Assessing Cumulative Effects in Kluane National Park

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Abstract

A cumulative effects assessment was performed, under contract with Parks Canada, for Kluane National Park Reserve (KNPR) in the Yukon Territory (Hegmann, 1995a). 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 (PMP) and in the surrounding region. 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).

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, disturbance nodes. zones of influence and disturbance factors.

Study background

Kluane National Park Reserve, established in 1976, covers 22,015 km^2 in the far south-western corner of the Yukon Territory, 160 km west of the Territory's major settlement and capital of Whitehorse (see Map 1). 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). 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 – Parks Canada wishes to retain visitors for longer periods of time to experience a wider range of activities.

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 (see Map 2). This 'green zone' includes most of the park's wildlife habitat. The proposed activities are largely constrained within narrow linear corridors (e.g. river valleys) that extend into the backcountry from the highways, and amongst a few visitor activity centres.

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 and assessment of any such interactions is fundamental to a cumulative effects assessment.

The valued ecosystem components (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 largely on the basis of results from previous screening reports (CPS, 1990; CPS, 1991) and the selection of a limited number of large mammals as indicators of change in the park.

Human impacts in the region include mining, proliferation of access roads, hunting, local community growth, and forestry. Tourism visitation, which has increased nearly 10 fold during the 1980s (Slocombe, 1991) includes a substantial "highway traveller" segment, and a smaller "destination traveller" segment. The latter includes a large frontcountry portion and a smaller but rapidly growing backcountry "adventure travel" portion that has recently grown at a rate of 12% p.a. This growth may be attenuated by various control (e.g. quota) mechanisms. Otherwise, at the current rate, backcountry visitation will experience a doubling of 1995 levels by the year 2002 (at 21,000 person-days).

Significant areas of backcountry use include rafting along the Alsek River and hiking along the west shore of the Slims River, the Cottonwood trail, and random hiking in the Donjek River valley. 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.

Study methodology

Methodology overview

Figure 1 illustrates the cumulative effects assessment (CEA) framework used in this study. Adopted from the "Adaptive Inquiry Process" (Hegmann and Yarranton, 1995; Hegmann, 1995b), the framework defines each step in implementing the CEA. The framework includes four stages: 1) Baseline – identifies the VECs and projects, and describes the park resources and human use scenarios; 2) Screening – 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. An important element of this process is that it is iterative. One should be able to re-examine work done (given availability of resources); 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.

The objectives of screening were to identify early on what was important to examine, identify the relevant projects according to the Park Management Plan (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.

The analysis of impact hypotheses, central to the framework, is based more on carefully reasoned narrative 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 (US FWS, 1993) and the Weaver Habitat Disturbance Model (Weaver et al., 1985), could provide some information but only at considerable expense.

Certain methodological elements or tools 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.

Methodological tools

Methodological tools are techniques that assist in the assessment of effects. Various tools may be called upon in an assessment to organize and present information, assist in developing a qualitative or quantitative prediction of effects, and summarize analysis results. The following tools were used in the Kluane study.

Scenarios

A scenario groups existing and "reasonably foreseeable projects" into distinct timeframes. This allows future projects, and changes to existing projects and human use, to be projected in a stepwise fashion. The three scenarios chosen were: (A) "Existing" projects and activities in and around the park; (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; and (C), "Long-term" projects that may take place between 10 to 20 years from now.

Disturbances and disturbance nodes

Disturbances are any impacts (projects or activities) that may cause a significant effect on VECs. Disturbance nodes (see Map 3) 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. Disturbance nodes may occur as a result of one or more projects at various spatial scales, 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.

Zone of influence and disturbance factors

A zone of influence (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 disturbance factor (DF) gauges the sensitivity of the animal to the disturbance. The ZOI and DF are attempts to distill many disparate observational based field studies into one single numerical or ranked quantity, albeit crude, for assessment purposes (e.g.

aircraft overflights have a ZOI of 500m and a DF rating of Medium for dall sheep. 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.

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.

Ecological principles

Certain 'rules of thumb' or principles 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. Some examples of principles, based on a review of literature, include:

- An animal may more readily adapt to a disturbance, particularly noise, if the activity pattern is regular, predictable and not associated with any danger.
- 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).
- 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 *et. al.,* 1986).
- 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).
- One should make conservative assumptions about the significance of effects on VECs when data is limited and the potential for continuing human encroachment is high. The "safe minimum standard of 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). 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.

Screening

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 was 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, 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'.

Projects and suspected significant effects were identified that 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), and the results put into a table. This assists in answering the most important cumulative effects question: what is producing an effect on what? Very localized effects were not considered significant unless use is expected to grow substantially (e.g. campers trampling campsite vegetation). The study did not examine visual, recreational carrying capacity, social, economic, and historical/archeological effects.

Effects were first ranked on a two-point scale of risk assessment that assesses the significance of an effect: it is either trivial or non-trivial. 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 screening made use of the following questions in succession (adopted from Duval and Vonk, 1994). One moves on to the next question if the answer is yes. The "threshold" from non-trivial to trivial occurs if one proceeds beyond question 3.

1. Will the project change reproductive capacity or productive capacity of habitat? If no, insignificant effect. (effect is then ranked as trivial.)

2. Is change in question 1 unacceptable? If no, probably insignificant effect. (effect 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. (effect is then ranked as trivial.)
4. Will recovery of population or habitat occur? If no, very significant effect. (effect is then ranked as non-trivial.)
5. Is a short-term recovery expected? If no, probably significant effect. (effect is then ranked as non-trivial.)

In the face of limited data, and before more detailed analysis is performed in step 9, the screening of effects 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.

Project synergies

Synergies, or project interactions, are based on examination of interactions between disturbance nodes. Step 6 in the CEA framework includes a preliminary determination 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).

Synergies were illustrated through the examination of three tables. The first two tables present information on disturbances and disturbance nodes. Table 1 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 2 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 3 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. Matrix ranks in Table 3 were determined by 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 3 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.

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, 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 earlier as having non-trivial effects, and frequent and regular use). The strength of synergies between disturbance nodes was considered as another attribute (e.g. indicative of frequency of activity).

A table correlated impacts on each wildlife VEC with six effects types that, if significant, may result or will result in adverse effects on wildlife. The effects types are loss of habitat, habitat fragmentation, alienation of habitat, obstruction to movement, direct mortality and management removals and/or destruction of animal by park wardens due to human safety concerns. Finally, an overall significance was provided for each project, indicating the suspected contribution of that project to total cumulative effects (from all projects) on that species.

Analysis

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, to 'weigh the evidence' during the hypotheses analysis, 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.

Cause and effect linkages

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.

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.

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 innate and learned responses have great "intra and inter-specific variation" (Knight and Cole, 1991).

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 ZOI represents a form of fragmentation as the habitat within the zone 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.

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 (qualitative implies here that no further ranking or arithmetic totalling of values was done.) The selection was based on examination, for each species, of where the most significant effects were in the effect's screening (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. Table 4 lists the 13 hypotheses selected.

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.

Evaluation of hypotheses

Each hypothesis analysis reviews certain effects types. Figure 2 shows those for Grizzly bear; the types are similar for the other species – such 'network' diagrams are useful in organizing the relationships in preparation of hypotheses analysis. Such a breakdown of effects are used to guide the effects hypotheses for all VECs. Central to an effect's assessment is determining 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.

For purposes of illustration of use of hypotheses, the following section summarizes the results from the analysis of hypothesis one. This provides an indication of what issues were considered and in what manner the hypotheses investigations were made.

Example hypothesis for effects on grizzly bear

Hypothesis one states: "Road and trail use in the Dezadeash, Kaskawulsh and Slims River valleys will adversely affect grizzly bear survival in the park".

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 ten 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. 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.

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, such as park bear population and trends and extent of bear dispersal from and within park.

The research could be focussed by the answering of sub-hypotheses, such as "The Alaska/Haines highway is a significant obstruction to bear movements between the park and the Aishihik region".

Hypothesis one is probably true in scenario B (and, therefore, also true in scenario C) 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).

Duration (of effect):	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 effect):	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

Conclusions to hypotheses

The study concluded that the species of most concern are grizzly bear and mountain goat, with effects on the remaining species probably not significant if mitigation measures 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) and the effects due to aircraft, road and trail use (hypotheses 9 and 10).

It must be understood that a "true" or "false" conclusion 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 the hypotheses analysis 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 analysis is 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". Neither the data nor the analytical tools are available (given the scope of the study) to reach such conclusions with sufficient confidence to make such firm 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.

Project contributions to overall effects

A final table (see Table 5) 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. 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? This analysis 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. Matrix ranks were determined by 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? 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.

Implications for park management

This cumulative effects assessment 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 Band, 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

The recommendations listed below were provided to assist park management in mitigating effects, interpreting cumulative effects issues in the park and determining appropriate management responses.

1. Implementation of mitigation measures, such as: visitor education; commercial operator permitting and adherence to industry guidelines or park policy; aircraft landing restrictions, minimum cruising altitudes, no-fly zones, and flight corridors; rafting party size restrictions and scheduling quotas; backcountry trail registration; and quotas and bearproof food containers for hikers.
2. Conducting wildlife related research, such as studies of grizzly bear population and trends, dispersal and immigration; verification of habitat carrying capacity estimates for dall sheep; and effects of hunting inside and outside park on park moose population.
3. Conducting human use related research such as studies on future regional trends in tourism growth and hunting; backcountry visitor use trends; and aircraft use patterns.
4. In the absence of specific population targets in the park 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, 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”. This study should provide evidence to assist park managers, staff and various stakeholder groups in determining if these policies are being compromised.
5. 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.
6. 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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Content and conclusions reached in this study represent the views of the author and do not necessarily reflect any official or unofficial position, advice or direction of Parks Canada.

Bibliography

CPS (Canadian Parks Service). 1990. Environmental Screening Information for the Kluane National Park Reserve Park Management Plan Alternatives 1990. Environment Canada, CPS, Prairie and Northern Region, Winnipeg.

CPS (Canadian Parks Service). 1991. Environmental Screening of Kluane National Park Reserve: 1990 Park Management Plan Review. Canadian Parks Service, Prairie and Northern Region, Natural Resource Conservation, Winnipeg.

Duval W. and P. Vonk. 1994. A Semi-quantitative Procedure for Preparation of Initial Environmental Evaluations and Assessment of Potential Impact Significance. Axys Environmental Consulting Ltd., Vancouver.

Geist, V. 1978. Behaviour. Pages 283-296 In Schmidt, J. L. and D. L. Gilbert ed. Big Game of North America; Ecology and Management. Stackpole Books, Harrisburg, Pa.

Government of Canada. 1995. Canadian Environmental Assessment Act. Ministry of Supply and Services, Hull.

Hegmann, G.L. 1995a. A Cumulative Effects Assessment of Kluane National Park Reserve, Yukon Territory. Parks Canada, Kluane National Park, Yukon.

Hegmann, G.L. 1995b. Implementing Cumulative Effects Assessments. Master's Thesis. University of Calgary, Faculty of Environmental Design, Calgary.

Hegmann, G. L. and G. A. Yarranton. 1995. Cumulative Effects and the Energy Resources Conservation Board Review Process. University of Calgary, Environmental Research Centre, Calgary, Alberta.

Knight, R. L. and D. N. Cole. 1991. Effects of Recreational Activity on Wildlife in Wildlands. Trans. 56th N. A. Wildl. and Nat. Res. Conf.: 238-247.

Komex International Ltd. 1995. The Impacts of Development of the Sheep River Project on Key Wildlife Species of Concern. Komex, Calgary.

Myers, N. 1993. Biodiversity and the Precautionary Principle. Ambio 22 (2-3): 74-79.

Orians, G. H., J. Buckley, W. Clark, M. E. Gilpin, C. F. Jordan, J. T. Lehman, R. M. May, G. A. Robillard and D. S. Simberloff. 1986. Ecological Knowledge and Environmental Problem-Solving: Concepts and Case Studies, National Academy Press, Washington, D. C.

Parks Canada. 1994. Parks Canada Guiding Principles and Operational Policies. Minister of Supply and Services, Hull.

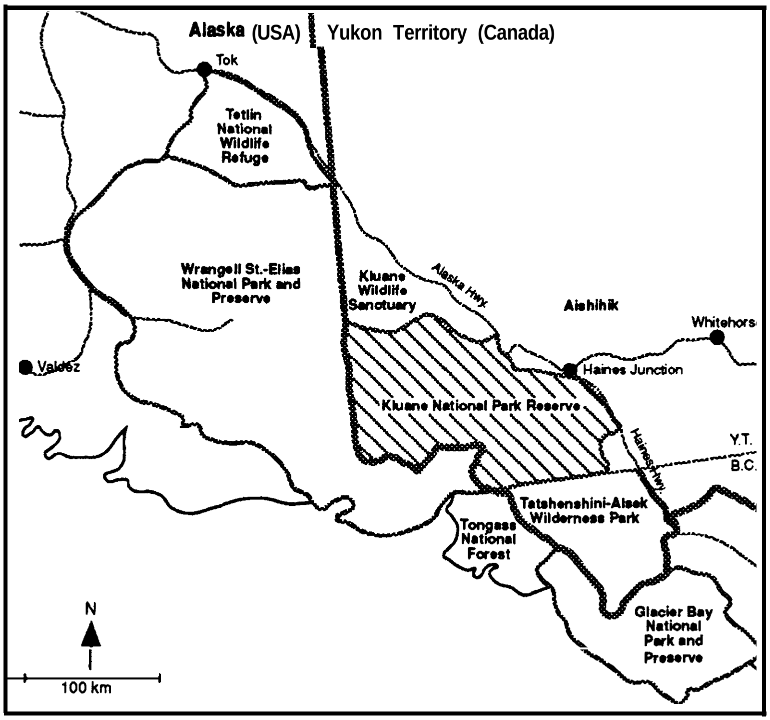
Shank, C. C. 1979. Human-Related Behavioural Disturbance to Northern Large Mammals: A Bibliography and Review. Foothills Pipe lines (South Yukon) Ltd., Calgary.

Slocombe, D. S. 1991. Seeking Sustainability in the Kluane/Wrangells: Science, Institutions, Individuals and a Biosphere Reserve. Presentation at the 1991 Western Regional Science Association Meeting, Monterey, California.

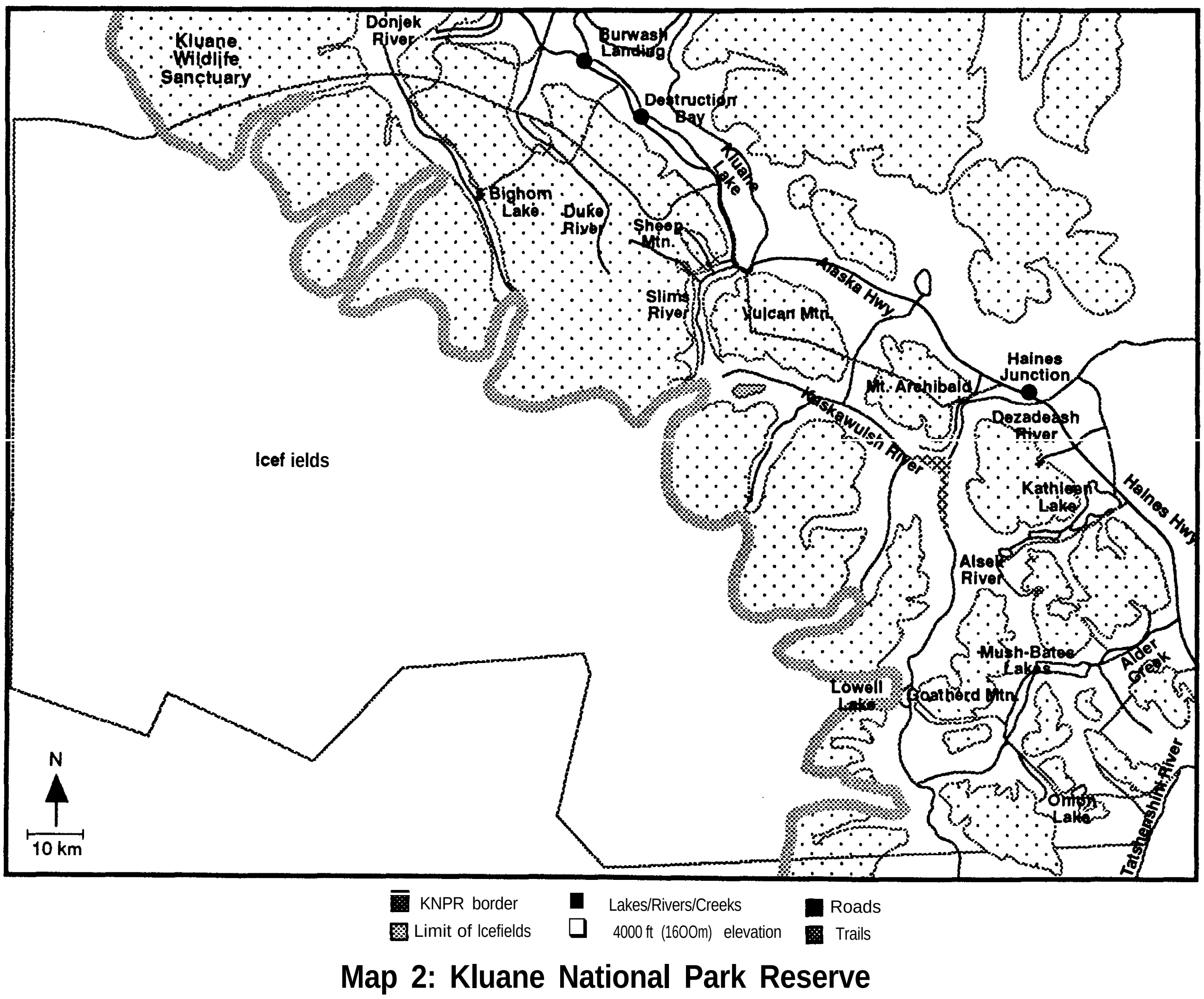
Slocombe, D. S. 1993. Implementing Ecosystem-based Management: Development of Theory, Practice, and Research for Planning and Managing a Region. Bioscience 43 (9): 612-622.

U.S. FWS (U.S. Fish and Wildlife Service). 1993. Guidelines for the Development of Community-level Habitat Evaluation Models. USFWS, Washington, D.C.

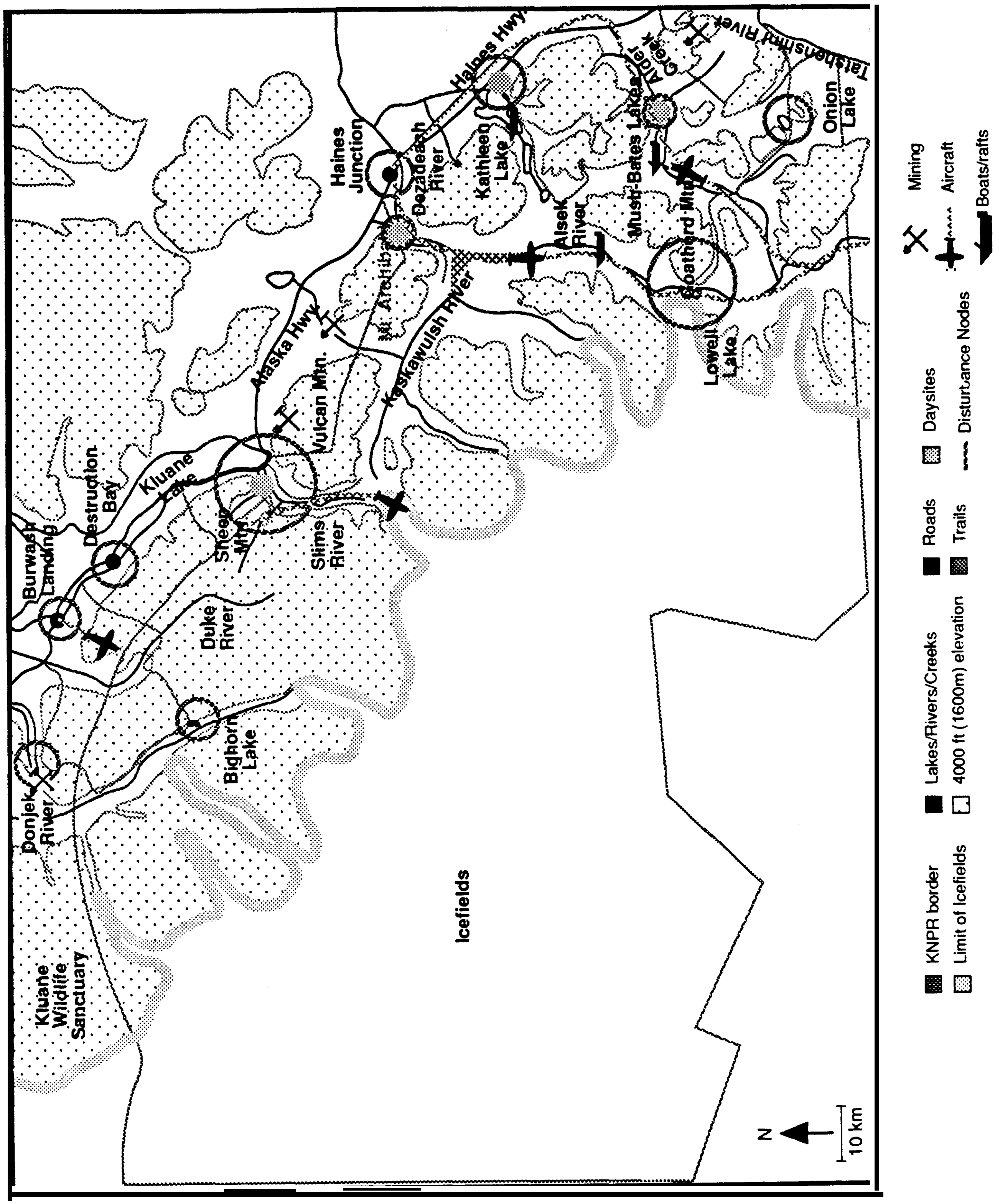
Weaver, J. L., R. Escano, D. Mattson, T. Puchlerz and D. Despain. 1985. A Cumulative Effects Model for Grizzly Bear Management in the Yellowstone Ecosystem. Pages 234-246 In Proceedings - Grizzly Bear Habitat Symposium. U.S. Forest Service, Ogden, Utah.



Map 1: Kluane National Park Reserve and region



Map 2: Kluane National Park Reserve



Map 3: Disturbances in Kluane National Park

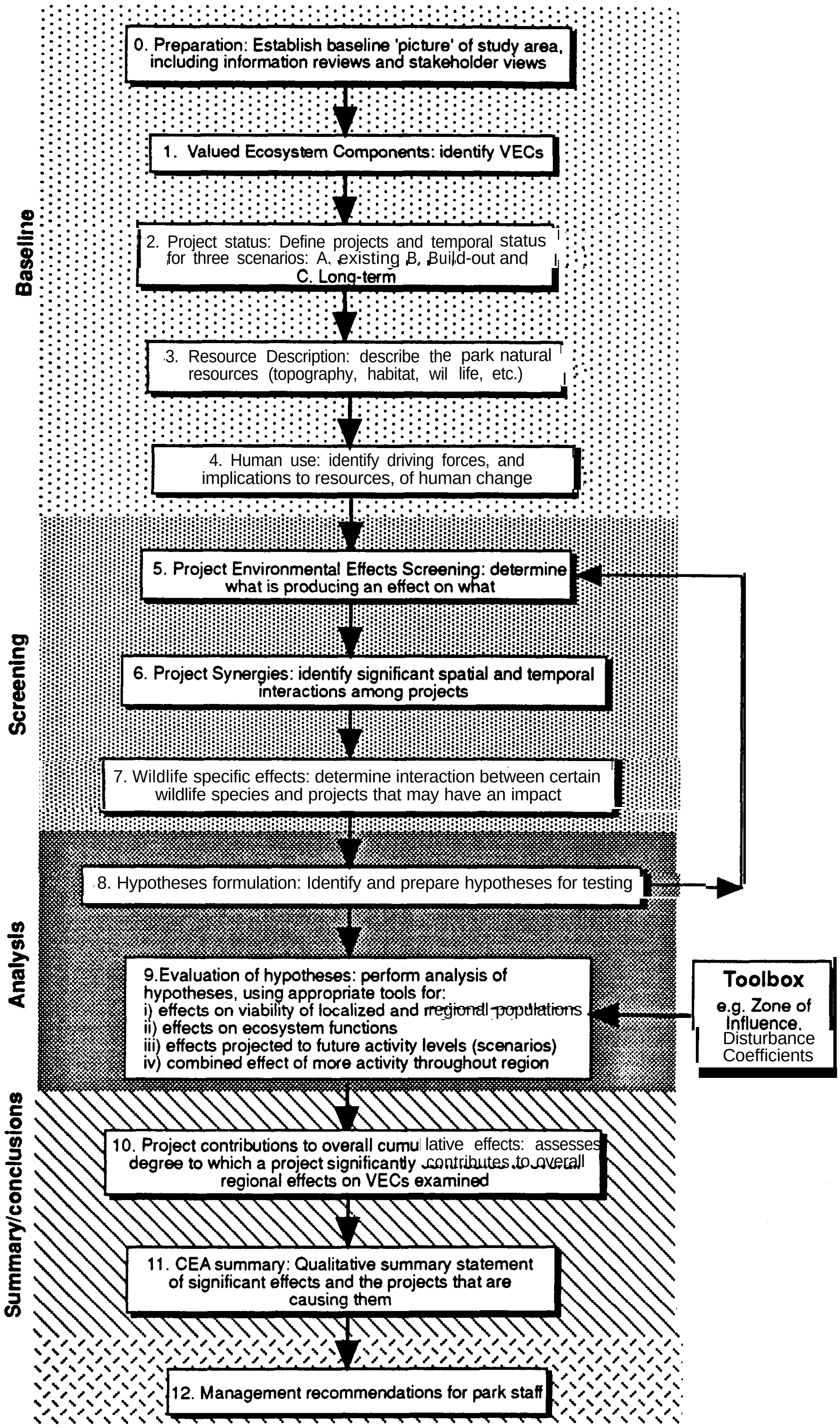


Figure 1: CEA framework

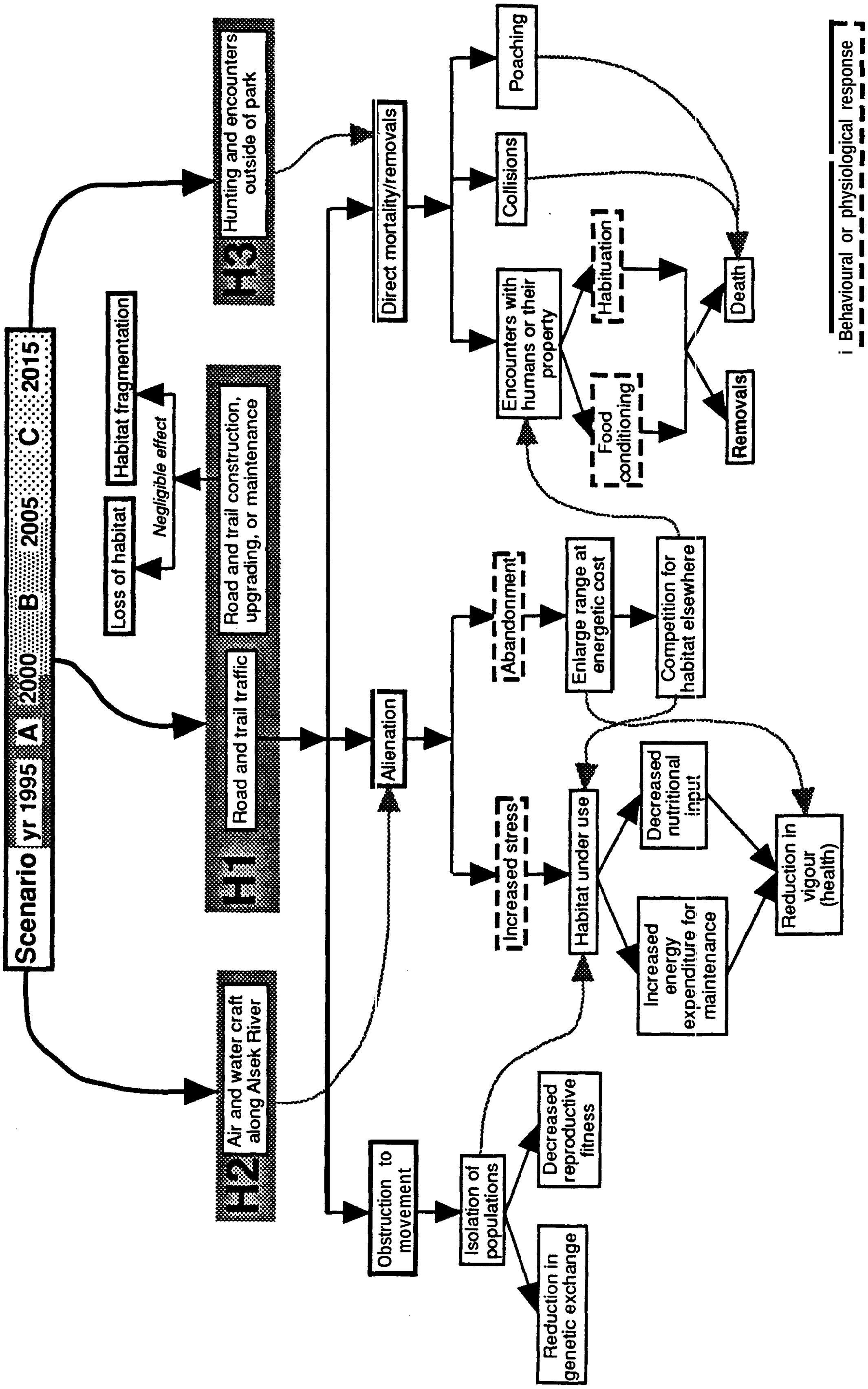


Figure 2: Effects linkages for Grizzly bear hypothesis 1

Table 1: 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)							FR	OR		FI	FI		X			X	
Alaska Highway (L)							OI				FI	FR	X			X	
Alsek Pass (P)		FI	OI	OR		OR				OR			X	X		X	
Alsek-Kaskawulsh River Valleys (L)		FI	OI						FR				X			X	
Hiking trail network (L)		OR			OR	FI							X			X	
Kathleen Lake (P)			FI	FI		OR							X			X	
Kluane Wildlife Sanctuary (A)					FI	OI	OR	FR		FI			X	X	X	X	
Lowell Lake/Goatherd Mtn. (P)	FR	FR	FI			FR			FR				X		X		
Mush-Bates Lakes/Alder Creek (L)		OR	FI	FI		OR	OR			OR					X	X	
Onion/Bighorn Lake (P)	OR	FI				OR							X	X	X	X	
Sheep Mtn. (P)		OR		FR		FI								X			X
Slims River Valley (L)		OR				FI							X	X	X		X
Townsites (P)	FR	OI		FI								FR	X				

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

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

Intensity of disturbance
(FR) = frequent (occurence) and regular (use pattern)
(FI) = frequent and irregular
(OR) = occasional and regular
(OI) = occasional and irregular
( ) = no action of significance

Table 2: Temporal overlap of disturbances

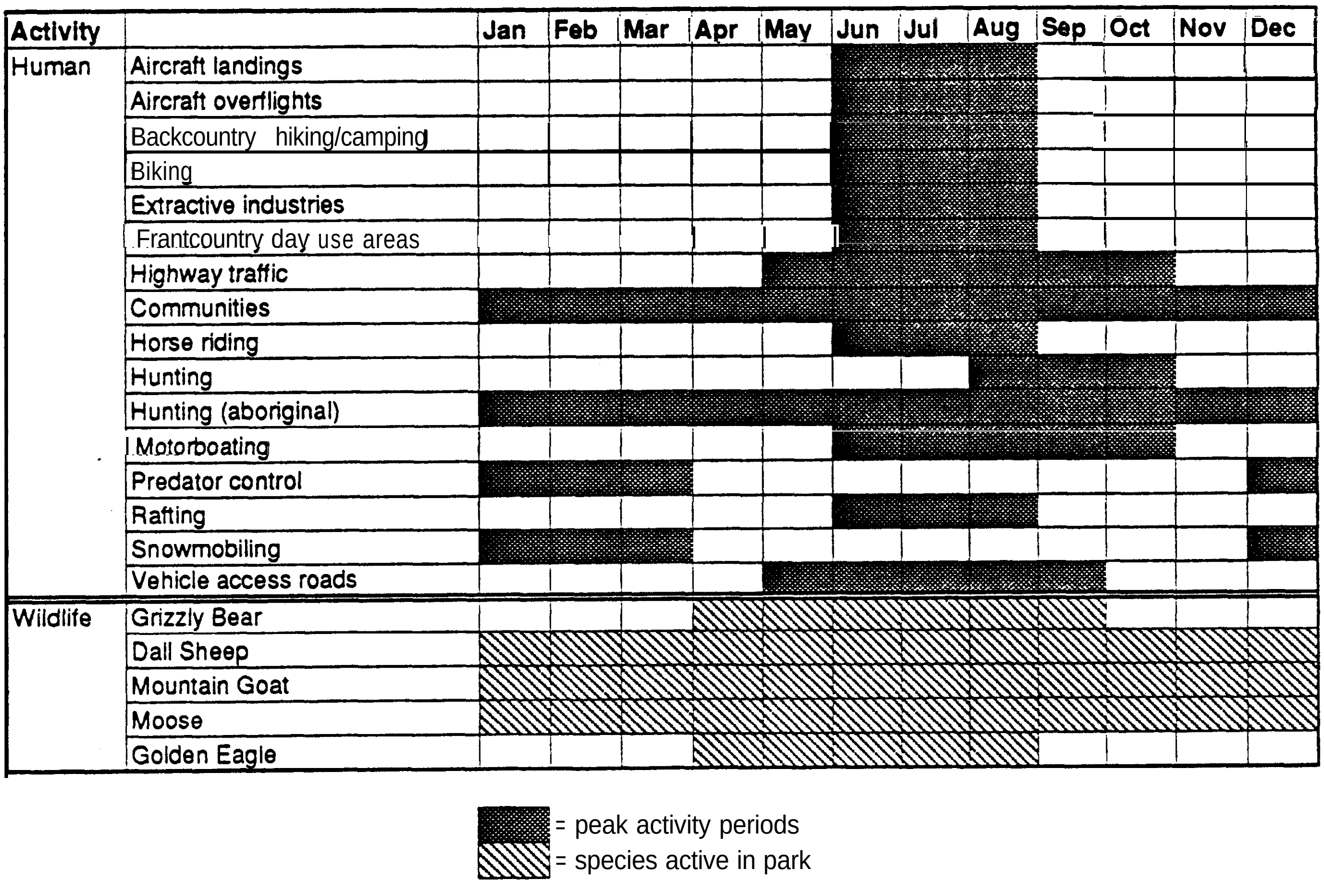


Table 3: Synergies between disturbance nodes

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	weak	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	weak
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 Vallev													weak
Townsites													

= weak synergy
= moderate synergy
= strong synergy

Table 4: **Hypotheses**

#	VEC	Hypothesis
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
2		Aircraft and watercraft use along the Alsek River Valley will adversely affect grizzly bear survival through behavioural changes and habitat alienation
3		Hunting and encounters outside the park will adversely affect grizzly bear survival through behavioural changes and direct mortality
4	Dall sheep	Road and trail use on and near Sheep Mountain will adversely affect dall sheep survival through behavioural changes and habitat alienation
5		Aircraft use over Sheep Mountain will adversely affect dall sheep survival through behavioural changes and habitat alienation
6	Mountain goat	Trail and aircraft use around Goatherd Mountain will adversely affect mountain goat survival through behavioural changes and habitat alienation
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
8	Golden eagle	Human activities along the Slims River Valley will adversely affect golden eagle survival through behavioural changes and habitat alienation
Impacf specific		
9	All wildlife VECs	Aircraft use in the parks green zone will adversely affect the long-term viability of wildlife VECs
10		Road and trail use in the park's green zone will adversely affect the long-term viability of wildlife VECs
11		River rafting on the Alsek River will adversely affect the long-term viability of wildlife VECs
12		Causes of direct mortality inside and outside the park will adversely affect the long-term viability of wildlife VECs
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

Table 5: Contribution to overall effects by projects proposed in 1990 Park Management Plan

Project	Location	Contribution to overall effects
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 or Lowell lakes	
Expand Sheep Mountain SPA	Slims River Valley	
Add archeological site SPA	Unknown	
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 maintenance	Dezadeash River	
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	
Upgrade integrated trail system	Throughout park	

* SPA= Special Protected Area

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