotheses conclusions. The conclusions suggest that the species of most concern are grizzly bear and mountain goat, with effects on the remaining species probably not significant if mitigation measures (see Recommendations in Executive Summary) are effectively applied. Also, it is apparent that by the time Scenario B occurs, effects on all wildlife VECs could be significant, but not necessarily result in collapse of populations. There is a small but not trivial likelihood of such a collapse occurring in Scenario C.

The use of the word "probable" in the hypotheses analysis is purposely done to reflect a risk evaluation approach to the assessments. Very little is sure in predicting effects on wildlife; hence a probabilistic approach is used in the conclusions. Owing to fewer data gaps and uncertainties, a higher confidence can be placed on the conclusions reached for some hypotheses. These include the hypotheses for sheep, goat and moose (hypotheses 4 to 7)[28] and the effects due to aircraft, road and trail use (hypotheses 9 and 10).

It must be understood that a "true" or "false" conclusion here is a qualitative decision based on best judgement, and belies the difficulty of predicting cause-effect relationships when both the impacts and VECs are changing with multiple interactions and wildlife data is often unavailable. Available information may poorly represent reality and interpretation may be questionable given what further research may provide about suspect relationships. Nonetheless, the principal use of Table 23 is to provide some direction to park decision makers as to where effects may be most significant. This may help determine where decisions on research and park policy could be directed and on what basis decisions on project implementation could be made.

It is instructive to note that the conclusions are not technically precise as to the fate of the species, although possibilities are discussed in general in the hypotheses. For example, predictions are not stated as "Effects of mortality on grizzly bears should result in a 20% reduction of current bear populations by the year 2000, thereby lowering the park population below minimum viable population levels" or "Mountain goats on Goatherd Mountain will be forced to move to new range further north of less quality due to aircraft activities". Neither the data nor the analytical tools are available (given the scope of the study) to reach such conclusions with sufficient confidence to make strong statements. The implication of what is said in the hypotheses (e.g. adversely affected) only suggests that future wildlife demographic and behavioural trends in response to disturbances may threaten the ability of the population to live in similar conditions and at similar numerical levels as currently exists. Assumedly, avoidance of such trends would constitute an important resource conservation goal in a national park.

7.2 Project contributions to overall effects

Table 24 qualitatively ranks the contributions of projects (i.e. the degree by which a project is responsible for contributing to overall effects on wildlife in the park) proposed in the PMP. As in Table 23, this presentation in brief summary fashion of complex information is intended to serve as a guide to decision makers, not as a definitive conclusion. This should assist park managers, along with the weight of evidence presented throughout this study, in answering the fundamental question: is there any one proposed project or combination of projects that may cause unacceptable and irreversible harm to wildlife in the park? Table 24 suggests that those projects may be Alsek River rafting management, aircraft support at Lowell Lake for rafters and hikers, the Alsek Pass road and day use area, and the boat shuttle to Lowell Lake.

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[28] Although much information is available for grizzly bear in general, little is available that is specific to the park.

In summary, the matrix ranks in Table 24 were determined by the author asking, for each project, the following questions in succession:

1. Are effects localized to project footprint, of short duration and of minimal significance to wildlife VECs as determined through hypotheses conclusions, inferral from conclusions (for areas and activities not directly covered in hypotheses), and results of wildlife screening as shown in Table 19? If yes, then value is "Low".
2. Are effects relatively limited to a single area or corridor, never or seldomly interact with other activities, and effects on VECs limited to brief periods of time or short distances from activity? If yes, then value is "Moderate".
3. Do effects from project cover a wide area, often interact with other activities, and effects on VECs are significant? If yes, then value is "High".

Assumptions made and conclusions reached in this cumulative effects analysis could be easily changed, upon acquisition of new information, by returning to an earlier step in the CEA framework and repeating the process (e.g. at the next park management plan review in five years). This iterative or 'adaptive management' approach would allow the gradual introduction of new data, perceptions and values. The result of a workshop reviewing this material at a later date could generate a very different set of data, assumptions and conclusions; however, the framework developed and information gathered here can be used again.

7.3 Implications of cumulative effects for park management

The proposed projects are in response to the park's objectives as stated in the *Park Management Plan*. The objectives, many common to most Canadian national parks, include protecting natural and cultural resources, provision of visitor services, facility improvement and protection of unique resources. Attempts by KNPR to improve backcountry access and frontcountry facilities might collectively result in unacceptable effects on the park's Valued Ecosystem Components. Proposed projects must meet the dual mandate, as stated in the *Park Management Plan* and *Guiding Principles and Operational Policies* of natural resource conservation and facilitation of visitor access.

This cumulative effects assessment, completed at hypothesis 13, cannot proceed any further with confidence until more data is obtained and determination of risk is made: to what degree are Parks Canada and other stakeholders (e.g. Champagne-Aishihik, local community residents, Yukon Government) willing to risk the possibility of loss of wildlife in the park, given the uncertainties of wildlife response to disturbances and evidence of adverse trends experienced in other wilderness areas? Given the importance of tourism to the local economy and to the Park's mandate of natural preservation, a conservative approach is recommended to ensure conservation of wildlife VECs that create some of that tourism demand.

More research and monitoring of course would always be useful. Data needs were identified in the hypotheses; these should be pursued to validate the effect's conclusions. However, the availability of data from such studies and the interpretation required may not be forthcoming before the next park management plan review. Therefore, assessments must be conducted based on available data and subjective valuations, to be reviewed again in subsequent plan reviews.

Recommendations in the Executive Summary list research, monitoring and mitigation measures identified in the Kluane study. This summary is intended to assist park managers in reviewing measures they may take to facilitate management of the Park, and to identify priority management actions.

Table 23: Hypotheses conclusions

#	VEC	Hypothesis	Probable conclusion
Species specific			
1	Grizzly bear	Road and trail use along the Dezadeash, Kaskawulsh and Slims River valleys will adversely affect grizzly bear survival in the park	True in scenario B
2		Aircraft and watercraft use along the Alsek River Valley will adversely affect grizzly bear survival through behavioural changes and habitat alienation	True in scenario B
3		Hunting and encounters outside the park will adversely affect grizzly bear survival through behavioural changes and direct mortality	True in scenario B
4	Dall sheep	Road and trail use on and near Sheep Mountain will adversely affect dall sheep survival through behavioural changes and habitat alienation	False
5		Aircraft use over Sheep Mountain will adversely affect dall sheep survival through behavioural changes and habitat alienation	False
6	Mountain goat	Trail and aircraft use around Goatherd Mountain will adversely affect mountain goat survival through behavioural changes and habitat alienation	True in scenario B
7	Moose	Recreational use and hunting along Alder Creek and the Mush-Bates Lakes will adversely affect moose survival through behavioural changes, habitat alienation and direct mortality	False
8	Golden eagle	Human activities along the Slims River Valley will adversely affect golden eagle survival through behavioural changes and habitat alienation	False
Impact specific			
9	All wildlife VECs	Aircraft use in the park's green zone will adversely affect the long-term viability of wildlife VECs	True in scenario B at Lowell Lake
10		Road and trail use in the park's green zone will adversely affect the long-term viability of wildlife VECs	True in scenario B at Alsek Pass
11		River rafting on the Alsek River will adversely affect the long-term viability of wildlife VECs	True in scenario B for bears and goats
12		Causes of direct mortality inside and outside the park will adversely affect the long-term viability of wildlife VECs	True in scenario C
13		The combined effects of all park and regional activities will result in reduced populations or extirpation of some or all wildlife VECs in the park	True in scenario C

Table 24: Contribution to overall effects by projects proposed in 1990 Park Management Plan

Project	Location	Contribution to overall effects
Existing		
Manage rafting	Alsek River	High
Manage rafting campsites	Alsek River	Low
Rafting support (Lowell Lake) with aircraft	Alsek River	High
Reduce Donjek Valley SPA*	Donjek Valley	Low
Backcountry tripping support with aircraft	Duke/Donjek area	Moderate
Icefields support with aircraft	Icefield Ranges	Low
Expand Alsek Valley Grizzly Bear Protection Area SPA	Kaskawulsh Valley	Low
Allow snowmobiling	Kathleen Lake	Low
Cottage removals	Kathleen Lake	None
Motorboat access	Kathleen, Mush Lake	Moderate
Backcountry day use hiking support with aircraft	Lowell lake	High
Delete Bates Lake Island and Shaft Creek SPA	Mush-Bates	None
Backcountry tripping support with aircraft	Onion, Bighorn or Lowell lakes	Moderate
Expand Sheep Mountain SPA	Slims River Valley	Low
Add archeological site SPA	Unknown	None
Proposed		
Mush Lake road maintenance	Alder Creek	Low
Upgrade Mush Lake (includes campground) Day Use Area	Alder Creek (at end of road)	Moderate
Build Alsek Pass Road	Alsek Pass	High
Build Alsek Pass Day Use Area	Alsek Pass (at end of road)	High
Motorboat shuttle	Bates Lake	Moderate
Sugden Creek Road maintenance	Dezadeash River	Moderate
Shuttle to Bear Camp	Dezadeash/Alsek River	Moderate
Shuttle to Lowell Lake (Jetboat, hovercraft)	Dezadeash/Alsek River	High
Upgrade Kathleen Lake day use trails	Kathleen Lake	Low
Upgrade Kathleen to Louise Lake portage	Kathleen Lake	Low
Build Alaska Highway pulloffs	Kluane Wildlife Sanctuary	None
Canoe rentals	Louise, Mush-Bates Lakes	Low
Upgrade Goatherd Mtn. (from Lowell Lake) trail	Lowell Lake, Goatherd Mtn.	Moderate
Upgrade Mush to Bates Lake portage upgrade	Mush-Bates	Low
Upgrade Mush-Bates trail to Goatherd Mtn.	Mush-Bates	Moderate
Build Observation Mtn. (from Slims West Day Use area) trail	Slims Valley	Moderate
Build Sheep Mtn. Sheep Interpretation trail	Slims Valley	Moderate
Sheep Creek road maintenance	Slims Valley	Low
Upgrade Kaskawulsh Glacier (from Vulcan Creek) trail	Slims Valley	Moderate
Upgrade Sheep Creek Day Use Area	Slims Valley	Moderate
Vulcan Creek Road maintenance	Slims Valley	Low
Upgrade integrated trail system	Throughout park	Moderate

* SPA= Special Protected Area

Contribution:
High (significant)
Moderate
Low (trivial)
None (   )

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- The literature search (especially regarding effects on wildlife) will be defined and limited by the consultants
- Analysis will proceed based on available data. The study schedule will not be delayed by delays in obtaining information beyond the period allotted as shown in the schedule.
- Any part of the work done may be quoted by George Hegmann and used as he wishes as part of his case study for his Master's thesis

Project schedule

The Project schedule is shown below (each number represents one week):

- start date February 20 for the following schedule (date follows time required to complete existing contractual obligations and course work)
- completion date May 19 (possible delays would be negotiated with Parks Canada)
- duration of 12 weeks (3 months, with one week built in near end for Park's review of draft report)

Activity	Feb		Mar				Apr				May		
	1	2	1	2	3	4	1	2	3	4	1	2	3
Data collection and literature search	■	■	■	■									
Site visit		■											
Review of CEAs				■									
Bounding the study					■								
Analysis and prediction of effects						■	■	■	■				
Prioritize for management review									■				
Draft report writing / map preparation										■	■		
Park's review of draft												■	
Final report editing and printing													■

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