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An integrated assessment of the cumulative impacts of climate change and industrial development on salmon in Western BC

Grizzly Bear: Summary of objectives and knowledge for decision support

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Purpose of this document

This document provides information for decision-makers considering risks or benefits to grizzly bears (*Ursus arctos*) on behalf of the public. Making such decisions requires understanding public values and the effects of alternative decisions on these values.

Societal values[1] and knowledge provide the foundation for applying risk management[2] in natural resource decision-making (Figure 1). Values define the scope of risk assessment. Scientific and traditional ecological knowledge support assessment of risk and benefit. Objectives—describing the desired condition of values— help to determine what combinations of risk and benefit are acceptable. Values and knowledge come together in decision-making when a decision-maker weighs assessed risk and expected benefits against publically-defined objectives (Figure 1).

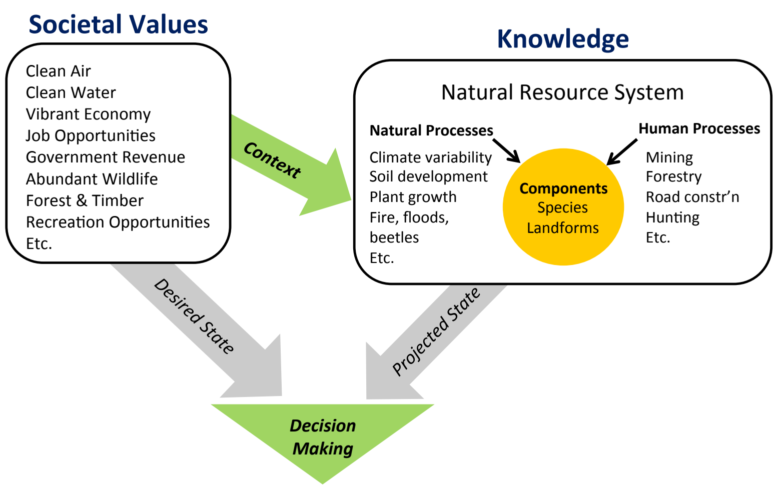

Figure 1. Diagram showing role of values and scientific knowledge in decision-making. Values are socially-defined and set the context and scope for an assessment of a natural resource system. Objectives define a socially-desired state for a value. Knowledge characterizes the influence of anthropogenic and natural changes to the landscape and determines the projected state of each value; indicators of state influence risk (or benefit) to each value. Resource management decisions consider weigh risks and benefits against public objectives.

This document summarizes information[3] for one value—grizzly bears—in the Northwest CEA Pilot Area (Figure 2 below). The next brief section describes the current status and distribution of grizzly bears. The document has two main sections: the first describing public direction; the second describing ecological knowledge. Ecological knowledge is based primarily on an expert workshop[4].

Distribution, ecology and status

Distribution: Canada supports about half of the North American population of grizzly bears and British Columbia supports about half of the Canadian population (MOELP 1995). The pilot area includes 6 of the

57 grizzly bear population units found in BC (CIS LRMP, Hamilton et al. 2004): part of Taku; Edziza-lower Stikine; Spatsizi; Upper Skeena-Nass; Stewart; and Cranberry (see map in Apps 2011[5]). There are five distinct grizzly bear population units Cassiar Iskut-Stikine plan area and habitat suitability and capability is rated as high[6].

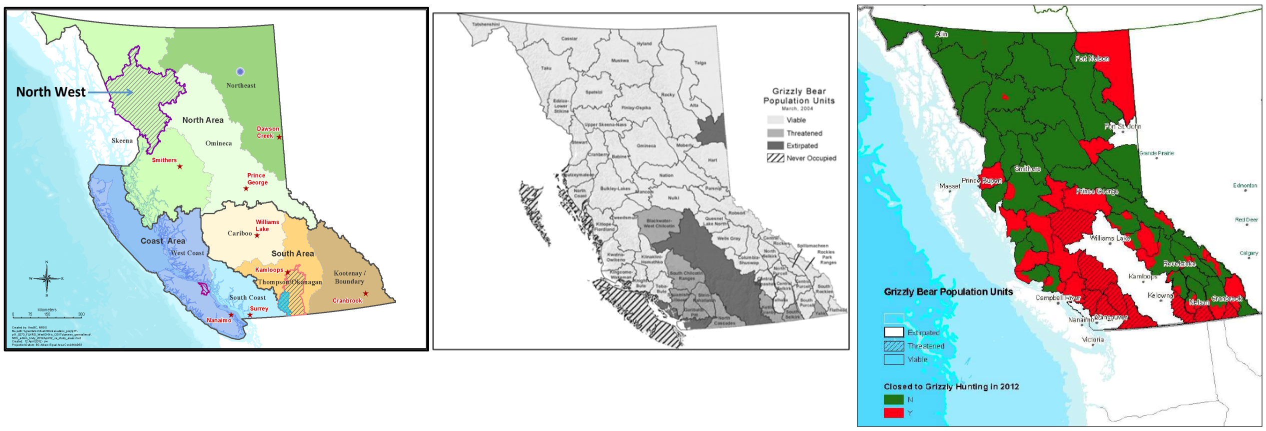

Figure 2. Northwest pilot area (left); grizzly bear population units (centre)[7] and viability and hunting status of each unit (right)[8].

Ecology[9]: Bears are generalists. They forage on plant greens associated with early seral forest, the understory of some types of old forest, and non-forest ecosystems, including wetlands, avalanche chutes, and rich sub-alpine to alpine areas. Bear densities are positively correlated to the productivity of plants that grow in early seral environments and wetter ecosystems tend to be more productive than drier ones. The availability of live and dead animals as a food source, particularly salmon, greatly increases habitat quality for grizzly bears. Consequently, areas with a consistently available animal food source can have a very significant positive effect on population productivity. In interior populations with variable access to an animal food source, the availability of plant foods may be more important in determining bear population numbers. Bears use older/mature forest as security and thermal habitat, for bedding, travelling, and denning. Forested areas adjacent to non-forested feeding habitats, such as wetlands and avalanche chutes, are important for providing both security and thermal cover for grizzly bears.

Life History[10]: Humans are the major cause of mortality in most grizzly bear populations and the majority of human-caused mortality occurs near human occupied areas or near roads. Bears die at a disproportionate rate when they are close to active roads and people who use the roads are armed. Mortality may occur from legal hunting, mistaken identity kill, self-defence kill, malicious killing, poaching, management control kill, landowner defence-of-life and property (DLP) kill, and vehicle collisions.

Status: Federally, grizzly bears are listed as a species of special concern, because their habitat faces risk from expanding industrial, residential and recreational developments, but they are not yet listed as threatened or endangered[11]. Grizzly bears have been extirpated or are threatened in the southern interior of British Columbia. They have viable populations of moderate to high density[12] that support hunter harvest in the pilot area (Figure 2).

Public direction for grizzly bear

Ecological and Social Context

Grizzly bears are an important game species in British Columbia, generating considerable license revenue for the province. They are a valued trophy animal, providing income for guide-outfitters in northern communities. The Cassiar area is considered to have some of the best big game hunting in North America[13].

The Iskut Stikine area, in north-eastern British Columbia, is a relatively remote area noted for its wilderness values and abundance of wildlife. Grizzly bears are key components of the predator-prey systems and the coastal grizzly-salmon ecosystems that are significant features of the biodiversity in the area (CIS LRMP).

Objectives for Grizzly

Federal

The grizzly bear's decline to threatened status would necessitate a recovery plan. **Hence the social objective is one of avoiding ecologically significant population decline**.

Provincial

The Wildlife Program plan[14], in conjunction with the BC Conservation Framework[15], sets the primary direction for wildlife management in BC, including grizzly bears. The plan has the vision of maintaining "*naturally diverse and sustainable wildlife supporting varied uses for current and future generations*". It includes several objectives:

- *Conserve and restore native wildlife species and their habitats*
- *Maintain the health of wildlife in B.C. where health includes the capacity of individuals or populations to respond to… challenges from their environment.*
- *Provide and manage sustainable uses of wildlife*
- *Prevent or reduce negative effects of wildlife-human encounters*

The BC Conservation Framework includes the following goals:

- *…maintain the full diversity of native species and ecosystems*

- *…prevent species and ecosystems from becoming at risk*

The Forest Planning and Practices Regulation of the Forest and Range Practices Act includes the objective to *"conserve sufficient wildlife habitat… for… the survival of regionally important wildlife…"* without unduly[16] reducing timber supply.

Under the Identified Wildlife Management Strategy, grizzly are defined as a Regionally Important Wildlife Species (http://www.env.gov.bc.ca/wld/frpa/species.html). The goals of the IWMS are to *"minimize the effects of forest and range practices on Identified Wildlife situated on Crown land and to maintain their limiting habitats throughout their current ranges and, where appropriate, their historic ranges"*. Appendix 1 provides an overview of regulations affecting grizzly bears in BC.

In addition to goals and objectives for wildlife, the provincial government's goals for grizzly bears include "*to maintain in perpetuity the diversity and abundance of Grizzly Bears and the ecosystems on which they depend throughout British Columbia"* and *"to improve the management of Grizzly Bears and their interactions with humans*" (MOELP 1995). Hence, the social objective is one of maintaining grizzly bear abundance and natural distribution. Note that the British Columbia government does not support hunting restrictions as a means of mitigating grizzly bear mortality related to industrial development.

In summary, provincial goals for grizzly bears aim to **maintain abundance and diversity in perpetuity**. Similarly, goals for wildlife aim to **maintain healthy (i.e., resilient) populations** that are sufficiently robust to **support use**, including harvest, **without becoming at risk**. The vision of maintaining naturally diverse populations and the objective of maintaining healthy populations imply that **populations should be well-distributed across their range**. Subordinate objectives that contribute to population objectives address habitat conservation and prevention of wildlife-human encounters.

Region: Iskut-Stikine

The pilot area can be divided into two sub-regions based on administrative units. The Cassiar Iskut-Stikine Land and Resource Management Plan area ("Iskut-Stikine") covers the northern portion of the pilot area. Most of the Iskut-Stikine lies in Tahltan territory; other First Nations in the area include Taku River Tlinget, Kaska Dena and Nisga'a[17]. Nisga'a have a land use plan, but it applies mainly to the Nass TSA and will be discussed below. Other First Nations do not have land use plans, although they have agreements with the Province governing collaboration. This section summarizes direction for grizzly bears from the Cassiar Iskut-Stikine Land and Resource Management Plan.

Grizzly bears contribute to the broad vision of maintaining *a "healthy environment including...abundant… wildlife populations… (2.2)"* [18] and support broad goals related to biodiversity, viable natural predator-prey systems, hunting and guide outfitting.

At the regional scale, **the social objective is one of maintaining healthy populations**:

- *"Maintaining healthy grizzly bear populations and the functional integrity of predator-prey systems is one of the primary goals of the LRMP"(CIS LRMP 2000).*
- *"Maintain habitat to support healthy wildlife populations"*
- *"Manage… populations to be a **sustainable**, renewable resource"*

Objectives for grizzly bears address habitat abundance and connectivity, displacement from habitat and mortality risk (i.e., human/bear conflict, hunting and road access) [19]:

- *Maintain the functional integrity of high value grizzly habitat; maintain large areas of high value grizzly habitat… by maintaining…well-distributed seasonally important habitats…; …maintain adequate old forests and fire-related habitat mosaics…; avoid critical… habitats… to reduce displacement and habitat loss; maintain habitat to support healthy wildlife populations*
- *…locate cutblocks to provide connectivity of appropriate seral forest linking grizzly habitats*
- *Minimize… disruption of bear habitat use….*
- *Minimize bear/human conflicts…; reduce human-bear interactions*
- *Manage hunting and other activities affecting grizzly bear mortality within established limits; manage hunting and other activities to limit bear mortality from all human causes to less than 4% of the estimated population; manage game populations as a sustainable, renewable resource*
- *Limit main stem road… one side of a valley; …rehabilitate roads that cross avalanche chutes…*

Region: South Nass

The Nass TSA covers the southern portion of the pilot area. Strategic land use plans cover the southern portion of the Nass TSA:

- the Nass South Sustainable Resource Management Plan[20]
- the Gitanyow Huwilp Land Use Plan[21]
- A Land Use Plan for Nisga'a Lands[22] and the Nass Wildlife Area, where Nisga'a, provincial and federal governments share wildlife management responsibility[23].

In the South Nass, grizzly are valued for their contribution to natural predator prey

> *"Large predator-prey systems…and their component wildlife species, are key values" in the Nass SRMP". (Nass SRMP)*

Plan intent and goals aim to **ensure healthy populations of grizzly bears that support sustainable harvest**.

> *"With respect to wildlife, the intent of the Nass South SRMP is… to maintain habitat to help ensure wildlife populations are capable of sustaining a Nisga'a hunter harvest….; to provide for Gitanyow continued use of wildlife resources; to provide for a sustainable harvest of big game species..."*

> *"Provide adequate grizzly bear habitat to ensure a healthy population of grizzly bears"*[24]

Objectives address habitat suitability and effectiveness, displacement, human-bear conflict and access.

Knowledge for grizzly bears

Factors that affect grizzly bear populations

Grizzly bear population size is determined by habitat productivity and effectiveness and by mortality risk. Habitat, mediated by territorial behaviour, determines potential density. Anthropogenic mortality can reduce density and lead to extirpation.

Grizzly bear ecotypes

The pilot area varies in climate and terrain, from coastal inlets with rugged mountains to interior boreal plateaus. Grizzly bears exhibit reasonable foraging flexibility and are adapted to many different ecosystems. Three ecotypes, with different behaviour and ecology, live in the pilot area (Table 1). Coastal areas generally support the densest populations because steep elevation gradients concentrate diverse vegetation types and because salmon runs provide a seasonal abundance of protein.

Table 1. Relative home range size and population density of grizzly ecotypes.

Ecotype	Protein source	Density in good habitat	Home range size
Coastal	Primarily fish	High	Small
Mixed	Variable	Medium	Very large*
Interior	Primarily terrestrial	Low	Large

*Some individuals travel long distances to access salmon.

Habitat factors

Bears are generalists, feeding on a variety of vegetation, berries and protein sources (Figure 3). In general, interior bears seek ungulates, small mammals such as ground squirrels and insects for protein. Coastal and “mixed” bears include spawning salmon in their diet.

Non-forested ecosystems, (e.g. avalanche chutes, wetlands, estuaries), early seral forest and some types of late seral forest provide vegetation (e.g., devils club, salmonberry, skunk cabbage, cambium) and berries. Fresh vegetation is an important food source in spring when bears emerge from hibernation. Non-forested ecosystems are particularly important where early seral forest is scarce and can limit bear density on the coast. Late seral habitat provides cover, particularly important in coastal rains, large trees and root wads used for denning in some locations, and forage. Mid-seral forests provide poor forage and cover and are difficult to move through. Bears will also consume human garbage and carcasses left by hunters, where and when these sources occur.

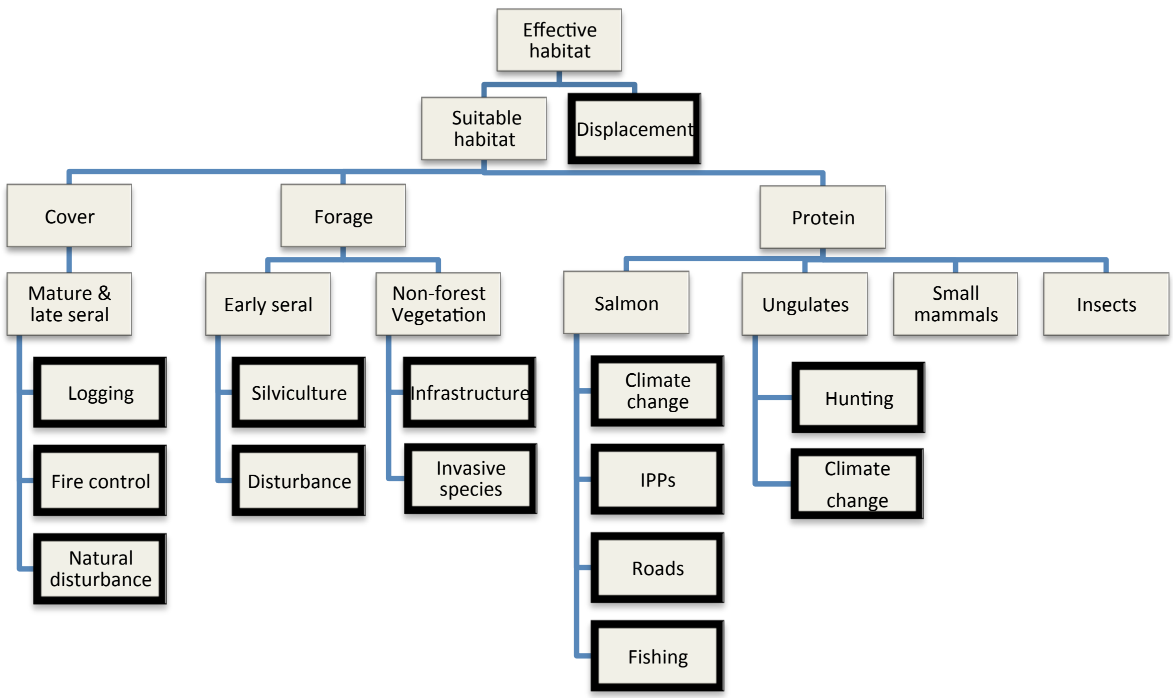

Figure 3. Components of grizzly bear habitat (light outline) and factors that affect them (dark outline).

Habitat loss and fragmentation

Non-forested vegetation types can be damaged by roads, pipelines, camps and industrial facilities (i.e., temporary or permanent infrastructure). Independent power projects (IPPs) can impact fish as well as flooding grizzly bear habitat or drying out riparian areas by diverting water. Climate change and development may reduce or even destroy fish runs.

Seral stage distribution reflects natural disturbance, fire control and timber harvesting and related silviculture. Climate change will affect natural disturbance.

Increased traffic and human presence, related to access, affect bear populations at two scales. Individuals may avoid habitats near roads. At the broader scale, connected grizzly populations can be fractured into more isolated sub-populations by high-traffic roads and associated human development. As development increases, Highway 37 has the potential to function as a fracture, and where habitat is attractive, to act as a population sink. Grizzly bear dispersal from core areas of secure and productive habitat can function to sustain populations where sinks occur.

Assessing Habitat

For the pilot area, base habitat assessment on

1) Updated BEI

2) Salmon biomass
3) Ungulate biomass[25]

Broad ecosystem inventory (BEI; e.g., avalanche tracts, wetlands; ~15 per BEC variant) is being compiled for the pilot area. Protein supply from salmon can be roughly estimated for different stream reaches based on average run size. Stream reach mapping is necessary to partition escapement data among source streams. The supply of protein from moose, the main ungulate in the pilot area, can also be roughly estimated from moose population estimates.

Mortality factors

Mortality, particularly of adult females, is a key determinant of grizzly bear population dynamics. In most regions, grizzly bear mortality is mostly due to people. Most human-caused mortality occurs near *communities* and *roads.* Human-caused mortality is a function of the probability of encounter (related to human and bear densities) and, for a given encounter, the probability of lethality. Lethality depends on bear behaviour, which is based on past experience with people, human behaviour, and the presence of a fire-arm.

Bear presence

Bear density varies with ecosystem productivity at the wildlife management unit scale. It varies spatially with season: in spring, most individuals are using valley-bottom habitat where they are more likely to overlap with people. At a smaller scale, bear presence is highest near concentrated natural food sources (e.g. salmon runs and berry fields) and anthropogenic attractants (e.g. garbage, carcasses, seeded vegetation).

Bear Behaviour

Bears are intelligent and adaptable. They can become accustomed (habituated) to predictable events and people. This habituation does not necessarily increase mortality if bear behaviour is not modified in a manner that encourages lethality. Well-managed bear viewing, for example, does not increase risk to bears. New roads into bear habitat may displace bears initially, but individuals may tolerate traffic as long as they survive. Bears that become food-conditioned, associating people with attractive food, experience vastly higher mortality rates. Complicating matters, social interactions among bears expose different classes of bears to different risks. For example, females and sub-adults may be more willing to tolerate traffic and human presence in order to avoid large males, putting them at potentially higher risk.

Human presence

Human presence in bear habitat depends on the location and size of human population sources and the ability of people to penetrate bear habitat (Figure 2). In the past decade, ATVs, GPS and Google Earth have increased accessibility everywhere.

Open roads provide the main source of access to grizzly bear habitat. People move beyond roads on foot or ATV depending on terrain. Road quality influences the time required to penetrate bear habitat. In general, people's willingness to explore remote areas drops off as access time reaches a threshold beyond a few hours. Jet boats can also provide easy access to prime bear habitats.

Human population sources include established communities, from cities to rural areas, and temporary camps (e.g., short-term mineral exploration or decades-long mining camps)[26]. Penetration depends on the proximity of population sources to bear habitat and on ease of movement. Seasonal exploration camps may pose risks that are difficult to trace.

Destination sites, such as remote fishing lodges, bear viewing stations and hot springs draw people into remote areas and increase human density within bear habitat. Heli-fishing and heli-skiing can bring people into otherwise secure habitat.

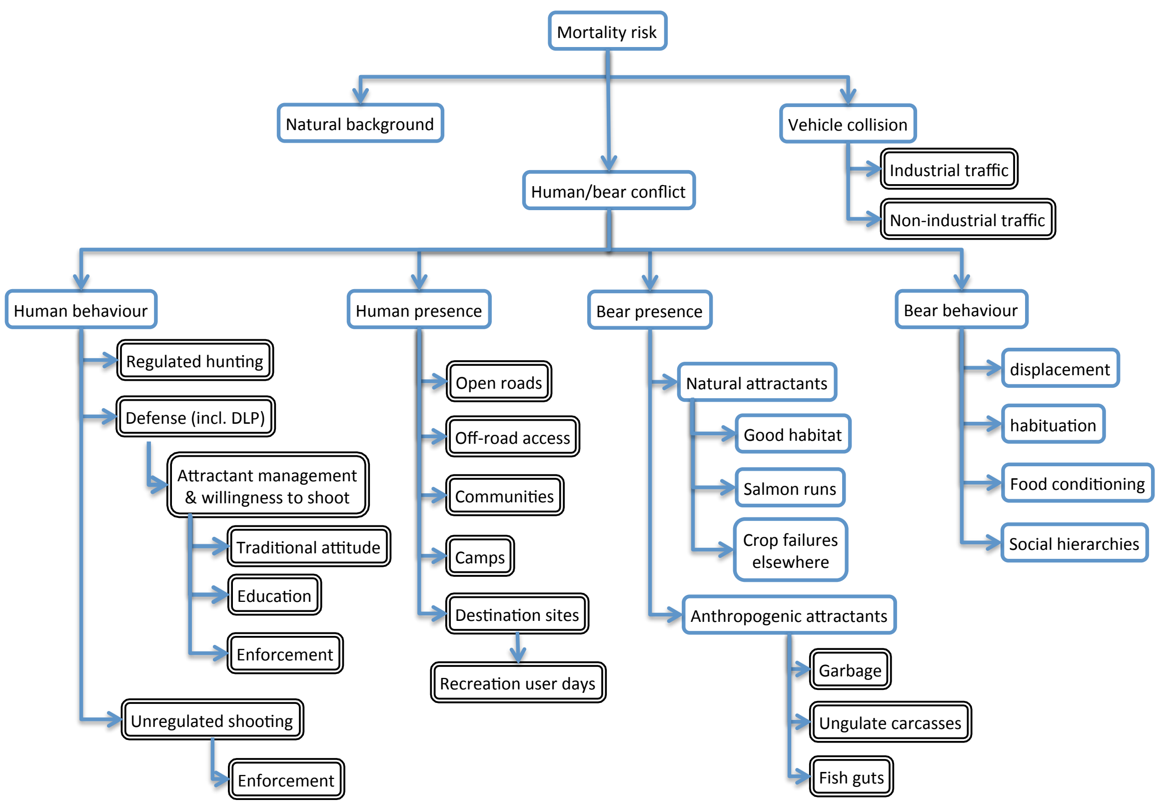

Figure 4. Factors affecting grizzly bear mortality.

Human behaviour

Three types of human behaviour kill grizzly bears: regulated hunting, unregulated hunting and defense. Management aims to limit total human-caused mortality to 6% of the population in a wildlife management unit per year[27]. Management of the regulated hunt assumes an unreported mortality level of 1 – 2% of the population; uncertainty is high. Poaching exists in the pilot area, but is difficult to detect, due to remoteness. Unreported kills increase with increased numbers of ungulate hunters.

The attitudes of people in an area affect both their willingness to shoot bears and their management of attractants. A "frontier" mentality exists in much of the pilot area. Attitudes can be influenced by education and enforcement of regulations.

The collective attitude established by the leadership in wilderness lodges and camps can be particularly important. In remote camps, there is a cultural need for after-hour recreational activities that may increase risk to grizzly bears. Environmental assessments can prohibit hunting and fishing on project approval certificates; such restrictions must be passed on to sub-contractors. Typically, major projects will propose bear management plans, but not many have monitoring programs.

Risk of grizzly bear population decline

Anthropogenic mortality is the main factor contributing to risk of population decline. Substantial changes in food supply, such as loss of fish runs, also affect this risk, but are not discussed here.

Definition of risk

In the context of the Northwest BC cumulative effects assessment pilot, risk is defined as the chance of not meeting a stated management objective.

According to provincial objectives, grizzly populations should be

- **abundant, diverse and healthy (i.e., resilient and not at risk);**
- **well-distributed across their range (to maintain health and genetic diversity);**
- **capable of supporting hunting;**
- **capable of supporting natural predator-prey systems.**

Provincial objectives are to maintain the natural abundance and distribution of grizzly bears and to maintain opportunities for viewing and hunting bears where possible. Providing for human use of grizzly bears implies the potential need for populations that are higher than the natural range of variability and raises the bar for habitat conservation. Similarly, regional objectives (from First Nations plans and LRMPs) are to maintain healthy populations. In addition the province does not wish to infringe of First Nation's rights with respect to harvesting grizzly bears.

Based on the objectives described above we define the desirable consequence as a near-natural population size and distribution of grizzly bears (Table 2). We define the undesirable consequence as a non-temporary population decline (moving from status 1 to 2 in Table 2) within a non-trivial portion of the population range.

Table 2. Assumed influence of population status on stated population objectives.

Population status	Abundance	Health	Hunting	Predator-Prey
1. Stable at near-natural levels or better	✓✓	✓✓	✓✓	✓✓
2. Stable at lower population level	X	✓	X	✓
3. Viable	X	X	X	X
4. Non-viable	X	X	X	X

In expert workshops, we used the following definition of risk:

Risk (Y-axis) is the probability of a grizzly bear population decline.

Scale of assessment

The density of grizzly bears varies widely across BC. The NW CEA Pilot area includes six grizzly bear population units[28] (PDF Map). Several wildlife management units occur within a population unit and bear densities are managed at this finer scale. Existing population units are currently based on expert opinion; work is proposed to define more realistic population units for grizzly bears, using DNA evidence.

Wildlife management units or landscape units may be the best spatial scale for assessing risk to grizzly bears from a provincial perspective for two reasons. First, assessing population distribution (i.e., well distributed populations imply resilience and diversity) requires assessment at a finer spatial scale than the population unit. Second, bear densities are already managed at the wildlife management unit scale.

For Gitanyow, the appropriate spatial scale for assessment is the Wilp, based on traditional management scales. Risk curves developed in expert workshops are sufficiently general that they can be applied at the scale of the Wilp.

Risk to grizzly bear populations versus road density

Habitat must be secure to be effective. Roads that increase human presence and traffic decrease the amount of secure, effective grizzly bear habitat. The behavioural response of bears to roads is complex and includes displacement from nearby habitat, tolerance of traffic and humans and attraction to forage typical of road easements. Displacement renders nearby habitat ineffective for some individuals. Tolerance and attraction place bears at higher mortality risk, making habitat near roads insecure and hence ineffective at the population scale.

Tony Hamilton and others have developed a rough relationship between road density and habitat effectiveness (Figure 5). Population decline is roughly proportional to habitat effectiveness. Habitat effectiveness declines with road density; several thresholds may exist. The first substantial decline in effectiveness[29] occurs when road density reaches 0.6 km/km^2. Suitable habitat is 0% effective when road density reaches 2.4 km/km^2. This indicator can be calculated for different regions, from Wilps to landscape units to population units. The indicator could be extended to include loss of effectiveness around linear corridors and other access trails.

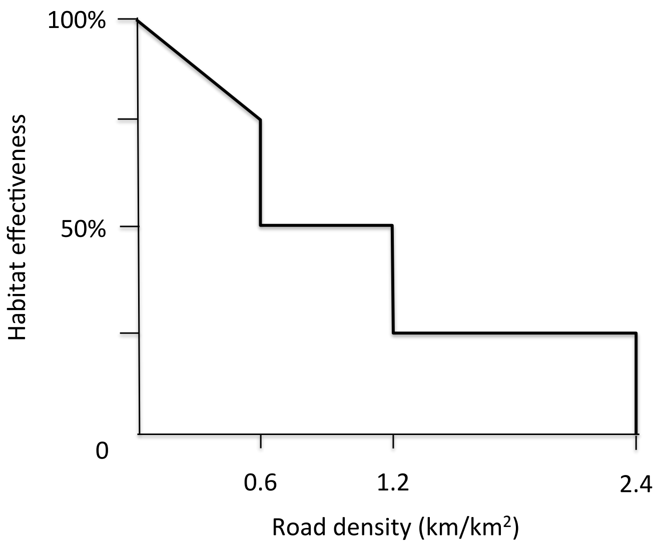

Figure 5. The influence of open road density on habitat effectiveness. The road density calculation uses the distance of class I and II roads within suitable habitat as the numerator and the area of suitable habitat as the denominator.

The risk curve is based on the following assumptions:

- No change in natural habitat or food supply
- Class I and II roads are included; lower-class roads and trails are not
- Every road has the same effect
- Currently, traffic flow is not included
- Road spacing and the pattern of fragmentation does not matter
- Increased grass forage available on road easements
- Moderate source of nearby human population in communities
- No camps or sources of attractants within habitat
- There are no “destination” sites attracting people to bear habitat

Uncertainty bands were not estimated for this risk curve, however, uncertainty is generally quite high for several reasons (Table 3).

Table 3. Sources of uncertainty that influence estimates of risk in Figure 3. Effectively gating roads can substantially reduce mortality risk

Source of uncertainty	Pressure on risk

If roads are effectively gated or otherwise impassable	↓↓↓
If traffic and collision risk are relatively low or high	↓↑
If off-road access is relatively poor or good	↓↑
If roads access areas of low bear use or high bear use (e.g., fish runs)	↓↑
If nearby human population (e.g., rural communities, camps) is relatively low or high	↓↑
If people are attracted to destinations (e.g., fish runs, hot springs) within bear habitat	↑
If people establish camps/lodges within bear habitat and do not manage attractants	↑
If roadside pullouts are within a 20 minute walk of good habitat	↑

Because the road density indicator does not account for human population sources, the risk relationship defined in Figure 6 should be used in conjunction with a risk relationship that reduces habitat effectiveness around communities and camps. In the NW CEA pilot project, where road density is relatively low, the presence of new human population centres, permanent or temporary, may pose the highest risk.

Risk to grizzly bears versus core security area

This indicator is essentially the inverse of road density. The probability of population decline increases as the proportion of core security area (unfragmented suitable habitat) decreases (Figure 6). The best estimate (solid line) suggests that population decline becomes very probable before unfragmented core habitat is entirely lost; uncertainty (shown by dashed lines) is high. The best-estimate curve shifts with factors listed in Table 2. Single linear corridors pose an interpretative challenge.

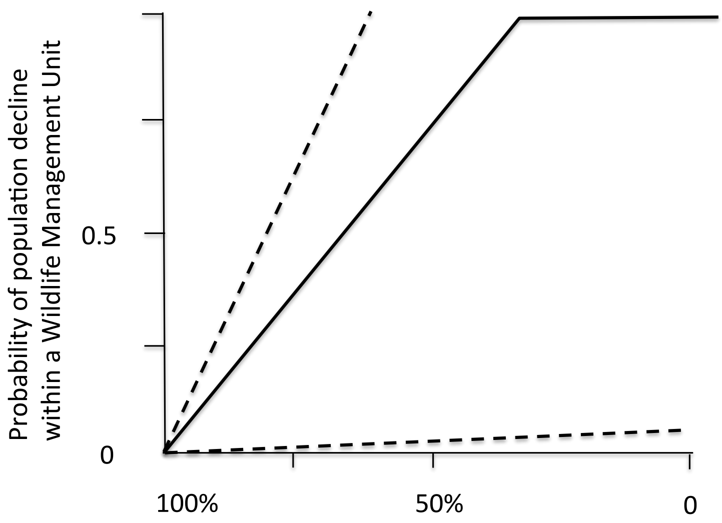

Figure 6. Probability of population decline within a management unit versus the amount of unfragmented (> 500 m from a Class I or II road) and adequately large (> 10,000 ha patches) suitable habitat (core security area) within the unit.

The risk curve is based on three specific assumptions:

- 10,000 ha of suitable unroaded habitat provides a minimum core security area
- Bears face relatively high mortality risk within 500m of a road
- Low-traffic roads (i.e., < Class II) do not substantially influence mortality

The X-axis indicator could be based on all road classes, weighted for their mortality risk. Changing the indicator would influence the shape of the risk response. There is uncertainty about the effect of lower-class roads because mortality may be high at the end of spur roads.

This indicator carries most of the assumptions described for the road density indicator except that it accounts for the pattern of fragmentation.

Around the best estimate risk curve (Figure 6), uncertainty bands (dashed lines) show that risk varies with a number of factors related to access and human population (see Table 3 above). For example, if there is no human population, risk follows the lowest dashed line, whereas if there is an easily-accessible destination and human attitudes that increase bear mortality, risk follows the top line.

Notes and References

[1] Values are defined as " the things that the people of British Columbia care about and see as important to ensure the integrity of the province's people and communities, economies and ecological systems" (REF xxxx)

[2] Risk management provides a formal approach to decision-making that weighs assessed risk against expected benefits across multiple values. It aims to identify development options where expected benefits outweigh the potential for loss or damage and where unacceptable risks are avoided (BC MoF 1999, Wise et al. 2004).

[3] This document should be considered as an **early draft of best available information** for assessing risk to grizzly bears in the pilot area. Risk estimates were developed at an expert workshop with wildlife managers familiar with the pilot area, however, the document requires more supporting literature and more review to be considered best available information. On a broad multi-discipline scale, the quality of knowledge is intermediate, based mainly on scientific extrapolation (partially-reproducible science) of peer-reviewed and gray literature with some scientific judgment (see classes defined by the Institute for Regulatory Science: http://www.nars.org/bas.html). This summary is indented to be a living document that can be improved by further review and by incorporating new knowledge.

[4] Reference to workshop summary.

[5] Apps, C. 2011. Grizzly bear population inventory and monitoring across the Skeena Region of British Columbia. Report for FLNRO, Skeena Region.

[6] Anon. 2000. Cassiar Iskut-Stikine Land and Resource Management Plan.

[7] Hamilton, A.N.. D.C. Heard, and M.A. Austin, 2004. British Columbia Grizzly Bear (*Ursus arctos*) Population Estimate. B.C. Ministry of Water, Land and Air Protection, Victoria, BC. 7pp.

[8] FLNRO. 2012. British Columbia grizzly bear population estimate for 2012.

[9] Based on Anon. 2012. Implications of mid-term timber supply to grizzly bears.

[10] Based on Anon. 2012. Implications of mid-term timber supply to grizzly bears.

[11] COSEWIC 2002—check xxxx

[12] FLNRO. 2012. British Columbia grizzly bear population estimate for 2012.

[13] Anon. 2000. Cassiar Iskut-Stikine Land and Resource Management Plan.

[14] Ministry of Environment. Undated. Wildlife Program Plan. Retrieved Jan 30, 2103 from http://www.env.gov.bc.ca/esd/.

[15] Ministry of Environment Conservation Framework: http://www.env.gov.bc.ca/conservationframework/

[16] The term "unduly" is not defined in legislation. Dictionary definitions of unduly include "disproportionate" and "unwarranted".

[17] Anon. 2000. Cassiar Iskut-Stikine Land and Resource Management Plan.

[18] Cassiar Iskut-Stikine LRMP.

[19] Cassiar Iskut-Stikine Land Use Plan.

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[20] Province of BC. 2012. Nass South Sustainable Resource Management Plan.

[21] The Gitanyow Lax'yip Land Use Pan forms Schedule A and B of the 2012 Gitanyow Huwilp Recognition and Reconciliation Agreement. The Nass South and Gitanyow plans have substantially similar content.

[22] Nisga'a Lisims Government 2002. A Land Use Plan For Nisga'a Lands.

[23] The Nisga'a Final Agreement (1999) establishes the Nass Wildlife Area and the right of Nisga'a citizens to harvest wildlife throughout the area; it also establishes the Wildlife Committee with members from Nisga'a, BC and Canada.

[24] Nass SRMP and Gitanyow Land Use Plan

[25] See details in workshop summary.

[26] Kyba report summarizes approved notices of work and can be used to estimate exploration activity.

[27] Ideally, mortality targets should be linked to trends in habitat supply; tolerable mortality also depends on the sex-ratio of the hunt.

[28] Mapped population units roughly divide a relatively continuous distribution of grizzly bears and should be considered uncertain. New, better-founded population units are under development.

[29] Near existing population sources, even relatively small ones, the first road into an undeveloped area may lead to a large increase in risk because it often accesses the valley bottom ecosystems that provide critical habitat to females with cubs in spring.