Appendix 2

Knowledge Base:

Information used for

Estimating Risk, Uncertainty and

Probability of Success

(January 2005)

prepared for

Babine Monitoring Trust Governance Design Group

by

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1. Goal: Maintain Biodiversity

Information Sources and Updates

Drafted: Karen Price and Dave Daust, September 2004, based on a comprehensive literature review of threshold amounts of habitat where impacts are detected[1], an expert workshop on maintaining terrestrial biodiversity in riparian areas[2], estimates of natural disturbance in nearby ecosystems[3], theoretical work on percolation theory, and a paper on landscape metrics in nearby areas[4].

Reviewed: Doug Steventon[5]

Updated:

Land-use Plan Summary

Maintaining biodiversity is a general goal of all the land-use plans for the watershed and of legislation.

Overview of Current Knowledge Relating to Goal

In the context of land-use management, biodiversity is primarily a function of the diversity and amount of ecosystems (which serve as habitats for species) and secondarily of their spatial pattern over landscapes. Ecosystem-based management hypothesises that maintaining a composition, amount and spatial distribution of ecosystems that reflects natural patterns will maintain biodiversity.

Ecosystem diversity reflects variation in the physical environment (e.g., climate, physiography), and in disturbance frequency and intensity. The biogeoclimatic ecosystem classification system (BEC) captures variation in the physical environment; seral stage and measurements of remnant structure capture disturbance frequency and intensity, respectively. Significant ecological variation occurs among BEC subzones and among site series within subzones. Similarly, seral stages differ ecologically and stands of a given age differ because of remnant structure.

Some ecosystems merit special attention because they are particularly important or because they are susceptible to damage. Riparian ecosystems, particularly floodplains and fans, are special because they are rich and productive—important to biodiversity. Rare ecosystems can be lost

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[1] Dykstra, P.R. 2004. Thresholds in habitat supply: a review of the literature. BC Ministry of Sustainable Resource Management Conservation Branch and BC Ministry of Water, Land and Air Protection Biodiversity Branch. Wildlife Report R-27.

[2] Price, K. and Church, M. 2002. Risk to ecosystem functions. Summary of expert workshops. Hydroriparian Planning Guide Background Information. Participants: Allen Banner (Regional Research Ecologist), Rachel Holt (Consultant), Laurie Kremsater (Consultant), Jim Pojar (formerly Regional Research Ecologist), Karen Price (Consultant), Doug Steventon (Regional Habitat Biologist)

[3] Steventon, J.D. 2002. Historic disturbance regimes of the Morice and Lakes Timber Supply Areas. Draft discussion paper. Prince Rupert Forest Region.

[4] Daust, D., A. Fall, G. Sutherland, D. Steventon and K. Price. 2003. Evaluation of landscape metrics for quantifying fragmentation in the Morice and Lakes IFPA area. Unpublished Report. 38 pp.

[5] Regional Habitat Biologist, Ministry of Forests, Smithers

from landscapes due to random disturbances. Deciduous and mixed deciduous-coniferous seral stages are vulnerable in landscapes managed for timber production. Similarly, some species or populations require special attention.

The spatial pattern of ecosystems influences the ability of organisms to move among their habitats—pattern influences connectivity. Spatial pattern also determines the amount of interior and edge habitat. Some species prefer interior habitats; others prefer edge. Interior old forest habitats are most vulnerable to impacts of forestry.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)

Moderate.

Rationale: Taken together, objectives and indicators from the Kispiox and the Bulkley cover most relevant factors influencing biodiversity (Table 1.1); plans for each region have different strengths. Objectives address both the diversity and pattern of ecosystems on the landscape. They highlight ecosystems that merit special attention. Landscape-level objectives deal with the amount and pattern of seral stages of each ecosystem over the landscape; stand-level objectives cover structure within stands and tree species diversity. Objectives addressing the ecological composition of landscapes and stands influence the goal most. Those applying to special ecosystems are of secondary influence, and objectives addressing pattern are least influential (Table 1.1). Because objectives for core ecosystems and landscape corridors are strategies to help achieve seral stage objectives, they have low influence.

Uncertainty about achieving the goal despite achieving all objectives arises for several reasons. No plans address all vulnerable species (although there are goals for grizzly bear and mountain goat); no objectives address invasive plants; objectives for stand structure are poorly linked to natural disturbance (see stand structure section). In additional, global warming is altering disturbance regimes.

Table 1.1. Summary of objectives and factors addressed and relative importance of each objective.

Objective Class	Factor addressed	Influence on Goal
• Maintain a natural seral-stage distribution	seral stage x ecosystem units	High
• Maintain core ecosystems in an ecosystem network	contributes to natural seral-stage distribution and influences pattern	Low
• Maintain connectivity in landscape corridors	contributes to natural seral-stage distribution, conserves riparian ecosystems and influences pattern	Low
• Maintain sensitive riparian areas	special ecosystem—riparian	Medium
• Maintain rare ecosystems	special ecosystem—rare	Medium

• Attain natural landscape pattern	spatial pattern of ecosystems	Low
• Maintain stand structure	remnant structure x seral stage	High
• Maintain tree species diversity	special ecosystem—deciduous	Medium

If the goal is not achieved, and species or genotypes are lost within the plan area, recovery potential is very low: loss of species and genes is irreversible; loss of populations is difficult to reverse. In highly dissected landscapes, like parts of the Babine, some organisms may be genetically distinct among sub-watersheds.

Influence of Goal on Other Goals (Question 2)

High.

Rationale: Loss of biodiversity carries a probability of a serious consequence for many other goals, including grizzly bears, fish, forestry, tourism and recreation.

Objective: Maintain Natural Seral-stage distribution of Ecosystems

Land-use Plan Summary

The objectives of creating core ecosystems and landscape corridors are a large part of the strategy to fulfill this objective. However, to ensure sufficient representation, the land-use plans call for analysis over the entire landscape rather than just within core areas.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

High.

Rationale: Table 1.1 above.

Recovery Period for Objective (Question 4)

Long.

Rationale: Old seral stages will take more than 140 or 250 years to recover depending on the BEC subzone. It is possible to mitigate some of the impacts to old forest by creating structurally-variable mature stands (e.g. leaving snags, creating gaps). However, it is unlikely that sufficient measures, beyond the level discussed under maintaining stand structure, will be taken. In addition, some elements of biodiversity, because of poor dispersal and/or particular requirements, depend on old trees.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,

- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether seral-stage targets, as designed, are successful in maintaining natural seral-stage distributions of ecosystems, and in turn, in maintaining biodiversity.

Indicators in the land-use plans include

- % old forest by BEC subzone
- % old and mature forest by BEC subzone
- % young forest by BEC subzone

Risk to biodiversity increases sigmoidally as the amount of any ecosystem decreases relative to natural levels (Figure 1.1). Inflexion points occur at 30% and 70% of natural (i.e. risk is high when amount is less than 30% of natural; risk is low when amount is greater than 70%; risk is intermediate between).

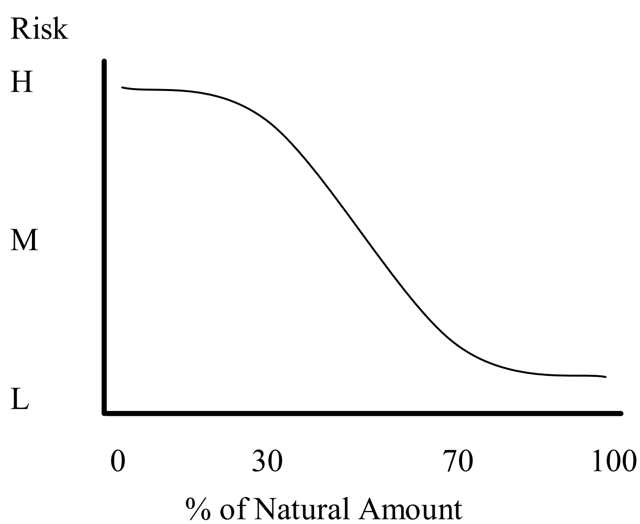

Figure 1.1. Risk to biodiversity versus percentage of each seral stage in each BEC subzone.

Risk curves are the same for each seral stage and subzone. Having too much of a particular seral stage poses a risk to species using other seral stages, but this risk is addressed by considering several seral stages.

Uncertainty around the curve is low when the amount of a seral stage is less than 30% of natural (i.e. when risk is high). Uncertainty is high elsewhere. A portion of the high uncertainty results from the limited resolution of the indicator: within BEC subzones, some ecosystems may be at high risk and others at low risk because harvesting generally targets certain ecosystems. This part of uncertainty is easily resolved by considering ecosystems (e.g. site series groups) within BEC subzones.

Even with ecosystems included, however, uncertainty remains relatively high in the middle of the curve. Most studies find impacts on species or populations when habitat abundance drops below 30% (high risk, low uncertainty); few studies for any given ecosystem find impacts when habitat is greater than 70% (low risk, low uncertainty). Uncertainty is greatest where the curve is steepest, because response varies among organisms (e.g. sensitive or specialist species respond at higher habitat abundance than generalists). This uncertainty is not easily resolvable.

The general sigmoidal curve is based on theoretical and empirical studies of a wide variety of organisms in a wide variety of ecosystems. Most studies consider the absolute amount of habitat rather than the percent of habitat relative to natural levels. The absolute amount of each ecosystem is important. Curves for absolute amount, however, vary tremendously among organisms and can only be drawn for particular, well-studied, species. The sigmoidal curve relating risk to biodiversity to relative ecosystem abundance offers the best current option for use as an initial hypothesis.

Moderate uncertainty is associated with natural disturbance estimates. The estimates are subject to the assumptions of the negative exponential model and the necessity of picking a time frame and spatial scale. The expected variation and range will be greater at smaller spatial scales. In addition, the Babine is at the fringe of the area used to generate natural disturbance estimates.

An additional type of uncertainty is associated with achieving indicator targets (i.e. location on the X-axis rather than the shape of the curve). Large natural disturbances, added to harvesting disturbance, can move seral stage composition away from planned targets.

Available Data (Question 6)

Data are available for current and future indicator values in the Bulkley; but not for current indicator values in the Kispiox. As a rough estimate, it is possible to assume that current risk is low with high uncertainty for all seral stages in the Kispiox. **Medium priority** for data collection in the Kispiox.

Natural seral-stage distributions are available for some of the BEC subzones based on an analysis for similar subzones in adjacent forest districts[6]. The numbers in Table 1.2 – Table 1.4 are calculated by dividing the percent of each seral stage listed in the sources by the predicted natural amount of each seral stage. The table does not break down analyses by BEC subzones because risks are similar (although some ranges will be narrower than those shown in the tables).

Table 1.2. Current and future indicator values (when known) for old forest.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley (Babine)	73 – 100	SOFR	21 – 39	LUP
Bulkley (Nilkitkwa)	73 – 100	SOFR	30 – 56	LUP
Kispiox	Unknown	--	41 – 64	SRMP

[6] Figure 3 in Steventon, J.D. 2002. Historic disturbance regimes of the Morice and Lakes Timber Supply Areas. Draft discussion paper. Prince Rupert Forest Region.

Table 1.3. Current and future indicator values (when known) for old and mature forest.

	Current Indicator Value (%)	Source	Future Indicator Value (%)	Source
Bulkley (Babine)	> 100	SOFR	39 – 51	LUP
Bulkley (Nilkitkwa)	> 100	SOFR	59 – 76	LUP
Kispiox	Unknown	--	71 – 78	SRMP

Table 1.4. Current and future indicator values (when known) for young forest.

	Current Indicator Value (%)	Source	Future Indicator Value (%)	Source
Bulkley (Babine)	78 – 100	SOFR	193 – 360	LUP
Bulkley (Nilkitkwa)	53 – 56	SOFR	143 – 270	LUP
Kispiox	unknown	--	139 – 260	SRMP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 1.5 - Table 1.7 are based on the indicator data and the current knowledge about risk and uncertainty described above. Note that although risk to young seral stage is generally low, guidelines for young seral are maxima rather than minima—the high abundance of young seral stages is a corollary of less-than-natural amounts of older seral stages.

Table 1.5. Current and future risk and uncertainty for old forest.

	Current		Future	
	Risk	Uncertainty	Risk	Uncertainty
Bulkley (Babine)	Low	High	High	Low
Bulkley (Nilkitkwa)	Low	High	Medium	High
Kispiox	Low *	High	Medium	High

* Estimated

Table 1.6. Current and future risk and uncertainty for old and mature forest.

	Current		Future	
	Risk	Uncertainty	Risk	Uncertainty
Bulkley (Babine)	Low	High	Medium	High
Bulkley (Nilkitkwa)	Low	High	Low	High
Kispiox	Low*	High	Low	High

* Estimated

Table 1.7. Current and future risk and uncertainty for young forest.

	Current		Future	
	Risk	Uncertainty	Risk	Uncertainty
Bulkley (Babine)	Low	High	Low	High
Bulkley (Nilkitkwa)	Medium	High	Low	High
Kispiox	Low*	High	Low	High

* Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: seral stage data already exist in digital format.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to analysing by subzone: **easy**.

Rationale: This question examines the effectiveness of the seral-stage targets by subzone at achieving the objective of maintaining a natural seral-stage distribution of ecosystems and the goal of maintaining biodiversity. It determines whether or not smaller ecosystem units (perhaps groups of site series) are sufficiently represented.

Ideally this question would be addressed using TEM mapping; TEM mapping, however, is costly. Initially, it could be addressed with PEM (which includes moderate uncertainty in the maps) or site productivity classes (which does not include as many ecological variables). The probability of reducing uncertainty is high—particularly in the low risk, high uncertainty classes—even using the low-cost alternatives to TEM.

A project using PEM requires no new data, examines several watersheds, and requires some GIS skills for a relatively simple analysis.

Uncertainty associated with the middle of the risk curve (30% to 70% of natural): **very difficult.**

Rationale: The diversity of species' needs and the complexities of interactions among species means that risk will vary among ecosystems and species. Field experiments over long periods are necessary.

Ease of Detecting Negative Consequences (Question 17)

Easy – very difficult.

Rationale: It is easy to detect when the % of any seral stage of any ecosystem is putting biodiversity at high risk. It is very difficult to detect actual impacts independently, because seral-stage distribution of ecosystems is the best coarse-filter surrogate for detecting impacts to biodiversity.

It is only possible to estimate actual costs for specific projects. Particularly for biodiversity, costs could range from fairly low (for studies based on existing databases) to incredibly high (field studies of particularly sensitive organisms).

Objective: Maintain Core Ecosystems

Land-use Plan Summary

All land-use plans include objectives to maintain core ecosystems. Ecosystem networks (core areas and landscape riparian corridors) are essentially a strategy for achieving other objectives over the plan area (e.g. old forest, representation, interior forest, rare ecosystems, sensitive riparian areas, connectivity). While specific objectives for core areas include providing ecological representation, old forest conditions and interior forest conditions, monitoring for these objectives occurs over the entire landscape (see other objectives).

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence on Goal (Question 3)

Low.

Rationale: Table 1.1 above.

Recovery Period (Question 4)

Long.

Rationale: Old forest conditions take 140 or 250 years to recover, depending on BEC subzone (see Objective to Maintain Natural Seral-stage distribution).

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Because specific objectives for core areas are monitored over the entire landscape, effectiveness monitoring for these objectives must be designed in concert with monitoring for other objectives. Effectiveness monitoring for core areas themselves asks whether the network retains its integrity.

Indicators include

- % alteration in core areas

Risk to ecosystem integrity in core areas increases sigmoidally with % alteration in core areas (based on principles described under the objective to Maintain Natural Seral-stage distribution; Figure 1.2).

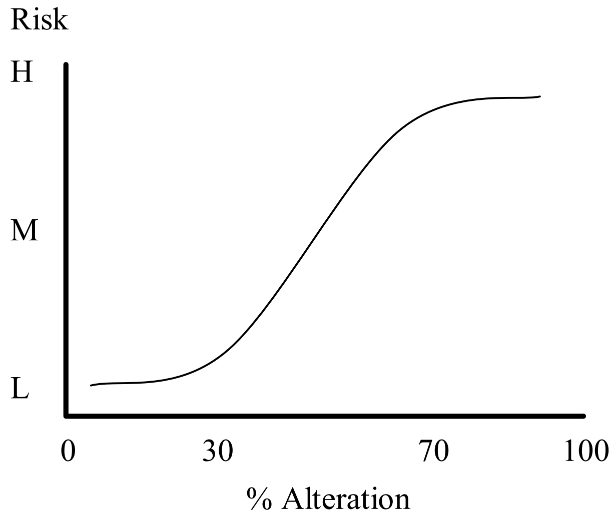

Figure 1.2. Risk to ecosystem integrity in core areas as a function of alteration in core areas.

It is difficult to design a curve linking % alteration in core areas with risk to biodiversity without knowing what proportion of representation comes from the core areas. For example, if core areas are the main means of maintaining biodiversity over the entire landscape, the curve could rise steeply, and any alteration within the core could pose high risk; whereas if the core areas are one of a suite of methods to maintain biodiversity, risk due to the same amount of alteration could be low.

Uncertainty around the curve is low at the ends (regions of low risk and high risk, respectively), and high in the middle (medium risk). Uncertainty about the relationship between % alteration of the core and the maintenance of biodiversity, however, is very high.

Fifty-nine percent of the forest cover in core areas is undefined (SOFR), adding additional uncertainty about the influence of core ecosystems on natural seral-stage distribution.

Available Data (Question 6)

Data are available for current and future indicator values in the Bulkley; but not for current values in the Kispiox. A rough estimate assumes low risk in the Kispiox core areas. **Medium priority** for data collection in the Kispiox.

The indicators are based on the % alteration within core ecosystems. For current values, the % of early seral stages gives an approximation of alteration (Table 1.8), although some of these stands could have been disturbed naturally.

Table 1.8. Current and future indicator values for core areas.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley	1% early seral	SOFR	0% alteration	LUP
Kispiox	unknown	--	0% alteration	SRMP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Estimated levels of risk and uncertainty (Table 1.9) are based on indicator values and the risk relationships described above.

Table 1.9. Current and future risk and uncertainty for core areas.

	Current		Future	
	Risk	Uncertainty	Risk	Uncertainty
Bulkley	Low	Low	Low	Low
Kispiox	Low*	Low	Low	Low

* Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Seral stage information exists.

Ease of Improving Risk Curve (Question 16)

Uncertainty associated with current indicator levels: **unnecessary**.

Rationale: The low levels of uncertainty associated with the current and future indicator levels suggest that improving the risk curve is unnecessary. Studies would be unlikely to further reduce uncertainty around the risk curve because of low statistical power. If exceptions to the suggested strategies lead to higher variation in the indicator value, raising risk to medium, it might be possible to resolve the higher uncertainty associated with the medium risk by studying sensitive organisms (e.g. epiphytes).

Uncertainty about the relationship between core integrity and biodiversity: **difficult – very difficult.**

Rationale: Improving knowledge about this relationship requires consideration of areas outside core ecosystems, likely involving field experiments over several years, and is better considered under other objectives.

Ease of Detecting Negative Consequences (Question 17)

Difficult – very difficult.

Rationale: Although it is easy to detect when the percent alteration of core areas puts the ecological integrity of the core areas at high risk based on the risk curve, it is very difficult to detect actual consequences. Such a project would require new field data, preferably an experimental design over a long period of time over several watersheds. Relative costs are high.

Actual costs will vary among specific projects. Given the expected low level of alteration, and the difficulty in monitoring sensitive species, the probability of detecting an effect is low.

Objective: Maintain Connectivity in Landscape Corridors

Land-use Plan Summary

Ecosystem networks (core areas and landscape riparian corridors) are a strategy for achieving other objectives over the plan area (e.g. old forest, representation, interior forest, rare ecosystems, sensitive riparian areas, connectivity). The objectives within landscape corridors are to maintain the connectivity of mature and old forest (SRMP Table 2) and to retain most of the structure and function associated with old forest (Bulkley LUPs Ob 1.2). Connectivity may refer to physical connectivity, where forest cover remains contiguous, or to functional connectivity, which allows movement and dispersal (different species can tolerate different amounts of habitat fragmentation). Indicators address both physical and functional connectivity.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence on Goal (Question 3)

Low.

Rationale: Table 1.1 above.

Recovery Period (Question 4)

Moderate.

Rationale: Mature forest conditions required to re-establish connectivity take 100 – 120 years to recover, depending on BEC subzone. Mitigation has some potential to create mature conditions through thinning and snag creation.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain mature and old forest, to limit cutblock size and road density, and to harvest in winter will maintain connectivity of mature and old forest in corridors.

Indicators in the land-use plans include

- % mature and old forest in corridors
- % of cutblocks greater than 3 ha
- km of road per km^2
- % of harvesting in winter

Two curves relate these indicators to risk. First, for small cutblocks, with limited road density outside the cutblock, risk to connectivity increases as the percent of mature and old forest decreases (Figure 1.3).

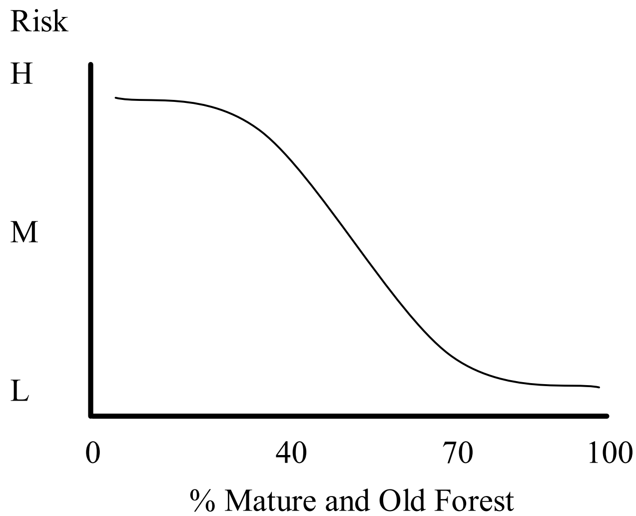

Figure 1.3. Risk to mature and old forest connectivity in corridors as a function the % of mature and old forest.

The shape of the curve arises because, on theoretical landscapes, patches become disconnected at approximately 60% habitat abundance. These theoretical landscapes are simple binary landscapes with a random distribution of patches. On real landscapes, patches become disconnected at approximately 40 to 70% remaining habitat. Thus 70% is assumed to be low risk and 40% to be moderate risk. Physical connectivity is not an ideal indicator of the effectiveness of corridors, but is the best option currently available. Little consensus exists on the effectiveness of corridors within the scientific literature.

With small cutblocks and no roads, uncertainty is low at high risk and high elsewhere. The high uncertainty at low and moderate risk levels results partly from a lack of resolution of the indicator: while the Bulkley land-use plans focus on old forest structure, the indicator combines mature and old forests. This uncertainty is easily resolvable by adding an indicator looking at the % of old forest. The relationship between the abundance of old and mature forest and physical connectivity also adds uncertainty (i.e. overall amounts do not describe pattern). This uncertainty can be resolved by measuring connectivity on maps.

Cutblock size and road density modify the basic curve. The curve assumes that blocks are small in relation to the corridor (i.e., they do not span the corridor width) and that no barriers are created by roads. Large cutblocks and increased road access disrupt connectivity and increase risk (shift the curve upwards). The magnitude of the increase in risk is difficult to predict; hence uncertainty will also increase, particularly at low and moderate risks. Road orientation, traffic density and cutblock width relative to corridor width will influence connectivity. This uncertainty can be reduced by measuring connectivity on maps in relation to different cutblock sizes and road densities.

The second curve describes the relationship between corridor use and winter logging (Figure 1.4).

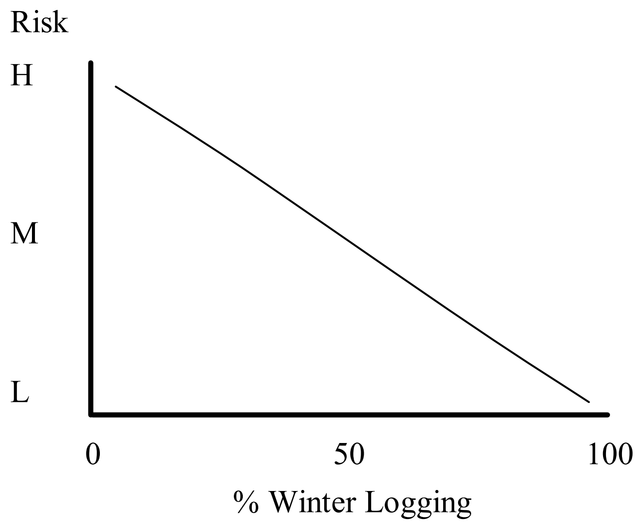

Figure 1.4. Risk to mature and old forest connectivity in corridors as a function of the percent of logging occurring in winter.

Although logging season does not affect physical connectivity, summer logging has a higher potential to disrupt animal movement, and hence functional connectivity.

High uncertainty occurs at all levels of risk. Wildlife response to human activity is not well known and varies among species. In addition, the duration of the activity, timing of activity and number of corridors affected will influence risk. Reducing this uncertainty requires field studies that are often difficult to conduct and interpret.

Available Data (Question 6)

Data are available to provide an estimate of the amount of mature and old forest within corridors in the Bulkley, but there is no future target level. Conversely, there is a future target for the amount of old and mature forest within corridors in the Kispiox, but no data on current levels. A rough estimate assumes that current risk in the Kispiox is low. It is not possible to estimate future risk in the Bulkley. **Medium** priority for collecting indicator data for Kispiox. **High** priority for setting target that matches objective in Bulkley.

The indicator values for the Bulkley in Table 1.10 show the percent of corridors with more than 70% mature forest (defined as greater than 80 years in the SOFR analyses). Future analyses should use definitions of mature and old given in the Biodiversity Guidebook. **Medium** priority for collecting current indicator values for the Bulkley. In the Babine, one small corridor contains less than 50% mature forest.

Table 1.10. Current and future indicator values for % of old and mature forest in corridors.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley (Babine)	66	SOFR	Unknown	--
Bulkley (Nilkitkwa)	100	SOFR	Unknown	--
Kispiox	unknown	--	70	SRMP

There are no data on current winter harvesting in either district Table 1.11). There is a future target for the Kispiox, but not for the Bulkley. **High** priority for collecting indicator data.

Table 1.11. Current and future indicator values for % of winter logging in corridors.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	100	SRMP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Estimated levels of risk and uncertainty (Table 1.12 - Table 1.13) are based on indicator values and the risk relationships described above.

Table 1.12 Current and future risk and uncertainty for connectivity.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley (Babine)	Moderate	High	Unknown	Unknown
Bulkley (Nilkitkwa)	Low	High	Unknown	Unknown
Kispiox	Low*	High	Low	High

* Estimated

Table 1.13. Current and future risk and uncertainty for winter logging.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley (Babine)	Unknown	--	Unknown	--
Kispiox	Unknown	--	Low	High

Information to Assess Costs and Benefits of Monitoring Projects

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Calculating the proportion of corridors with a high percent of old and mature forest is a relatively simple GIS task.

Ease of Improving Risk Curve (Question 16)

Uncertainty associated with lack of indicator resolution: **easy.**

Rationale: It is easy to add an indicator looking at the percentage of old forest as well as forests over 80 years old.

Uncertainty associated with use of corridors: **very difficult**.

Rationale: Field experiments of corridor use have proven very difficult to conduct.

Uncertainty associated with pattern, cutblock size and road density: **moderate**.

Rationale: It is possible to resolve this uncertainty by subjectively measuring connectivity on maps.

Uncertainty associated with winter logging: **difficult**.

Rationale: Wildlife response to human activity varies among species. The duration and timing of activity and number of corridors affected will influence risk. Reducing this uncertainty requires field studies that are often difficult to conduct and interpret.

Ease of Detecting Negative Consequences (Question 17)

Very difficult.

Rationale: Although it is easy to detect when the percent alteration of corridors puts connectivity at high risk based on the risk curve, it is very difficult to detect actual consequences. Such a project would require new field data, preferably an experimental design over a long period of time over several watersheds. Relative costs are high.

Objective: Maintain Rare Ecosystems

Land-use Plan Summary

Land-use direction calls for specific attention to rare ecosystems, because these ecosystems are at higher risk from stochastic events (i.e. it is easier for a disturbance to affect all of a rare ecosystem than all of a common ecosystem). Kispiox direction is more explicit (maintain structural and functional integrity of red and blue listed plant communities) than Bulkley direction (retain representative examples of rare plant communities). The Kispiox has a target of no reduction in functional area. The Bulkley includes strategies to locate rare plant communities within wildlife-tree patches and core areas.

Rare ecosystems are based on the plant associations used in the Biogeoclimatic Ecosystem Classification System. Many occur in old forest. They map onto site series.

Ecosystems may be rare naturally or may be rare because of historic alteration (e.g., logging). Ideally, only naturally rare ecosystems would be addressed here. Rarity due to alteration could be addressed under maintaining a natural seral-stage distribution, if analysis was completed for each rare plant association or site series.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence on Goal (Question 3)

Moderate.

Rationale: Table 1.1 above.

Recovery Period (Question 4)

Long.

Rationale: The low density of rare ecosystems limits colonisation and dispersal of rare plants. Full recovery may not be possible. Rare ecosystems often occur in old forest, and can take over 250 years to re-establish following disturbance.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether the strategies to maintain rare ecosystems are successful.

Indicators include

- % reduction in functional area of listed ecosystems

Risk to biodiversity versus the percent of each rare ecosystem unaltered increases rapidly as the amount of unaltered ecosystems decreases. Risk is medium at 90% of natural abundance and high at 70% of natural abundance (Figure 1.5).

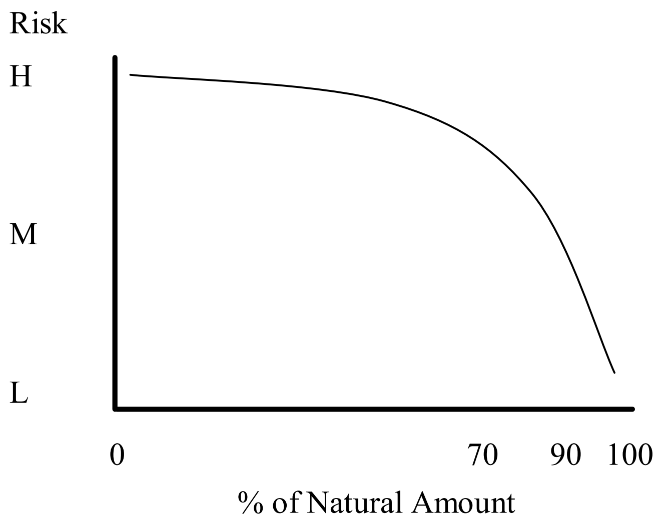

Figure 1.5. Risk to biodiversity versus percentage of area unaltered for each rare ecosystem.

For each rare ecosystem, uncertainty is low at low abundance (i.e. when risk is high), high at intermediate abundance and moderate at high abundance (i.e. at low risk). Actual risk varies somewhat by ecosystem, but this uncertainty is difficult to resolve: some ecosystems may be more sensitive than others. Moderate uncertainty at high abundance results from errors associated with ecosystem mapping (i.e. both the natural abundance of each ecosystem and the remaining abundance are uncertain). This uncertainty is resolvable.

When risk to all rare ecosystems is considered, uncertainty associated with high abundance increases to high. First, the indicator only considers listed ecosystems. Truly rare ecosystems likely have not been described and listed. These unlisted rare ecosystems may be at particular risk because of lack of awareness. Conversely, some listed ecosystems are not truly rare and could be at less risk than suggested by the curve. Local knowledge is useful to reduce these uncertainties. Second, listed ecosystems are only considered rare in certain structural stages (usually old). Past activities have already reduced the functional area of listed ecosystems. In some past analyses, historically altered areas—that would potentially develop the rare plant communities given sufficient time—are no longer included in the indicator. It is possible to resolve this latter uncertainty by including rare and potentially rare ecosystems, where "potential" refers to young seral stages of site series that potentially will develop the rare communities.

Available Data (Question 6)

No data are available to assess current indicator levels in the Bulkley or the Kispiox. The State-of-the-Forest Report does not calculate the proportion of rare ecosystems that have been logged. Data are available for future indicator levels for both districts. It is not possible to estimate current indicator levels. **High priority** for collecting indicator data.

The future values in Table 1.14. are based on the target for the Kispiox, and on calculations of the proportion of rare ecosystems that are not likely to be harvested (included in protected areas, class 1 special management zones, core areas, non-forest areas and non-productive areas) in the Bulkley.

Table 1.14. Current and future indicator values for rare ecosystems.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley	Unknown	--	10 ecosystems 80% reduction; only 1/31 ecosystems with less than 30% reduction	SOFR
Kispiox	Unknown	--	0% reduction	SRMP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Estimated levels of risk and uncertainty (Table 1.15) are based on indicator values and the risk relationships described above. The future uncertainty in the Bulkley has been increased from low because the calculations are for the entire TSA and because stand-level protection is not considered. Additional uncertainty surrounds future risk in the Bulkley, because no target level of alteration is specified for rare ecosystems and because the strategy to retain rare ecosystems in wildlife-tree patches is vague.

Table 1.15. Current and future risk and uncertainty for rare ecosystems.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Unknown	Unknown	High	Moderate
Kispiox	Unknown	Unknown	Low	High

Information to Assess Costs and Benefits of Monitoring Projects

Ease of Collecting Indicator Data (Question 15)

Moderate.

Rationale: This information requires an analysis of PEM (or TEM) data, comparing existing rare ecosystems with their historical extent.

Ease of Improving Risk Curve (Question 16)

Uncertainty associated with sensitivity of different ecosystems: **very difficult**.

Rationale: Due to their rarity, it is neither possible nor desirable to include rare ecosystems in experimental tests of sensitivity.

Uncertainty associated with non-listed rare ecosystems: **easy – moderate**.

Rationale: A study based on local knowledge and interviews would be easy; field work would be difficult, especially in already-harvested areas.

Uncertainty associated with original coverage of listed ecosystems: **moderate**.

Rationale: This uncertainty can be reduced by including rare and potentially rare ecosystems, where "potential" refers to young seral stages of site series that potentially will develop the rare communities. PEM can be used as a first estimate; TEM is better. Over time, as inventory improves, the information should be easier to extract from databases.

Ease of Detecting Negative Consequences (Question 17)

Easy.

Rationale: It is easy to detect when the percent alteration of rare ecosystems puts biodiversity at high risk based on the risk curve. It is also easy to detect negative consequences because loss of any rare ecosystem has, by definition, a consequence for biodiversity. Field work actually examining species loss or community shifts is however, much more difficult.

It is only possible to estimate actual costs for specific projects. Costs could range from very low, associated with projects based on existing databases to very high for field studies of sensitive organisms.

Objective: Maintain Tree Species Diversity

Land-use Plan Summary

The Bulkley LRMP aims to maintain coniferous and deciduous diversity. The Kispiox SRMP only addresses deciduous ecosystems. Bulkley LUPs explicitly aim to represent the natural species composition of each biogeoclimatic subzone. Deciduous ecosystems deserve special focus because silviculture favours coniferous species. Silviculture also favours some conifer species over others.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence on Goal (Question 3)

Moderate.

Rationale: Table 1.1 above.

Recovery Period (Question 4)

Medium.

Rationale: Tree species diversity can recover in less than 100 yr, given some minor mitigation. Deciduous trees generally occur in early seral stages (< 100 yr), but returning to natural abundance may take more than 100 yr, without mitigative practices that favour deciduous species. Similarly, coniferous trees can return to their original diversity in early seral stages, given mitigation. In later seral stages, succession will increase the diversity of monocultures over time.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain certain proportions of deciduous stands on the landscape and to maintain certain proportions of each tree species in managed stands will maintain tree species diversity.

Indicators include

- % area of natural deciduous-leading ecosystems
- % tree species component of managed early seral stands

Two relationships describe risk to tree species diversity. Risk to tree species diversity decreases proportionally as the area of deciduous-leading stands increases up to the natural amount (Figure 1.6). Medium risk falls between 33% and 67% of natural.

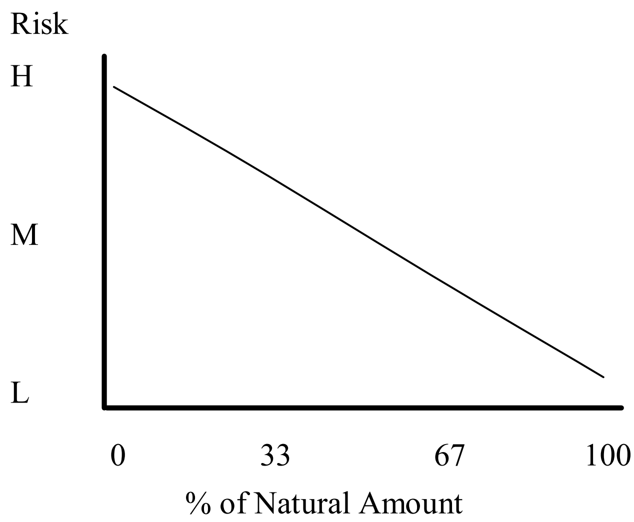

Figure 1.6. Risk to tree species diversity versus percent area of deciduous ecosystems.

Uncertainty around the curve is low for moderate and high risks and moderate for low risks. The moderate uncertainty at low risk levels results from the lack of a good estimate of the natural proportion of deciduous stands on the landscape. This uncertainty is easily resolved by studying ecologically-similar, natural landscapes.

Similarly, risk to tree species diversity decreases as the proportion of each tree species increases up to the natural amount (Figure 1.7).

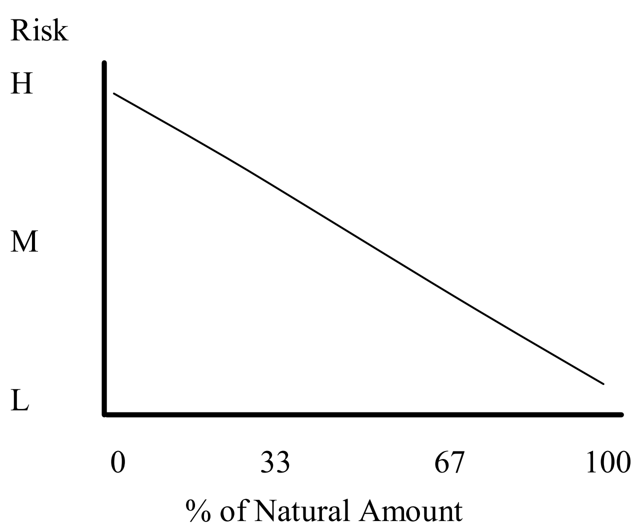

Figure 1.7. Risk to tree species diversity versus percent component of each tree species in early seral stands.

Uncertainty around the curve is moderate. Part of the uncertainty, at all risk levels, results from considering only managed stands—information from young unmanaged stands is missing. This uncertainty is easily resolved by surveying young natural stands. Part of the high uncertainty at a low risk level results from the lack of a good estimate of tree species composition in young natural stands. This uncertainty is easily resolved by studying the composition of natural stands.

Available Data (Question 6)

For the deciduous ecosystem indicator, no data describe current or future levels in the Bulkley or Kispiox (Table 1.16). **High priority** for data collection.

For the tree species composition indicator, no data are available to estimate current indicator values in the Kispiox or future indicator values in the Bulkley or the Kispiox (Table 1.17). No plans provide specific targets to serve as future indicator values. Data are available for the Bulkley, but are weak: tree species composition is compiled for the entire TSA rather than by landscape unit. **Medium priority** for data collection in the Kispiox; **medium priority** for collecting landscape unit scale data in the Bulkley.

A rough estimate based on the proportion of the landscape harvested suggests that risk to tree species diversity for both indicators is currently moderate in the Babine, and low in the Nilkitkwa and the Kispiox. Based on the area available for harvest, future risk is expected to be moderate in the Kispiox and Nilkitkwa and high in the Babine. The uncertainty associated with this rough estimate is high at all risk levels.

Table 1.16. Current and future indicator values for amount of deciduous ecosystems.

	Current Indicator Value (%)	Source	Future Indicator Value (%)	Source
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

Table 1.17. Current and future indicator values for tree species component in managed stands.

	Current Indicator Value (%)	Source	Future Indicator Value (%)	Source
Bulkley TSA (SBS mc2) spruce	> 100	SOFR	Unknown	--
Bulkley TSA (SBS mc2) pine	> 100	SOFR	Unknown	--
Bulkley TSA (SBS mc2) fir	~ 60	SOFR	Unknown	--
Bulkley TSA (SBS mc2) aspen	~ 100	SOFR	Unknown	--
Bulkley TSA (ESSF mc) spruce	> 100	SOFR	Unknown	--
Bulkley TSA (ESSF mc) pine	> 100	SOFR	Unknown	--
Bulkley TSA (ESSF mc) fir	~ 60	SOFR	Unknown	--
Bulkley TSA (ESSF mc) aspen	~ 60	SOFR	Unknown	--
Kispiox	Unknown	--	Unknown	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Estimated levels of risk and uncertainty (Table 1.18) are based on indicator values and the risk relationships described above. Note that data in Table 1.17 are for entire Timber Supply Area; hence risk must be estimated for the study area.)

Table 1.18. Current and future risk and uncertainty for tree species component in managed forests.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley (Babine)	Medium*	Medium	High*	Medium
Bulkley (Nilkitkwa)	Low*	Medium	Medium*	Medium
Kispiox	Low*	Medium	Medium*	Medium

*Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Involves database calculations of past, present and projected future deciduous ecosystems.

Ease of Improving Risk Curve (Question 16)

Uncertainty associated with natural proportion of deciduous stands on landscape: **easy**.

Rationale: Requires analysis of existing inventory information on natural landscapes.

Uncertainty associated with natural tree species composition: **easy**.

Rationale: Surveys of the composition of natural stands would resolve this uncertainty. Field work is likely necessary.

Uncertainty associated with failing to include young unmanaged stands: **moderate**.

Rationale: Requires surveys of amount of young natural forest and estimates of composition.

Ease of Detecting Negative Consequences (Question 17)

Difficult.

Rationale: Would require experimental studies of organisms' response to tree species diversity.

Objective: Maintain Sensitive Riparian Areas

Land-use Plan Summary

Objectives address all water bodies and pay specific attention to fluvial ecosystems, but not to fans. The Forest Practices and Range Act contains objectives to conserve several ecological values associated with riparian areas. The Kispiox LRMP has an objective to maintain riparian areas. Management strategies in the Bulkley and Kispiox TSAs include ecosystem networks, incorporating landscape riparian corridors along streams. Default strategies in FRPA include riparian reserves around streams, lakes and wetlands. The size of the reserve and management zones depends on the class (based on size and fish presence) of the associated waterbody. The Kispiox LRMP includes a specific objective to maintain sensitive areas "such as wetlands, floodplains and riparian areas".

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Table 1.1 above.

Recovery Period for Objective (Question 4)

Variable; long for some functions.

Rationale: Some elements of riparian function recover relatively quickly (e.g. shrub cover); some take over 100 years (e.g. downed wood, old riparian ecosystems); others may not return to the same state after disturbance (e.g. changes in stream morphology following hillslope failures).

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship or
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether the strategies to maintain riparian reserves and management zones are successful in maintaining riparian function, and in turn, in maintaining biodiversity.

Riparian areas occur where water influences land. Riparian areas are highly productive terrestrial ecosystems that also greatly influence hydrological ecosystems. The presence of water affects the microclimate and the productivity and structural diversity of the adjacent forest. Forests adjacent to streams maintain bank stability, filter runoff and provide a source of litterfall and downed wood structure. Fans and fluvial ecosystems (including floodplains) are particularly sensitive to disturbance.

Indicators include

- percent alteration of fluvial ecosystems
- percent of waterbody surrounded by target reserve width or better
- percent of waterbody surrounded by target management zone width or better

Risk to sensitive (fluvial) riparian areas increases sigmoidally as the percent of intact (i.e., unaltered) fluvial ecosystems decreases relative to natural (Figure 1.8). Inflexion points occur at 50% and 90% of natural (i.e. risk is high when intact ecosystems are less than 50% of natural; risk is low when intact ecosystems are more than 90% of natural; risk is intermediate between).

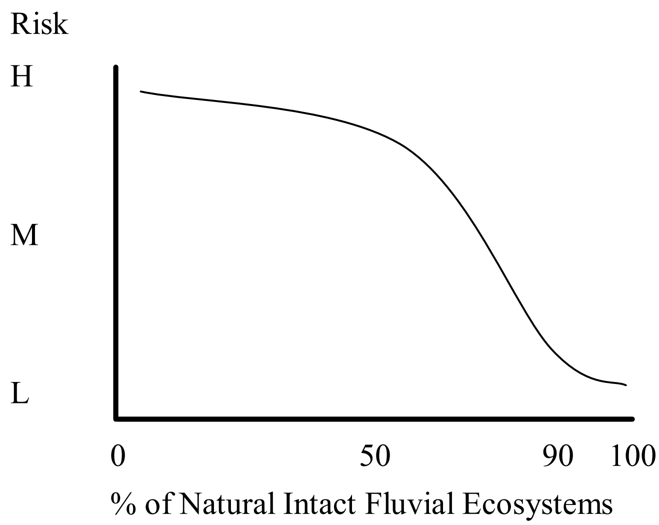

Figure 1.8. Risk to sensitive riparian areas versus intact fluvial ecosystems (percent of natural).

Less sensitive fluvial ecosystems (e.g. small, low-gradient streams without floodplains) would follow a similarly-shaped, but less sensitive curve, with inflexion points at 30% and 70%.

Uncertainty around the fluvial curve is low when the percent alteration is higher than 50% (i.e. when risk is high). Uncertainty is high elsewhere. A portion of the uncertainty results from not explicitly including fans in the indicator. Fans are inherently unstable and linked to downstream fluvial ecosystems. This portion of uncertainty can be resolved by including fans, as well as floodplains, explicitly in the indicator.

It is not possible to draw risk curves relating the percent of waterbodies surrounded by target-width reserve and management zones because of two types of uncertainty. First, hydrologically- and ecologically-defined riparian zones are sometimes wider, and sometimes narrower, than the fixed-width targets. In addition, blowdown can greatly alter buffers. This uncertainty could be resolved by considering hydrologically and ecologically appropriate reserve widths and monitoring buffer widths over time to allow for blowdown. Second, the resolution of the indicator is too broad to account for different sensitivities of different portions of waterbodies. For example, 99% of a river could be surrounded by a target-width reserve, but the remaining 1% could include all of the tributary junctions along the river.

Additional uncertainty arises because the activities within riparian management zones can vary considerably.

Available Data (Question 6)

Data are unavailable for current indicators (Table 1.19). There is no clear target for the Bulkley. Rough estimates are not possible. **High** priority for data collection. **High** priority for setting targets in the Bulkley. Uncertainty is too high to use indicator values looking at the percent of target-width reserves and management zones.

Table 1.19. Current and future indicator values for intact fluvial ecosystems.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	100%	SRMP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 1.20 are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 1.20. Current and future risk and uncertainty for alteration to fluvial ecosystems.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Low	High

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Benefits are calculated from the sections above; the information below gives a preliminary idea about costs.

Ease of Collecting Indicator Data (Question 15)

Moderate.

Rationale: Determining percent alteration from maps is straightforward. Measuring the impacts of blowdown, however, requires field work.

Ease of Improving Risk Curve (Question 16)

Uncertainty relating to fans: **easy – moderate**.

Rationale: This uncertainty can be reduced by explicitly considering fans in the indicator. Identifying fans on air photos requires skill and careful analysis. Field checks are sometimes necessary.

Uncertainty relating to target-width reserves and management zones: **difficult.**

Rationale: Designing an indicator to look at the percent of hydrologically and ecologically appropriate reserve widths is relatively easy. Documenting the effectiveness of these widths requires field work over time.

Ease of Detecting Negative Consequences (Question 17)

Moderate – very difficult.

Rationale: It is relatively easy to detect changes to stream morphology and to detect blowdown. It is difficult to detect changes to patterns of downed wood over time and very difficult to detect changes to use of riparian corridors by mobile organisms.

Objective: Attain Natural Landscape Pattern

Land-use Plan Summary

Legislation and land-use plans include objectives to create harvest patterns that reflect the spatial patterns of natural disturbance. The objective in the Kispiox SRMP specifically focuses on patch-size distribution while the objectives in the Bulkley LUPs and in legislation are more general (i.e., pattern). Legislation includes a temporal aspect; land-use plans consider temporal features under objectives to maintain seral-stage distribution.

Bulkley LUPs give patch-size targets for natural disturbance units. The Kispiox SRMP gives targets by watershed. Both the Bulkley and the Kispiox provide special targets for landscape riparian corridors, the Babine River SMZ and high value grizzly bear habitat (high value, mixed forest habitat in the Bulkley).

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Low.

Rationale: Table 1.1 above.

Recovery Period for Objective (Question 4)

Long.

Rationale: Pattern recovers slowly in older seral stages (unless fragmentation is called for) and rapidly in the first seral stage (a simple reflection of logging objectives). Mitigation is difficult, particularly where seral stage objectives limit further logging.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship or
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether the patch-size indicators and targets are successful in attaining a natural landscape pattern.

Indicators include

- % of area logged in each patch-size class in each identified land class in the Kispiox.
- % of area nearing rotation age (e.g., 80 to 100 yr) in each patch-size class in each identified unit in the Bulkley.

Risk to landscape pattern increases as the percentage of area in each patch-size class moves further from natural (Figure 1.9).

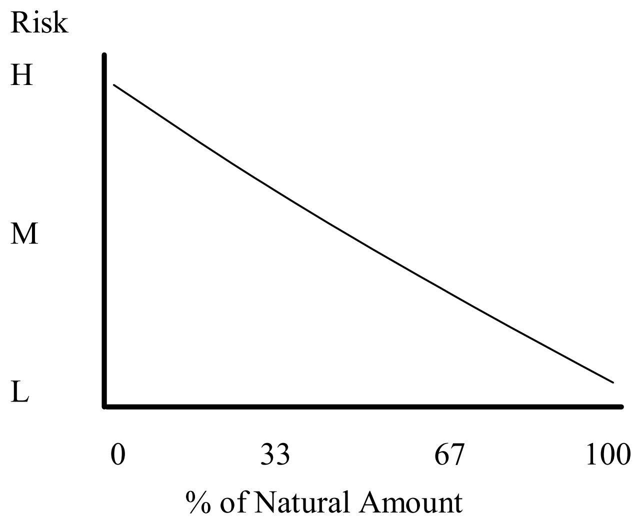

Figure 1.9. Risk to landscape pattern versus percent in each patch-size class relative to natural amounts.

Patch-size distribution is a good, ecologically-relevant measurement of landscape pattern. The overall influence of landscape pattern on biodiversity, however, is highly uncertain, because different species respond to different scales and because interactions among species generate complex response patterns. Uncertainty around the curve also exists because each indicator considers only a single age class (area logged in the Kispiox; area near rotation in the Bulkley). This uncertainty varies across seral stages. Moderate to high uncertainty exists about patterns created in mature and old seral stages, because the initial post-harvest pattern will be modified by natural disturbance and by subsequent harvesting (second rotation). Conversely, uncertainty is low in young and pole seral stages, because post-harvest disturbance is limited.

Minor uncertainty exists about the appropriate period within which adjacent (or overlapping) disturbances should be considered part of the same patch. The Bulkley LUPs use a 20-year period and the Kispiox SRMP uses a 10-year period.

Moderate uncertainty exists about how well target patch-size distributions reflect natural disturbance. Similar caveats apply to the method of calculating the range of natural variability as discussed under the objective to maintain a natural seral-stage distribution of ecosystems.

Available Data (Question 6)

Current data are available for the Bulkley, however, they describe area logged rather than area nearing rotation (see indicators); target data are available for the Bulkley and the Kispiox. As a rough estimate, it is possible to assume that current risk is low with high uncertainty in the Kispiox, because of limited logging. **Medium priority** for data collection in the Kispiox.

Natural patch-size distributions are available for relevant BEC subzones based on an analysis of subzones in adjacent forest districts[7]. The numbers in Table 1.21 - Table 1.22 below are calculated by dividing the amount the current and target amounts found in the referenced sources by the predicted natural amount of each patch-size class.

Table 1.21. Current and future indicator values for percent of natural patch size in the Bulkley.

	Current Indicator Value (%)		Source	Future Indicator Value (%)	Source
	Babine	***Nilkitkwa***		***Bulkley (all)***	
Bulkley ESSF (<40)	> 100 [a]	> 100	SOFR	> 100	LUP
40-80	> 100	> 100	SOFR	> 100	LUP
80-250	> 100	0	SOFR	> 100	LUP
250-5,000	0	0	SOFR	0	LUP
80-5,000 [b]	*68%*	*0*	*SOFR*	*41%*	*LUP*
Bulkley SBS (<40)	> 100	> 100	SOFR	65%	LUP
40-250	> 100	> 100	SOFR	75%	LUP
250-1,000	> 100	0	SOFR	> 100	LUP
1,000-10,000	0	0	SOFR	0	LUP
250-10,000 [b]	*65%*	*0*	*SOFR*	*> 100*	*LUP*

[a] data for the Babine and Nilkitkwa in SOFR appears to show the percent area occupied by each early seral patch size class of the entire landscape, rather than of early seral; thus, these data were adjusted
[b] the final patch size class shows a combination of the previous two patch size classes and provides a low resolution view of the data

Table 1.22. Current and future indicator values for percent of natural patch size in the Kispiox.

	Current Indicator Value (%)	Source	Future Indicator Value (%)			Source
	Kispiox (all)		***Shedin*** [a]	***Babine*** [b]	***Hanawald*** [c]	
Kispiox ESSF (< 1)	Unknown	---	Unknown [d]	Unknown	Unknown	SRMP
< 80	Unknown	---	> 100	> 100	> 100	SRMP
80-250	Unknown	---	85%	> 100	0	SRMP
250-5,000	Unknown	---	61%	0	> 100	SRMP
80-5,000	Unknown	---	68%	41%	74%	SRMP

[a] targets presented in SRMP were scaled to address mathematical errors in Shedin watershed
[b] Babine and Shelagyote watersheds
[c] Hanawald, Gail/Thomlinson and Nichyeskwa watersheds
[d] resolution of digital data used in Steventon 2002 was not sufficient to detect disturbances of less than one hectare

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 1.23 are based on the indicator data and the current knowledge about risk and uncertainty described above. Indicator data from different subzones in the Bulkley and different watersheds in the Kispiox are combined to provide a larger, more appropriate area for assessing landscape pattern.

[7] Steventon, J.D. 2002. Historic disturbance regimes of the Morice and Lakes Timber Supply Areas. Draft discussion paper. Prince Rupert Forest Region.

Table 1.23. Current and future risk and uncertainty for natural patch size.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley ESSF (<40)	Low	High	Low	High
40-80	Low	High	Low	High
80-250	Med	High	Low	High
250-5,000	High	High	High	High
80-5,000 [b]	Med	High	Medium	High
Bulkley SBS (<40)	Low	High	Medium	High
40-250	Low	High	Low	High
250-1,000	Med	High	Low	High
1,000-10,000	High	High	High	High
250-10,000 [b]	Med	High	Low	High
Kispiox ESSF (< 1)	Low *	High	unknown	unknown
< 80	Low *	High	Low	High
80-250	Low *	High	Med	High
250-5,000	Low *	High	Med	High
80-5,000	Low *	High	Med	High

* Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Benefits are calculated from the sections above; the information below gives a preliminary idea about costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data already exist.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to the response of different species: **very difficult.**

Rationale: Several expensive studies have tackled this problem and have yielded inconclusive results.

Uncertainty related to different seral stages: **moderate**.

Rationale: The scope of the indicator could be increased to include mature and old seral stages. Target patch-size distributions for these later seral indicators could then be derived from existing studies or by simple simulations of natural disturbance. Alternatively, uncertainty about the relationship between the patch-size distribution following logging and the patch-size distribution in later seral stages can be partly resolved by landscape simulations.

Ease of Detecting Negative Consequences (Question 17)

Difficult.

Rationale: Calculating patch-size distribution uses existing data. It is very difficult, however, to detect consequences to biodiversity related to patch-size distribution.

Objective: Maintain Stand Structure

Land-use Plan Summary

The Kispiox SRMP and the Bulkley LUPs include objectives to retain the structural attributes of old forest in managed stands. Legislation includes the more specific objective to retain wildlife trees. Stand-structure objectives in the Kispiox and Bulkley are vague relative to some of the other biodiversity objectives because they do not specify an amount of structure to retain (e.g., reflecting natural disturbance).

The Kispiox SRMP provides wildlife-tree retention targets (expressed as percent of cutblock area) for different block sizes and subzones within watersheds. The Bulkley LUPs provide targets for subzones within landscape units. Legislation provides default targets. The Kispiox SRMP also provides targets for different types of structures by subzone.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

High.

Rationale: Table 1.1 above.

Recovery Period for Objective (Question 4)

Long.

Rationale: Stand heterogeneity and large structures take more than a century to develop. Some mitigation is possible (e.g., creating snags), but potential is limited (e.g., tree size limits snag size) and activities are unlikely to be cost effective.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship or
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether the targets for stand structure, in addition to other biodiversity objectives, are successful in maintaining a sufficient amount of stand structure to maintain biodiversity.

Natural disturbance leaves behind structural remnants of the pre-disturbance stand, including live trees, snags and coarse woody debris (scattered and in patches). These structures play important ecological roles in the young, post-disturbance stand.

Indicators include

- % area in wildlife-tree patches by block size and land class
- % of wildlife-tree patches (by area) that are < 500m from another wildlife-tree patch or mature or old forest
- volume of downed wood per hectare by subzone
- number of snags per hectare by size class and subzone
- number of live trees per hectare by size class and subzone

Vagueness in the stand-structure objective complicates risk assessment for wildlife-tree patches and structural attributes. If the objective is simply to maintain a diversity of stand attributes, then having one of each attribute may suffice—leading to an ecologically irrelevant risk curve. Based on the strategies in the SRMP and LUPs, the objective appears to be more focussed—perhaps to maintain an ecologically-relevant amount of structure or to maintain an amount that reflects natural disturbance. The risk curve below is created assuming that the amount should reflect amounts arising from natural disturbance. Risk to stand structure increases sigmoidally as the percentage of retained patches, or of structural attributes, moves away from the amount of remnants left following natural disturbance (Figure 1.10 and Figure 1.11).

The separation of the patches should be used to modify the above risk curve—patches greater than 500 m apart increase risk.

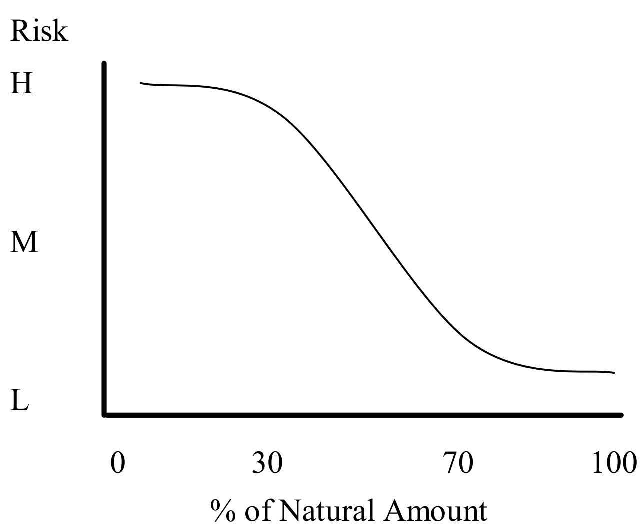

Figure 1.10. Percent area in wildlife-tree patches versus natural percentages.

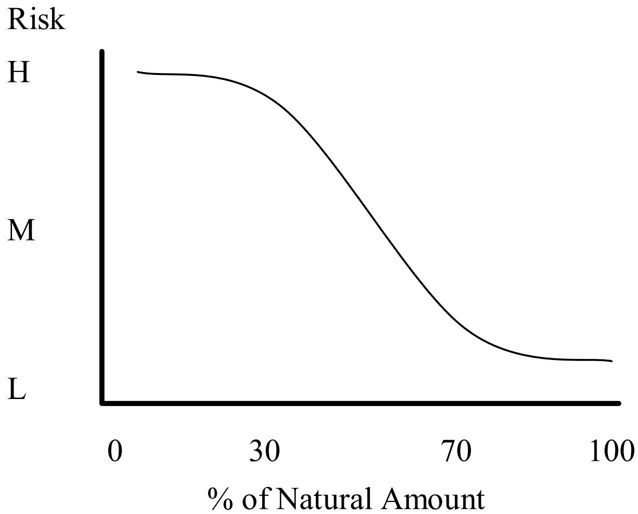

Figure 1.11. Amount of attribute (down wood, snags, live trees) versus natural amounts.

The area in wildlife-tree patches and their distance apart provide the simplest estimate of structural retention. Adding downed wood, snags and live trees provides further information. Minor uncertainty exists about the quality of wildlife trees. If only wildlife-tree patch indicators are used (i.e., omitting downed wood, snags and live trees), moderate uncertainty arises because wildlife-tree patches vary considerably in content.

Moderate to high uncertainty arises because estimates of natural amounts of post-disturbance structure are weak.

Low uncertainty is associated with the effects of blowdown on wildlife-tree patches assuming that naturally-created wildlife-tree patches have a similar probability of blowing over as patches in managed stands.

Available Data (Question 6)

Data about current wildlife-tree patches are available. These patches, however include some temporary reserves. No data describe structural conditions following natural disturbance for the area. Hence, estimates of long-term remnant structure are not available. **High priority** for data collection. The only firm targets in the land-use plans apply to wildlife-tree patches.

Information to Assess Costs and Benefits of Monitoring Projects

Ease of Collecting Indicator Data (Question 15)

Moderate.

Rationale: Attributes (beyond wildlife-tree patches) require field surveys.

Ease of Improving Risk Curve (Question 17)

Uncertainty related to structural conditions following natural disturbance: **moderate – difficult**.

Rationale: Ideally, this uncertainty should be resolved through field studies. Rough estimates may be available from existing studies.

Ease of Detecting Negative Consequences (Question 17)

Very difficult.

Rationale: Requires field studies of organisms linked to structure.

2. Goal: Maintain Wildlife

Information Sources and Updates

Drafted: Karen Price and Dave Daust, September 2004 based on meetings with Steve Gordon[8] and Rick Marshall[9].

Reviewed: Rick Marshall, December 2004.

Updated:

Land-use Plan Summary

Maintaining wildlife is listed as a broad goal within both the Kispiox and Bulkley LRMPs. The more specific SRMP and LUPs, however, do not address wildlife as a whole, but focus on grizzly bears (Babine LUP, SRMP) and mountain goats (Bulkley LUPs). The SRMP explicitly assumes that objectives designed to achieve other goals will provide the habitat needs of most other species.

Overview of Current Knowledge Relating to Goal

In the context of land-use management, maintaining wildlife depends upon maintaining a sufficient diversity and amount of ecosystems (which serve as habitats) as well as viable populations of species. Factors affecting populations include environmental conditions (e.g. winter severity), predator numbers, hunting (regulated or not), and disturbance associated with industrial or recreational activities.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)[10]

High.

Rationale: Although the LRMPs include goals to maintain wildlife, specific objectives and indicators listed under wildlife deal with a very small portion of wildlife concerns. Detailed land-use plans rely on strategies designed to achieve other goals. Strategies deal only with wildlife use in Enhanced Timber Development areas and large mammal use of the area north of the Babine River. Strategies are not included for species that are affected by disturbance rather than habitat (e.g. wolverine).

If the goal is not achieved, recovery potential is very low: loss of species and genes is irreversible; loss of populations is difficult to reverse.

[8] Section Head, Ecosystem Section, Ministry of Water, Land and Air Protection, Smithers

[9] Wildlife Biologist, Fish and Wildlife Section, Ministry of Water, Land and Air Protection, Smithers

[10] Questions refer to Procedures in Monitoring Framework

Influence of Goal on Other Goals (Question 2)

Moderate.

Rationale: Loss of wildlife carries a probability of a serious consequence for tourism and recreation. Loss of keystone species may impact biodiversity.

Objective: Maintain Wildlife Habitat and Populations

Land-use Plan Summary

Objectives listed under biodiversity, grizzly bears, mountain goats, water quality, visual quality and botanical forest products are part of the strategy to maintain wildlife habitat and populations. Very little remains under this objective.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Sole objective.

Rationale: Because so little remains under the goal, the objective is identical to the goal.

Recovery Period for Objective(Question 4)

Long.

Rationale: Loss of species or genes is not recoverable. Loss of populations is difficult to reverse. Habitat requirements vary among species; some may recover relatively quickly, but some habitat requirements may take over 100 years to recover.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain wildlife habitat and populations are successful.

Indicators in the land-use plans include

- % of stand-level high wildlife use areas within Enhanced Timber Development (ETD) areas deleted or managed specially
- winter-only public access on the Nichyeskwa Connector.

Risk to wildlife habitat in ETD areas decreases as more of the identified habitat is specially managed. It is not possible to draw a generic curve because strategies within ETD areas will be site-specific and because risk curves will vary among species (i.e. uncertainty will be high).

Provincial regulations require that strategies be developed for identified species at risk.

Winter-only access on the Nichyeskwa Connector is designed to reduce mortality due to poaching and unregulated hunting north of the Babine. Uncertainty arises because individuals of some species are more concentrated in winter, and hence may suffer higher mortality rates.

Available Data (Question 6)

Data are not available for management in ETD areas (Table 2.1). **High priority** for data collection in the Bulkley (ETD areas apply only to the Bulkley portion of the Babine).

The Nichyeskwa Connector is closed for the summer (SOFR).

Table 2.1. Current and future indicator values (when known) for ETD areas.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley	Unknown		100	LUP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 2.2 are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 2.2. Current and future risk and uncertainty for ETD areas.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Unknown	Unknown	Low	Low

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data exist; compiling by species adds some extra work.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to species-specific curves: **Difficult**.

Rationale: Even experimental approaches would have great difficulty in detecting effects.

<u>Ease of Detecting Negative Consequences (Question 17)</u>

Difficult.

Rationale: Monitoring vertebrate populations requires long-term, intensive sampling to overcome natural variation and achieve sufficient power to detect effects.

3. Goal: Maintain Grizzly Bears

Information Sources and Updates

Drafted: Karen Price and Dave Daust, September 2004 based on SRMP risk analysis and interviews with Len Vanderstar[11] and Tom Smith[12].

Reviewed by Tony Hamilton[13], January 2005.

Updated:

Land-use Plan Summary

The land-use plans include general objectives for entire planning areas as well as objectives for specific mapped habitat and access control zones. Special Management Zones (Babine River SM2, Babine River SMZ, Barbeau Creek, Atna-Shelagyote) are designed, in part, to maintain grizzly bears.

The Babine SRMP planning accepts that the grizzly bear population of Babine watershed will decline over time; hence the goal is actually one of mitigating the decline rather than maintaining current populations (modelling estimates that the population will decline by 16% with full implementation and by 30% without implementation).

Overview of Current Knowledge Relating to Goal

Grizzly bear populations are influenced by rates of birth, death, emigration and immigration. Three types of factors affect risk to grizzly bear populations in the Babine watershed. First, direct mortality as a result of human/bear interactions increases death rate due to hunting, poaching and protection. Second, disruption of feeding and movement activities decreases birth rate and increases death rate. Third, loss of high-value habitat primarily decreases survivorship. Emigration and immigration add low to moderate uncertainty to population estimates. Social interactions complicate all factors; for example, females with young often choose to use areas that males avoid—often areas with high human use.

Direct mortality due to human/bear interactions poses the biggest risk. Increased access into bear habitat is the main factor responsible for changing both human/bear interactions and disruption.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)

Moderate – high.

Rationale: The plan area represents a sub-population of grizzly bears who travel from great distances to take advantage of the salmon in the Babine River. Mortality outside the plan area

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[12] Wildlife Officer, Ministry of Water, Land and Air Protection, Smithers, BC
[13] Forest Wildlife Biologist, Ministry of Water, Land and Air Protection, Victoria, BC

increases the uncertainty about achieving the goal, even if all objectives are achieved within the Babine Watershed. Grizzly bears also depend upon the fish in Babine River—a resource with a very uncertain future. Finally, possible changes in hunting regulations adds uncertainty. Current protection provisions call for a decrease in grizzly bear harvest if uncertainty is high.

If the goal is not achieved, recovery potential is very low: loss of genes is irreversible; loss of populations is difficult to reverse. Dispersal potential is low: females inherit territories from their mothers and dispersal pressure only exists where mortality is very low.

Influence of Goal on Other Goals (Question 2)

Moderate.

Rationale: Grizzly bears affect tourism and recreation, and are important to biodiversity as part of a keystone interaction (bears – fish – forest).

Objective: Reduce Human/bear Interaction

Land-use Plan Summary

Objectives to reduce human-bear interactions that apply throughout plan areas are listed in the Babine LUP, the SRMP, and the Babine River Corridor Park MDS. Further objectives are specified within defined zones (Shenismike West, Babine River SMZ in the Kispiox; Nichyeskwa South and North and Babine River SM2 in the Bulkley).

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

High.

Rationale: Direct mortality due to human/bear interactions poses the biggest risk to grizzly bears.

Recovery Period for Objective (Question 4)

Long.

Rationale: Bear populations recover slowly because of low reproductive rates and limited dispersal potential for recolonisation. Re-introduction carries high costs and limited probabilities of success. Mitigation of the risks associated with open roads is possible through screening, limiting lines of sight, controlling garbage and only seeding de-activated roads.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Human/bear interactions increase the risk of mortality due to hunting, poaching and protection. Mortality risk is a function of the rate of encounters between people and bears and on the lethality of the encounters. The objective to reduce human/bear interaction includes strategies to minimise access (overall road density, and roads near critical habitat), to reduce visibility (sight distance, screening), and to educate visitors. The first two strategies aim to decrease the number of encounters, while the third aims to reduce lethality. Many strategies also apply to the objective to minimise disruption of bear activity.

A strategy with the Babine River Corridor Park calls for development of a Human/Bear Management Plan. Once this plan has been completed, it will likely contain additional strategies and indicators.

Indicators in the land-use plans include

- density of open roads per watershed; length of road in high-value habitat; length of road <150 m from critical habitat;
- % of road through listed areas and habitats with screening; % of road with >300m sight distance in Babine River SMZ and SM2;
- initiation of education programmes.

Effectiveness monitoring asks whether the strategies to decrease access, to reduce visibility and to increase education reduce human/bear interaction. Mortality is the most direct measurement of interaction. Hence effectiveness monitoring requires examination of grizzly bear mortality in relation to the indicators of access, visibility and education. Because different strategies apply to different zones, it is important to compare mortality among zones.

Road Access

Roads affect both mortality and displacement. It is difficult to tease apart relationships because of interaction effects. While adult males generally avoid road corridors, adult females with cubs tolerate high human presence along road corridors and can become habituated. These females are then subject to increased mortality risk due to poaching and conflict with people who stop and camp in their habitat. In all demographic modelling exercises, adult female survivorship is the most important factor determining population trends.

The risk to grizzly bear mortality increases steeply with the first road into an area, particularly because these roads are often located in good valley-bottom habitat (Figure 3.1). The curve rises more gently until another threshold at $0.6 km/km^2$. The curve would be similar, but shifted to the left for roads through high-value habitat and near to critical habitat, because of higher bear density in these areas.

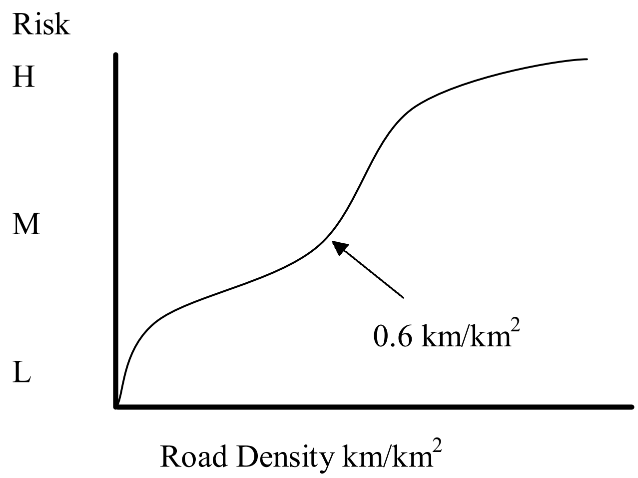

Figure 3.1. Risk to grizzly bear mortality versus road density within watersheds or habitat units.

This curve is general and based on research from a variety of studies. It could be refined for the Babine Watershed.

Above a density of zero, the uncertainty around this curve is moderate at high risk, and high elsewhere for several reasons. First, mortality associated with roads is related to the level of traffic on the roads and to the distance to communities of 5,000 people or more. Displacement, and subsequently mortality, effects appear at about 10 vehicles/week and are large at 10 vehicles/day. Illegal and protection mortality increases near to communities. Second, the degree to which deactivated and gated roads preclude access also adds to uncertainty. If roads are accessible to all-terrain vehicles or motorcycles, mortality risks still exist. Third, uncertainty is associated with the effectiveness of mitigation strategies on roads. Because food habituation increases risks on roads, strategies that affect food availability change the risk level. For example, the presence of seeded forage along open roads will increase mortality, visual screening and good garbage management will decrease mortality. Examining indicators related to these factors could reduce uncertainty in the risk relationship. Fourth, bear density varies across the landscape. Calculating indicator values by watershed or by habitat types (as prescribed in land-use plans), and controlling for bear density, will reduce this uncertainty. Fifth, uncertainty arises because of limitations in mapping: for example, considering critical habitats within only high-value habitat units carries some uncertainty because moderate habitat units also include critical habitats in a mosaic; in addition, some important bear travel routes have not been mapped. Improved mapping and examination of a wider spectrum of habitat units could reduce these uncertainties. Finally, uncertainty arises because not all mortality is known (unreported mortality is assumed to be 50%, but unknown).

Screening

The presence of visual screening, or winding roads moderate the road density curve above by shifting it to the right (i.e. lower risk for same density of roads). If roads are screened, and sight lines are short, bears are less visible and less likely to be shot. Uncertainty about the effectiveness of screening strategies is moderate. Monitoring the effectiveness of screening will reduce some of the uncertainty in the curve related to road density (Figure 3.1 above).

Education

Risk to bear mortality decreases as education efforts increase (Figure 3.2). In particular, efforts to educate ungulate hunters about appropriate behaviour around grizzly bears would decrease the probability of conflict and decrease bear mortality. There is no information to suggest that a non-linear curve would be more appropriate than a straight line.

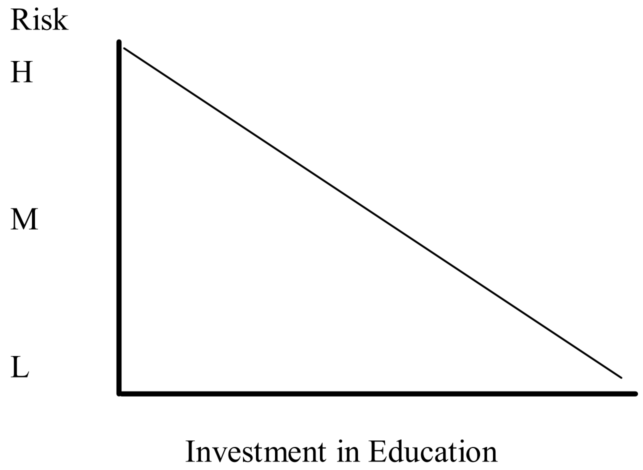

Figure 3.2. Risk to grizzly bear mortality versus investment in education programmes.

Uncertainty is high around this curve, partly because investment is not directly related to programme effectiveness, and partly because programmes need to be tailored to specific audiences.

Available Data (Question 6)

Data on the success of access controls (gates) are available in Bulkley. No data are compiled on road density per watershed. Road-density targets exist only for two watersheds in the Kispiox (Table 3.1). Description of management activities in grizzly bear habitat in the State-of-the-Forest report does not include a discussion of roads through or near to habitat. There are no data available for screening or other mitigative efforts. Priority is **high** for collecting indicator data.

There are no data available for education (Table 3.2). Priority is **high** for collecting indicator data.

Table 3.1. Current and future indicator values (when known) for road density.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Hanawald and Shedin	No information	--	Target $0.6 km/km^2$ for 80% of watershed area	SRMP
Elsewhere	Conflicting information: Some watersheds have already exceeded 0.6 km/km2 (e.g. Gail, Nilkitkwa, Nichyeskwa)[1]; modelling suggests that road density will not exceed low-risk density in other watersheds[2]	[1]Len Vanderstar; [2]James Cuell	No target	SRMP

Table 3.2. Current and future indicator values (when known) for education.

	Current Indicator Value	Source	Future Indicator Value	Source
Plan area	Unknown	--	No specific target	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 3.3 - Table 3.4 are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 3.3. Current and future risk and uncertainty for road density.

	Current Risk	Current Uncertainty	Future Risk	Future Uncertainty
Hanawald and Shedin	Unknown	--	Moderate	High
Elsewhere	High in some watersheds	Moderate	Unknown	--

Table 3.4. Current and future risk and uncertainty for education.

	Current Risk	Current Uncertainty	Future Risk	Future Uncertainty
Plan area	Unknown	--	Unknown	--

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy – moderate.

Rationale: Calculating road density is a relatively simple GIS task. Keeping track of education programmes is simple book-keeping. Compiling information on the extent of mitigative activities, however, requires more effort.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to vehicle use and proximity to communities: **moderate**.

Rationale: Monitoring vehicle patterns and human activities (e.g. ad-hoc campsites, ungulate hunting) requires field work, but is much easier than monitoring bears themselves.

Uncertainty associated with access control: **moderate.**

Rationale: Field checking of tracks is possible.

Uncertainty associated with effectiveness of mitigative strategies including screening, limiting lines of sight, seeding and access restriction: **difficult.**

Rationale: Because these strategies are applied to limited areas, and because bears wander widely it will be more difficult to analyse these data rigorously. Roadside seeding, however, is amenable to an experimental approach that would increase the chances of success. Rough estimates of traffic on deactivated roads could be based on tracks. Estimates for closed roads could be based on tracks or a counting device.

Uncertainty related to variation in bear density across habitat units: **moderate**.

Rationale: Stratified data on mortality and road density by different habitat units could be easily analysed. Statistical power, however, will likely be low. All analyses of mortality related to human-bear interactions must control for the probability of encountering a bear (related to habitat quality and total bear population).

Uncertainty associated with mapping: **easy – moderate.**

Rationale: Analysing already-defined, moderate habitat units would be easy. Mapping movement corridors would be more difficult, likely requiring some field checking. Some information on trails and denning already exists.

Uncertainty associated with mortality outside the plan area: **difficult.**

Rationale: Refining the risk curve will require examining data from outside, as well as within, the plan area. Given that different strategies are applied in different areas within the Babine Watershed, however, long-term monitoring of mortality numbers and locations could resolve local uncertainty.

Ease of Detecting Negative Consequences (Question 17)

Easy – very difficult.

Rationale: It is easy to detect reported mortality. It is very difficult to detect unreported mortality. Detecting changes in population is difficult because no baseline information exists. Internationally accepted methods exist to estimate grizzly bear populations, but these methods are expensive and time consuming, requiring study over an area larger than the Babine Watershed—very difficult. It is much easier to estimate relative, than absolute, population. Hair collection in salmon spawning channels is moderately difficult.

Objective: Minimise Disruption of Bear Activity

Land-use Plan Summary

Objectives to reduce disruption apply primarily to mapped units, identified as important, and high-value habitat.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Disruption has a lower impact on bear population than direct mortality, but is related to mortality.

Recovery Period for Objective (Question 4)

Short – moderate.

Rationale: Providing that bears are minimally disrupted in surrounding areas, recovery from a short period of industrial activity is relatively quick (within two decades).

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

As well as increasing direct mortality, human activities can disrupt bear behaviour and decrease the use of high-value habitats. This class of objectives includes area-specific strategies to minimise disruption to use of high-value habitats and to bear movement between habitats. There is a long list of indicators. These can be grouped for initial risk assessment (as below), but should also be considered separately for specific projects.

Indicators included in land-use plans include

- amount and type of motorised use by zone in active season
- % of harvesting activity in active season by zone
- duration of inactivity by zone

Effectiveness monitoring asks if the strategies controlling the amount, duration and season of activity minimise disruption of bear activity.

Disruption is related closely to the probability of human/bear interaction; hence human presence during active seasons (bears are active in spring, summer and fall in different locations) and the duration of activity in an area are appropriate indicators. Motorised use depends partly on harvesting activity, complicating interpretation of these indicators.

High levels of industrial and public use increase mortality risks, and increase disruption (see also discussion under objective to minimise human/bear interactions). The zone of influence is relatively narrow, usually less than 500 m, and as low as 150 m where cover is thick. Over the medium term, bears gradually habituate to some level of industrial use. Displacement is more likely if people stop and walk into bear habitat. In particular, camping sites (official or ad-hoc) change bear behaviour. As a first estimate, the risk curve relating motorised use during the active season to risk to grizzly bear disruption follows the same shape as the better-known curve for road density (Figure 3.3). The curve is shifted (i.e. higher risk for a similar road density) because the indicator examines road use through high-value habitat. Uncertainty is high in the moderate risk portion of the curve and moderate at the ends.

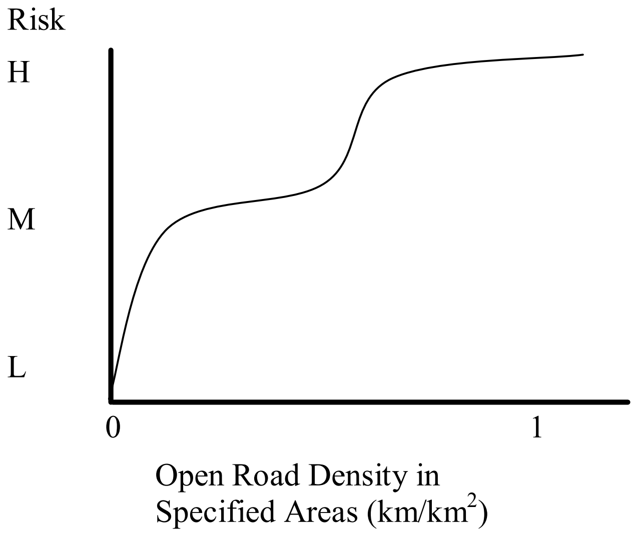

Figure 3.3. Risk to grizzly bear disruption versus amount of motorised use in active season.

Risk of disruption increases steeply as harvesting activity increases during bear season because bears do not return immediately following displacement (Figure 3.4). Uncertainty is high at moderate risk and moderate at low and high risk because of social interaction and habituation.

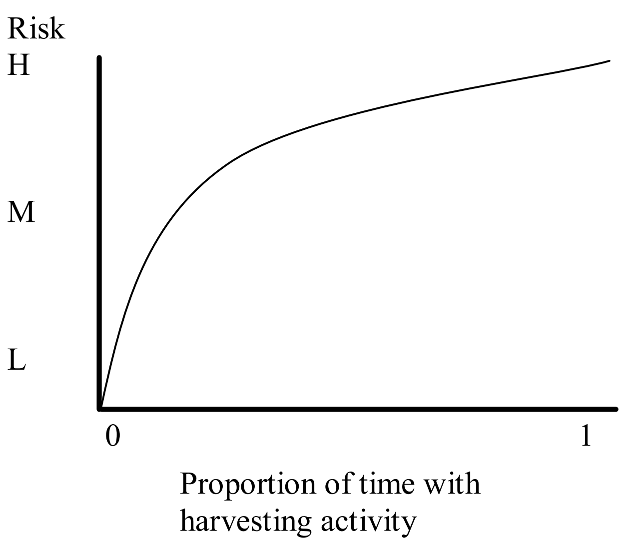

Figure 3.4. Risk to grizzly bear disruption versus harvesting activity during active season.

The risk of disruption decreases as the duration of the inactive period between harvesting passes increases (Figure 3.5). If there is no lengthy recovery period following the cessation of operations, the decrease will follow a negative exponential curve. Presence of a recovery period leads to a sigmoidal curve. Hence, uncertainty is high at the moderate to high risk portion of the curve and low at the low risk portion. Local evidence for low risk associated with short duration of activity followed by a long period of inactivity comes from the Big Slide area.

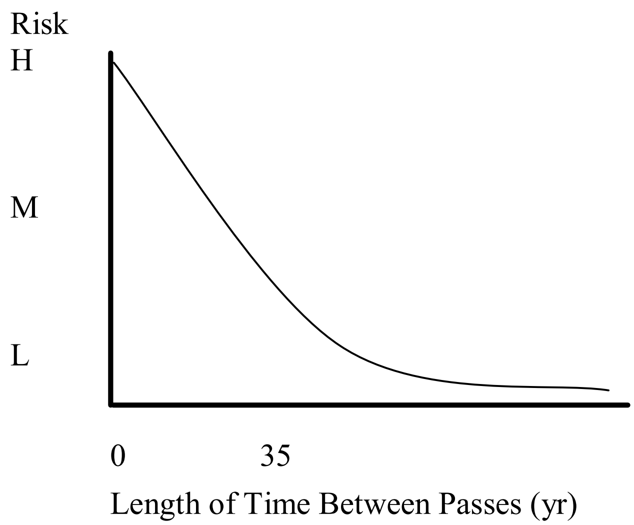

Figure 3.5. Risk to grizzly bear disruption versus duration of inactive period between passes.

In general, uncertainty associated with disruption is higher than uncertainty associated with mortality, because changes in bear behaviour and activity are potentially complex and difficult to detect. However, targets of low levels of activity within the bear season and of short duration of activity carry a low risk and low uncertainty with one caveat. Even if all harvesting occurs in winter, many related activities, including road construction, surveying and silviculture, occur during the active season for bears. This activity should be reflected by the amount of motorised use.

Uncertainty arises in all three curves because there is no indicator currently listed that deals with disruption due to activities on Babine River itself. Floatcraft, and particularly motorised boats, are known to displace bears from the river for periods. Similarly, there is no indicator related to backcountry recreation activities in the rest of the watershed. Possible future heli-skiing operations could disrupt bear denning activities in late winter/early spring. There is no agreement in the bear research community about the effects of habituation at concentrated human recreation sites: habituated bears may be more vulnerable when they move beyond recreation sites, or conversely, habituation may be site-specific and pose no increased mortality risk as bears travel elsewhere.

Uncertainty is also associated with the boundaries of important bear movement zones. A movement corridor between denning habitat in the Sherry-Rosenthal and the Babine River is not included in an access management zone. The potential presence of a major industrial road running through one of the three major passes between denning habitat and the Babine adds additional uncertainty.

Minor uncertainties include the relative effects of small and large vehicles and the effects of winter access on moose, an important food source.

In summary, for the three curves above, uncertainty is high at moderate risk and moderate at high and low risks, partly reflecting the lack of indicators for non-harvesting activities and partly reflecting lack of knowledge about habituation and social interaction.

Available Data (Question 6)

Data on the success of access controls (gates) and on compliance with targets within mapped grizzly bear habitat are available in Bulkley (Table 3.5). Road density data are shown in Table 3.1. There are no targets for activities on the Babine River or for backcountry recreation activities in the rest of the watershed. Priority is **high** for collecting indicator data in the Kispiox.

Table 3.5. Current and future indicator values (when known) for disruption.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Harvesting: Bulkley	Harvesting complies with targets	SOFR	Variety of targets for road use in specific areas	Babine LUP
Harvesting: Kispiox	Unknown	--	Variety of targets for road use in specific areas	SRMP
Other activities: Plan area	Disruption seems a minor effect at present, perhaps because development north of the Babine River has recently begun.	Len Vanderstar	Potential presence of a major industrial road (the Stewart Connector) running through one of the three major passes between denning habitat and the Babine River; no targets for recreational activities	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 3.6 are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 3.6. Current and future risk and uncertainty for disruption.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Harvesting: Bulkley	Low	Moderate	Low	Moderate
Harvesting: Kispiox	Unknown	--	Low	Moderate
Other activities: Plan area	Low*	Moderate	High*	Moderate

* Estimated

Ease of Collecting Indicator Data (Question 15)

Easy – moderate.

Rationale: Data on amount and type of use by season are not generally compiled, but do not present any particular theoretical difficulties.

Ease of Improving Risk Curve (Question 16)

Uncertainty associated with the relationship between disruption and motorised use, harvesting activity and duration of inactivity: **difficult**.

Rationale: Assessing levels of disruption requires tracking bear movement patterns and observing behaviour (directly or indirectly). Because bears learn from their mothers, there will be a lag time in adjustment to new patterns of movement or behaviour. Additionally, bear use of different habitats varies among years as berries and fish vary. Hence, studies must be long term.

Uncertainty associated with mapping: **moderate.**

Rationale: Mapping movement corridors would likely require some field checking. Some information on trails and denning already exists.

Uncertainty associated with recovery period after cessation of activities: **moderate – difficult.**

Rationale: Detecting whether bears are returning to disturbed areas would be easier than detecting changes in their behaviour at the site.

Uncertainty associated with river-based activities: **moderate – difficult.**

Rationale: Assessing the levels of disruptions associated with river-based activities requires observing bear behaviour. Standardised information collected by park users or rangers, however, could give an indication of the magnitude of the effect, and a well-designed experiment carried over several years could give a more precise answer.

Uncertainty associated with heli-skiing or other backcountry recreation on bear movement and habitat use: **difficult**.

Rationale: A literature survey would be necessary to establish parameters for the study. Because baseline information exists prior to any recreational activity, this study could have a powerful before-after design, and be useful to other areas.

Ease of Detecting Negative Consequences (Question 17)

Difficult.

Rationale: It is difficult to detect changes in bear behaviour related to human activities because such studies must be both intensive and long-term.

Objective: Maintain High-value Habitat

Land-use Plan Summary

Special management zones, including Barbeau Creek, the Babine River SMZ and SM2 and the Atna/Shelagyote include maintenance of grizzly habitat as reasons for their special status. Specific objectives are also associated with “high-value habitat” and “critical” habitat types.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Low – moderate.

Rationale: Although habitat is necessary, direct mortality poses a higher risk to maintaining grizzly bears.

Recovery Period for Objective (Question 4)

Moderate.

Rationale: Although forage recovers quickly (in about 10 years), forest that intercepts snow well and provides thermal cover takes more than 100 years to develop. First pass harvesting likely improves habitat value, as it replaces the disturbance effects of fire. Extensive areas of mid-seral forest, however, will negatively effect bear habitat. If oldgrowth conditions are lost over time, these will take many decades to recover.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Land-use plans refer to mapped high-value habitat as well as to critical habitat types within the mapped areas. There are also areas of "high habitat value" adjacent to mapped habitat areas (e.g. Sperry-Rosenthal). Grizzly bears in the Babine watershed depend on vegetation (spring greens and berries), salmon, moose calves and goats for food. Babine River Corridor Park is home to the salmon population; important vegetation associations are included as "critical habitat" types; moose often share these habitats.

High-value habitat describes groups of biogeoclimatic site series that are important to bears, but not rare. This habitat is important over the year, but it is not possible to determine that any one patch is critical. As opposed to the relatively common site series making up high-value habitat, critical habitats are individually important. Wetlands, south-facing chutes and riparian ecosystems are critical seasonally.

Indicators included in land-use plans include

- % of intact high-value habitat
- % of intact critical habitats; % of critical habitats with sufficient adjacent forested habitat for cover and bedding

Effectiveness monitoring asks whether the strategies limiting alteration of habitat maintain habitat use.

High-value Habitat

Risk to habitat use follows a generally sigmoidal increase as the amount of high-value habitat declines (Figure 3.6). There is a trough at high habitat abundance, where risk decreases as logging replaces fire, leading to increased moose and forage. Over time, however, risk increases as oldgrowth decreases. Risk is highest when the timber-harvesting landbase covers a large proportion of total forest. The graph assumes that disturbed areas is equally distributed across seral stages.

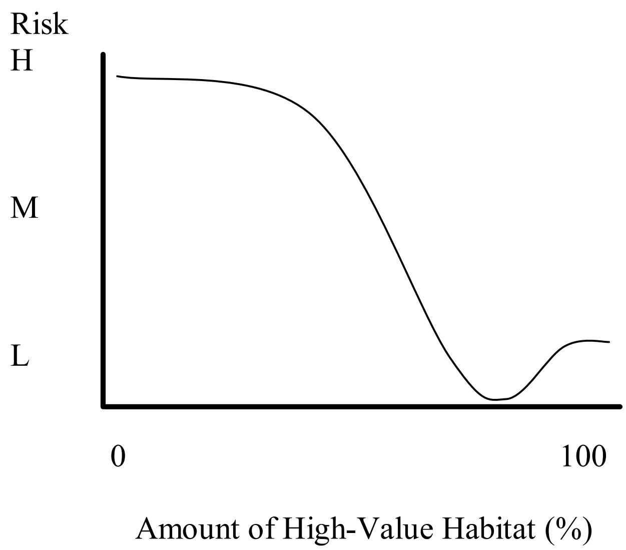

Figure 3.6. Risk to habitat use versus amount of intact high-value habitat.

The amount of high-value habitat available is directly linked to the capability of an area to support grizzly bears—the indicator is appropriate. Because critical habitats are also found within moderate habitat units, there is some uncertainty associated with excluding these units from the indicator. Uncertainty around the relationship between available habitat and habitat use is low at high risk levels and moderate at low and moderate risk levels when other factors (e.g. access) are controlled.

<u>Critical Habitat</u>

Cover around critical habitats reduces the mortality risk and displacement due to human activities.

Risk to habitat use increases sigmoidally as the amount of critical habitat declines (Figure 3.7).

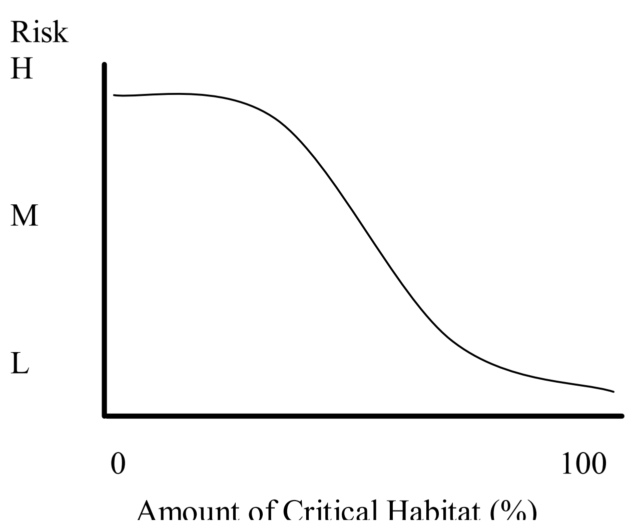

Figure 3.7. Risk to habitat use versus % of intact critical habitat.

Uncertainty around the relationship between available habitat and habitat use is low at high risk levels and moderate at low and moderate risk levels when other factors (e.g. access) are controlled.

Some uncertainty exists because of the range of strategies employed to protect high-value and critical habitat in different areas.

Available Data (Question 6)

Data on forest harvest in high-value habitat are available for the Bulkley (Table 3.7), but not for the Kispiox. Activities in high-value and critical habitats are not distinguished. Risk is estimated as low in the Kispiox because of limited harvesting. Priority is **moderate** for collecting indicator data in the Kispiox and **moderate** for distinguishing between high-value and critical habitat data in the Bulkley.

Table 3.7. Current and future indicator values (when known) for high-value and/or critical habitat.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Kispiox	Unknown	--	No harvesting of critical habitats; provide 100 m of functional forest adjacent to critical habitats	SRMP
Bulkley (Babine)	All recent harvesting in compliance with LUP	SOFR	No harvesting of critical habitats; provide 100 m of functional forest adjacent to critical habitats	Babine LUP
Bulkley (Nilkitkwa)	No harvesting in Barbeau Creek SM2	SOFR	No harvesting in Barbeau Creek watershed	Nilkitkwa LUP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 3.8 are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 3.8. Current and future risk and uncertainty for high-value and/or critical habitat.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Kispiox	Low*	Low	Low	Low
Bulkley (Babine)	Low	Low	Low	Low
Bulkley (Nilkitkwa)	Low	Low	Low	Low

*Estimated

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data on harvesting in relation to mapped grizzly bear habitat are already in digital format.

Ease of Improving Risk Curve (Question 16)

Uncertainty associated with different strategies: **difficult**.

Rationale: The different strategies present an excellent opportunity to study the effect on bears of different strategies in relation to moderate-value, high-value and critical habitats. As with other bear studies, it requires well-designed field experiments.

<u>Ease of Detecting Negative Consequences (Question 17)</u>

Difficult.

Rationale: Although it is easy to detect when changes to mapped habitat put habitat use at high risk based on the risk curve, it is more difficult to detect changes in actual habitat use.

4. Goal: Maintain Mountain Goats

Information Sources and Updates

Drafted: Karen Price and Dave Daust, September 2004 based on meetings with Steve Gordon[14] and Rick Marshall[15].

Reviewed: Rick Marshall and Steve Wilson[16].

Updated:

Land-use Plan Summary

Bulkley LUPs include specific objectives for goats. Although the Kispiox LRMP includes objectives for goats, the SRMP has no specific objectives, assuming that the Atna-Shelagyote SMZ and access control strategies address the LRMP objectives. The SRMP notes that LRMP direction could result in future guidelines.

Overview of Current Knowledge Relating to Goal

In winter, goats use forested areas with low snow cover. In the Babine Watershed, in the coast – interior transition, the ability of forest to intercept the deep, wet snow is particularly important. Snow-interception forest can take over 100 years to develop. Older stands are also important because of the abundance of lichen litterfall, which goats use extensively when other forage is unavailable due to deep snow. In summer, goats need steep escape terrain, preferably near to forage. Populations are patchily dispersed, rarely migrating among habitat islands.

Accidents are the major mortality factor, although predation and starvation also kill many kids. Hunting, unregulated harvest and disturbance increase mortality rates. Hunting and unregulated harvest are related to ease of access; disturbance and displacement are most often related to industrial activities, particularly during the natal period.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)[17]

Low – moderate.

Rationale: Maintaining goat habitat, controlling harvest (by controlling access) and preventing disturbance, if successful, should achieve the goal. There is some uncertainty, however, because of the geographic limitations of objectives. In particular, the Kispiox portion of the Babine Watershed has no objectives for goats beyond special management areas.

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[14] Section Head, Ecosystem Section, WLAP Smithers

[15] Wildlife Biologist, Fish and Wildlife Section, WLAP Smithers

[16] Consultant, EcoLogic Research, Gabriola Island, BC

[17] Questions refer to Procedures of Monitoring Framework

If the goal is not achieved, recovery potential is very low: loss of species and genes is irreversible; loss of populations is difficult to reverse. Goats recolonise vacant habitat very slowly. Transplants are expensive and may be unsuccessful.

Influence of Goal on Other Goals (Question 2)

Low.

Rationale: Although some people hunt goats in the Babine, goats are not the principal draw for most tourists or recreationists.

Objective: Maintain Goat Habitat

Land-use Plan Summary

Special management zones in both the Kispiox (Atna-Shelagyote SMZ) and Bulkley (Barbeau Creek SM1) were created in part to achieve this objective. The Bulkley LUPs include specific objectives to provide thermal and snow-interception cover and forage near identified winter habitat.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Equivalent to other objective.

Rationale: Measures to protect habitat and populations are both necessary.

Recovery Period for Objective (Question 4)

Long.

Rationale: Although shrubby forage recovers quickly (in about 10 years), forest that intercepts snow well, provides thermal cover and provides epiphytic lichen litterfall takes more than 100 years to develop.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain mountain goat habitat are successful.

Indicators in the land-use plans include

- Type and patch-size distribution of harvest within 200 m of identified goat habitat
- Presence of forested connectors between mountain ranges in Kotsine Pass

Some uncertainty exists because the indicators do not include alteration to particular habitat features (e.g. escape terrain, mineral licks).

Uncertainty is too high to draw a risk curve linking patch-size distribution and/or harvest type to risk to goat habitat. Neither harvest type nor patch-size distribution provide any information about the amount of forest harvested—all forest habitat could be harvested within 100 (or fewer) years, albeit in small patches or selection systems. It is not clear whether clearcuts are barriers to goat movement. If the rate of cut near to identified habitat was low, and intervening forest was old, using small cutblocks or non-clearcut systems would carry low risk. Conversely, neither patch size nor harvest system would reduce the risk associated with a high rate of cut.

Uncertainty could be reduced sufficiently to draw a risk curves if the indicator included the amount of old forest within 200 m of identified goat winter habitat (Figure 4.1). In winter range habitat, risk increases sigmoidally as the percent of unmodified forest declines[18]. Literature suggests that goats generally remain within 400 m of escape terrain. Extrapolating this result suggests that forest within 400 m of identified habitat is important. Because the indicator only considers forest within 200 m, the curve is shifted to the right, with inflexion points at 50 and 90%. Hence, even if patches are small, or alternative harvesting systems are used, risk at 30% modification will be medium, and at 50% modification will be high.

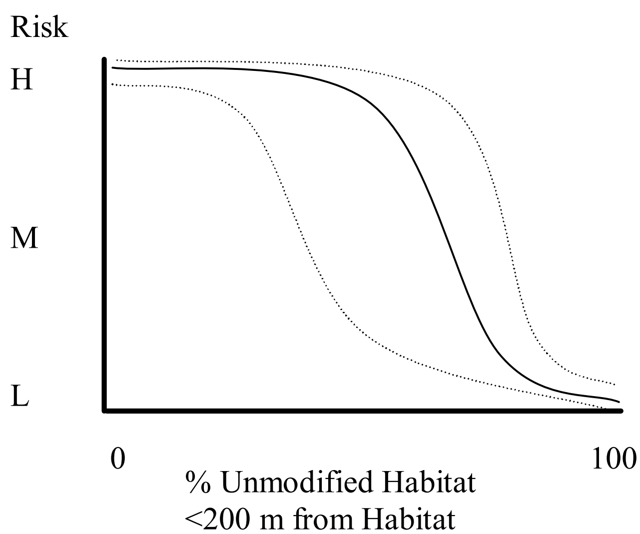

Figure 4.1. Risk to goat habitat versus % of unmodified habitat within 200 m of identified habitat.

Uncertainty is low at both ends of the curve, and high in the middle. Uncertainty is increased because of lack of information about harvesting between 200 – 400 m from identified habitat. In

[18] Fox, J.L, C.A. Smith and J.W. Schoen. 1989. Relation between mountain goats and their habitat in southeastern Alaska. US Department of Agriculture Forest Service. General Technical Report PNW-GTR-246.

particular, special management in this zone could reduce the risk and move the curve towards symmetrical.

The strategy to maintain forested connectors between mountain ranges in Kotsine Pass cannot be graphed as a risk curve because there is no continuous indicator. Goats regularly travel several kilometres among pockets of suitable habitat. High-elevation ridges are probably more common travel corridors than forest areas. Leaving a forested corridor likely reduces risk over the long-term, however, allowing rare migration among drainages. Virtually nothing is known about goat use of corridors, however, and uncertainty is therefore high. Additional uncertainty arises because other corridors are not considered (in part because they cross management boundaries; e.g. Thoen to Natlan peaks).

Available Data (Question 6)

Data on whether strategies have been implemented are available in Bulkley (Table 4.1 - Table 4.2). Information on the proportion of area harvested is also available. No target exists for proportion of area harvested. No data exist for current or future indicator values in the Kispiox. Because the SRMP suggests that strategies may be needed to meet LRMP objectives, priority to collect indicator data is **high** in the Kispiox.

Table 4.1. Current and future indicator values (when known) for patch size and/or harvesting system.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley	Recent harvesting meets target; < 1% of forest near habitat harvested	SOFR	All harvest in small patches or non-clearcut; no target for amount harvested	LUP
Kispiox	Unknown	--	No target	--

Table 4.2. Current and future indicator values (when known) for forested connectors in Kotsine Pass.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley (Babine)	--	--	--	--
Bulkley (Nilkitkwa)	Connectors exist*	--	Connectors exist	LUP

*Estimated

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 4.3 - Table 4.4 are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 4.3. Current and future risk and uncertainty for patch size and/or harvesting system.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Low	High	Unknown*	High
Kispiox	--	--	--	--

* Uncertainty is too high to estimate future risk.

Table 4.4. Current and future risk and uncertainty for forested connectors in Kotsine Pass.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley (Babine)	--	--	--	--
Bulkley (Nilkitkwa)	Low*	Low	Low	High
Kispiox	--	--	--	--

*Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data on harvesting near to identified habitat are available digitally.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to amount of habitat harvested: **easy**.

Rationale: Data are available digitally.

Uncertainty associated with unknown activities between 200 and 400m: **easy.**

Rationale: Data are available digitally.

Uncertainty associated with middle of curve relating amount harvested to risk: **very difficult, likely not resolvable.**

Rationale: Multiple confounding factors (disturbance, goat harvest, severe winters, disease) will make it very difficult to tease out the effects of habitat loss. Replicated experiments over long time periods would be necessary.

Uncertainty associated with use of forested connectors: **not resolvable.**

Rationale: Due to the rarity of migration behaviour, studies would need to be very long term. Statistical power would be very low, preventing detection of effects.

Ease of Detecting Negative Consequences (Question 17)

Easy – very difficult.

Rationale: It is easy to detect when risk to habitat is high based on the risk curve. It is very difficult to relate impacts to goats because of confounding factors and natural variability.

Objective: Maintain Goat Populations

Land-use Plan Summary

Bulkley LUPs include an objective to provide security from unregulated harvest in important habitat and a strategy to minimise disruption during the natal period. Seasonal access control on the Nichyeskwa Connector is partially designed to protect mountain goats.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Equivalent to other objective.

Rationale: Measures to protect habitat and populations are both necessary.

Recovery Period for Objective(Question 4)

Long.

Rationale: It is very difficult to reverse the loss of a population. Goats are patchily distributed and follow traditional routes..

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain mountain goat populations are successful.

Indicators in the land-use plans include

- Density of accessible roads within 1 km of identified habitat.
- Amount of harvesting within 200 m of habitat during natal time

Access

Because of lack of information, the risk curve for road density within 1 km of habitat is initially assumed to be linear with high uncertainty (Figure 4.2). Increased access increased risk to goats from hunting and unregulated harvesting, but the shape of the curve is undefined.

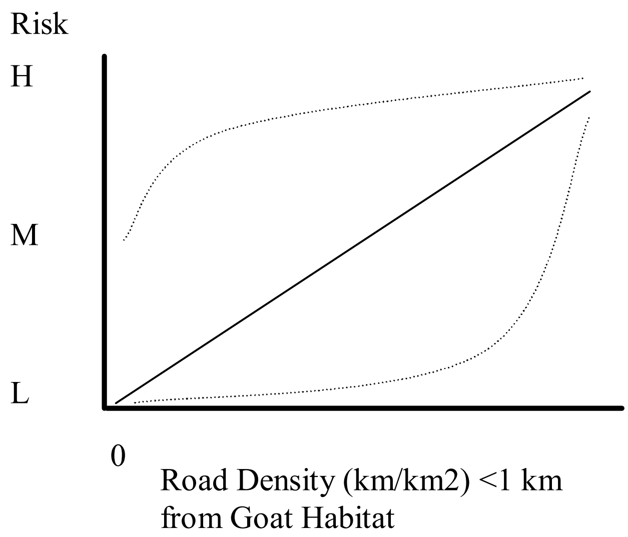

Figure 4.2. Risk to goat population versus road density within 1 km of habitat. Note that values on X-axis are unspecified.

Plotting the number of goats against road density would reduce the uncertainty around this indicator.

Road location adds uncertainty: some roads may be close to good habitat, but located such that recovering a killed goat would be impossible. Disturbance could also increase rates of accidental falls.

The increased uncertainty at low levels of risk arise because of unknown impacts of roads located more than 1 km away.

<u>Natal Disruption</u>

Harvesting during the natal period disturbs goats, causing habitat abandonment, short-term displacement, changed behaviour and increased mortality of kids due to accidental falls and decreased time spent feeding. Information exists relating distance from industrial activities to level of disturbance, but very little is known about long-term effects to goat populations. Hence, although it is assumed that risk to a population increases with increased disturbance, uncertainty is high.

Disturbance increases as distance from disturbance decreases (Figure 4.3). Disturbance type influences this curve; in general, helicopter operations disturb goats more than conventional harvesting activities. Road-building (in the short-term), however, and increased access (over the long-term), can also have high impacts.

High uncertainty arises about the effectiveness of the strategy to avoid activities within 200 m of habitat during the natal period because there is no indicator for activities beyond 200m. As shown in Figure 4.3, goats are disturbed by activities up to 1.5 km away.

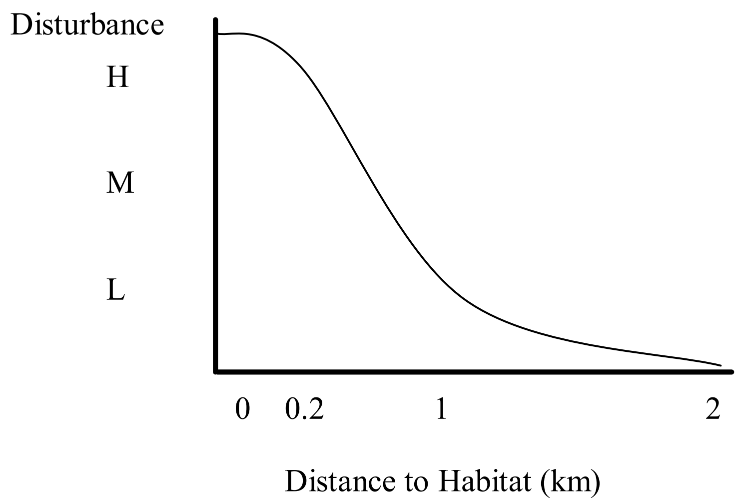

Figure 4.3. Level of disturbance versus harvesting during natal period.

Available Data (Question 6)

Data on whether strategies have been implemented are available in Bulkley (Table 4.5 - Table 4.6). No data exist for current or future indicator values in the Kispiox. Because the SRMP suggests that strategies may be needed to meet LRMP objectives, priority to collect indicator data is **high** in the Kispiox.

Table 4.5. Current and future indicator values (when known) for road density within 1 km of habitat.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley	Targets achieved	SOFR	No open roads within 1 km of habitat	LUP
Kispiox	Unknown		Unknown	

Table 4.6. Current and future indicator values (when known) for harvesting within 200 m of habitat during natal period.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley	Targets achieved	SOFR	No harvest	LUP
Kispiox	Unknown		Unknown	

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 4.7 - Table 4.8 are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 4.7. Current and future risk and uncertainty for road density within 1 km of habitat.

	Current		**Future**	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Low	Moderate	Low	Moderate
Kispiox	Unknown	--	Unknown	--

* Estimated

Table 4.8. Current and future risk and uncertainty for harvesting within 200 m of habitat during natal period.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Low	High	Low	H
Kispiox	Unknown	--	Unknown	--

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data on road location and harvest location are available digitally, but may not be sufficiently accurate to use in analysis.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to impacts of road density within different distances of habitat: **moderate - difficult**.

Rationale: It would be relatively easy to complete a GIS exercise comparing road densities in various locations with the number of reported (or estimated) kills. Because of a poor relationship between road density and harvest, particularly over the relatively small plan area, statistical power would likely be low, and long-term studies over larger areas would be necessary.

Uncertainty associated with response to various types of disturbance at different distances: **difficult.**

Rationale: Reducing this uncertainty requires field experiments and short-term behavioural observations.

Uncertainty related to long-term population impacts of various behavioural changes associated with different disturbances: **very difficult**.

Rationale: Reducing this uncertainty requires behavioural observations and population monitoring over many years.

Ease of Detecting Negative Consequences (Question 17)

Difficult.

Rationale: Baseline population estimates have been completed for various portions of the Babine, but no repeat measurements have been taken. Because of high natural variability, it will be very difficult to detect biologically significant declines in goat population due to low statistical power.

5. Goal: Maintain Fish Habitat and Populations

Information Sources and Updates

Drafted: Karen Price and Dave Daust, September 2004 based on interview with Dana Atagi[19] and review paper on riparian logging[20].

Reviewed:

Updated:

Land-use Plan Summary

Both LRMPs list general objectives to protect fish habitat and populations. However, the Babine SRMP includes no specific objectives (except for bull trout), assuming that objectives for special management zones, Babine River Corridor Park, biodiversity and water quality will achieve LRMP objectives. The Bulkley LUPs list a single objective to retain structure within riparian management zones. Objectives under biodiversity and water quality are also relevant to goals for fish. The Babine River Corridor MDS includes an objective to protect fish, specifically targeting bull trout and steelhead.

Neither land-use plans, nor provincial regulations have jurisdiction over anadromous fish populations (except for steelhead). Federal regulations (Department of Fisheries and Oceans) require no harmful alteration to fish habitat.

Overview of Current Knowledge Relating to Goal

Fish habitat depends on riparian structure as well as water flow, quality and temperature. Large pieces of downed wood increase channel complexity, form pools and provide shelter. Riparian vegetation moderates water temperature, filters sediment, stabilises channel banks and provides nutrients to the aquatic system.

Fish populations depend on available habitat, harvest pressure, and, in the case of anadromous species, on oceanic conditions. Harvest levels outside the Babine watershed have the biggest impact on salmon and steelhead populations. In the past, up to 70% of sockeye and steelhead were caught before reaching the Babine (steelhead as by-catch in the salmon fishery). Recently, strategies to avoid interception have lowered steelhead mortality. Once in the Babine, steelhead are subject to a catch-and-release fishery. Mortality rates are about 3 – 10% per encounter until the fish move to inaccessible winter habitat in deep canyons or the outlet of Babine Lake.

Bull trout remain in the Babine watershed. They need cold water, spawn in very small streams and use large pools to aggregate prior to spawning migration. Predation risk is very high during spawning; hence cover is critical. Populations are low and patchily distributed.

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[19] Section Head, Fish and Wildlife, WLAP, Smithers

[20] Young, K. 2001. A review and meta-analysis of the effects of riparian zone logging on stream ecosystems in the Pacific Northwest. Technical Paper #4 for Hydroriparian Planning Guide.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)[21]

High.

Rationale: Anadromous fish are affected by conditions well beyond the Babine Watershed. Uncertainty relating to ocean conditions, climate change, fishing pressure and other factors are all high. Objectives in land-use plans only deal with riparian structure, bull trout and steelhead.

If the goal is not achieved, recovery potential is very low: loss of species and genes is irreversible; loss of populations is difficult to reverse.

Influence of Goal on Other Goals (Question 2)

High.

Rationale: Loss of fish carries a probability of a serious consequence for grizzly bears, biodiversity, cultural heritage, tourism and recreation.

Objective: Maintain Fish Habitat

Land-use Plan Summary

The Bulkley LUPs include objectives to retain structure within riparian management zones in order to maintain natural channel and bank stability and reduce windthrow in riparian reserve zones. They do not, however, provide any specific targets. The SRMP does not include any specific strategies for fish habitat, assuming that other objectives will achieve LRMP goals relating to fish habitat. The Park MDS has an all-encompassing objective to protect fish.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

High.

Rationale: It is not possible to maintain fish populations without adequate habitat. Although social aspects (i.e. fishing) have a higher influence on the goal, these are not part of land-use plan monitoring.

Recovery Period for Objective (Question 4)

Long.

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[21] Questions refer to Procedures for Monitoring Framework

Rationale: Although some elements of habitat (e.g. shade, invertebrate food sources) recover quickly; other elements, particularly structural complexity and flow stability, related by large downed wood, take more than 100 years.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain riparian structure are successful at providing shade, maintaining natural channel and bank stability and reducing the risk of windthrow in the reserve zone.

Indicators in the land-use plans include

- Amount of structural retention in riparian management zone.

Risk to fish habitat increases sigmoidally as riparian structure decreases relative to natural levels (Figure 5.1). This curve integrates the various functions of riparian structure in providing fish habitat. Risk is high above about 20% of natural structure, and low when 80% remains.

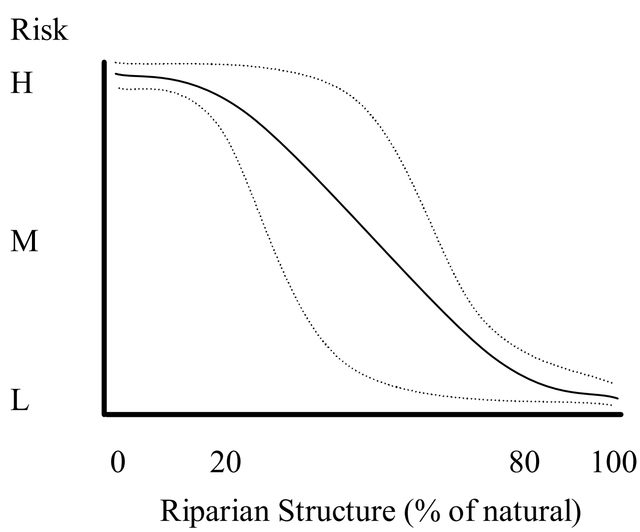

Figure 5.1. Risk to fish habitat versus structural retention in the riparian management zone.

Uncertainty is high is the middle of the curves. Uncertainty exists because no indicator measures the width of the riparian zone and because windthrow often removes some of the retained structure. Considerable research exists on ecologically-appropriate riparian zones. At least one tree height is necessary to maintain function to the aquatic system[22]. Thus, retention may be best measured relative to a buffer zone of one site-potential tree height.

Stream size adds uncertainty. Large trees are most important to stream structure around mid-sized streams where downed wood lies directly in the channel and can span the channel width. Structural retention around small streams in the Babine is particularly important to stabilise the easily-mobilised sediment.

Available Data (Question 6)

Data are available for the major streams and rivers included in Landscape Riparian Corridors (LRC) in the Bulkley, but not for streams outside these corridors (Table 5.1). It is possible to estimate impacts on these smaller streams based on "best management practices" included in the Riparian Management Guidebook, assuming that trees remain standing. There are no specific targets in either the Bulkley or Kispiox. Because of potential changes in riparian regulations, it is not possible to estimate a future target for streams not included in LRC. **Medium priority** for collecting indicator data in the Bulkley and the Kispiox.

Table 5.1. Current and future indicator values (when known) for riparian structure.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley (Babine)	Several LRC have < 70% mature forest (Boucher Creek corridor has < 50% mature forest); estimate S3 streams with < 66% retention and S4 streams with < 30% retention.	SOFR	70% mature forest in LRC; no target for other streams	LUP
Bulkley (Nilkitkwa)	All LRC have > 70% mature forest; estimate S3 streams with < 66% retention and S4 streams with < 30% retention.	SOFR	70% mature forest in LRC; no target for other streams	LUP
Kispiox	Estimate streams follow Riparian Guidebook best management practices.	--	No target	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 5.2 are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 5.2. Current and future risk and uncertainty for riparian structure.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley (Babine; most LRC)	Low	Low	Low	Low
Bulkley (Babine; some LRC)	Medium	High	Low	Low
Bulkley (Babine; S3)	Medium*	High*	No target	No target
Bulkley (Babine; S4)	High*	Low*	No target	No target
Bulkley (Nilkitkwa; LRC)	Low	Low	Low	Low
Bulkley (Nilkitkwa; S3)	Medium*	High*	No target	No target
Bulkley (Nilkitkwa; S4)	High*	Low*	No target	No target
Kispiox	--	--	No target	No target

* Estimated

[22] Young, K. 2001. A review and meta-analysis of the effects of riparian zone logging on stream ecosystems in the Pacific Northwest. Technical Paper #4 for Hydroriparian Planning Guide.

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Moderate.

Rationale: It would be easy to compile planned levels of retention (data exist), but more difficult to measure standing retention (requires field checking).

Ease of Improving Risk Curve (Question 16)

Uncertainty related to middle of curve: **moderate**.

Rationale: It would be possible to complete a retrospective study in representative reaches of the region, examining the relationship between retention and fish habitat. However, such a study might be easier to complete outside the Babine Watershed.

Ease of Detecting Negative Consequences (Question 17)

Moderate.

Rationale: Baseline data exist within watershed restoration files. Many reconnaissance studies have mapped fish distribution and habitat at a 1:20,000 scale[23]. Water temperature has also been monitored.

Objective: Maintain Bull Trout

Land-use Plan Summary

The SRMP includes an objective to conserve critical bull trout habitat in the Shelagyote River and its tributaries. The SRMP notes that many habitats are either buffered by core ecosystems or riparian corridors, or in the Atna-Shelagyote SMZ. The Bulkley LUPs do not include any objectives for bull trout. The Park MDS includes objectives to protect the park's bull trout.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Bull trout are a species of concern.

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[23] See companion document: Price and Daust. 2004. Gaps in Past Monitoring and Current Monitoring Responsibilities in the Babine Watershed.

Recovery Period for Objective (Question 4)

Long.

Rationale: Loss of a species is not recoverable; loss of a population difficult to reverse.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain bull trout are successful.

Indicators in the land-use plans include

- Distance of permanent bridge from bull trout staging areas on Shelagyote River
- % of habitat protected within core ecosystems, riparian corridors or SMZ
- Effort to seek funding to monitor by-catch if required

The first indicator is related to harvest pressure. Bridge sites are often good staging areas; angling at these areas would lead to a high mortality rate. The target (750 m) is designed to provide a low risk. A risk curve would depend upon how far people would be willing to walk to catch a bull trout. Insufficient information exists to draw such a curve. Additional uncertainty arises because bull trout may use stream systems that have not yet been surveyed. At the low risk point, uncertainty is assumed to be moderate.

The second indicator examines the proportion of bull trout habitat protected through other objectives. Risk to bull trout decreases at an unknown rate with increased amount of habitat protected (Figure 5.2).

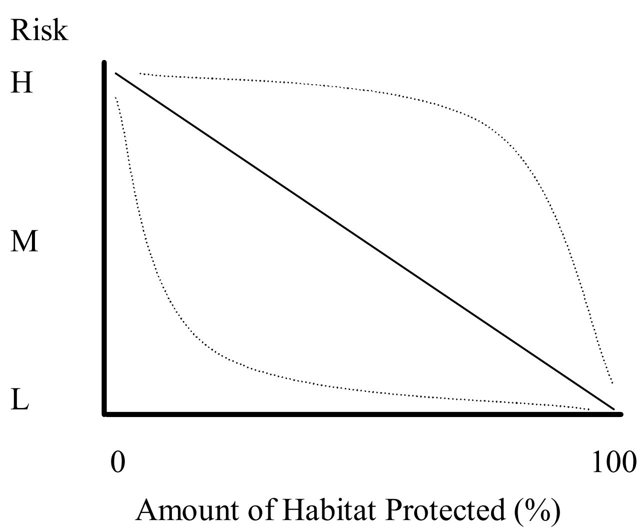

Figure 5.2. Risk to bull trout versus % of protected habitat.

Uncertainty is high along this curve. The curve depends on the amount of small streams that are within protected or specially-managed zones. Effects outside these areas add uncertainty. For example, harvesting can increase downstream temperature, and culverts can reduce access upstream.

Uncertainty related to bull trout populations is high because of the limited geographic range included in the land-use plans.

Effort to seek funding for research on by-catch depends upon a decision that such research is necessary.

Available Data (Question 6)

No data are available for current values (Table 5.3 - Table 5.4). There are no targets within the Bulkley LUPs. **High priority** for data collection.

Table 5.3. Current and future indicator values (when known) for bridges.

	Current		Future	
	Indicator Value	Source	Indicator Value (m)	Source
Bulkley	Unknown	--	No target	--
Kispiox	Unknown	--	750	SRMP

Table 5.4. Current and future indicator values (when known) for protected habitat.

	Current		Future	
	Indicator Value	Source	Indicator Value	Source
Bulkley	Unknown	--	No target	--
Kispiox	Unknown	--	No target	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 5.5 - Table 5.6 are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 5.5. Current and future risk and uncertainty for bridges.

	Current		Future	
	Risk	Uncertainty	Risk	Uncertainty
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Low	Moderate

Table 5.6. Current and future risk and uncertainty for protected habitat.

	Current		Future	
	Risk	Uncertainty	Risk	Uncertainty
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated

using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy (bridge)**; difficult** (special management zones).

Rationale: It is easy to determine bridge distance from the surveyed staging areas on the Shelagyote River. It is difficult to collect data on the amount of habitat protected by special management zones because so little is known about bull trout distribution throughout the Babine Watershed.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to protected habitat: **difficult**.

Rationale: Reducing this uncertainty would require considerable field work just to provide baseline data on bull trout distribution.

Ease of Detecting Negative Consequences (Question 17)

Difficult.

Rationale: There is very little baseline information. Existing studies have only examined staging areas in the Shelagyote River. It is likely that bull trout use other, non-surveyed, systems. Because bull trout are sparse and patchily-distributed, field work would require considerable time and effort.

Objective: Maintain Steelhead

Land-use Plan Summary

The only specific strategy that specifically considers steelhead is within the Babine River Corridor MDS, under an objective to protect the park's fish.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Steelhead are a species of concern.

Recovery Period for Objective(Question 4)

Long.

Rationale: Loss of a species is not recoverable; loss of a population is difficult to reverse.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain steelhead are successful.

Indicators in the land-use plans include

- Studies to define problems and investigate risks of repeated capture
- Effort to seek funding for monitoring as required

Mortality risk has been investigated in catch-and-release fisheries. The probability of mortality for steelhead is 3 – 10% per capture. Because of limited access to the protected Babine River Corridor, the rate of capture is unlikely to increase by a large amount. Because the fish are continually moving towards their over-wintering habitat, it is unlikely that many are caught repeatedly. The biggest uncertainty relating to steelhead population is the level of interception before the fish reach the Babine Watershed.

Available Data (Question 6)

No data are available; no targets exist (Table 5.7). **High priority** to collect indicator data.

Table 5.7. Current and future indicator values (when known) for repeated capture.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Park	Unknown	--	No target	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 5.8 are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 5.8. Current and future risk and uncertainty for repeated capture.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Park	Unknown	--	Unknown	--

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: It would be easy to compile the existing studies of catch-and-release mortality.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to repeated capture: **moderate**.

Rationale: Determining the mortality associated with repeated capture would require an experimental approach.

Ease of Detecting Negative Consequences (Question 17)

Very difficult.

Rationale: There is only a single estimate of steelhead population within the Babine[24]. There is currently no effective method to survey steelhead; very few pass through the fish fence, making counts there unreliable. Statistical power is too low to detect effects.

[24] See companion document: Price and Daust. 2004. Gaps in Past Monitoring and Current Monitoring Responsibilities in the Babine Watershed.

6. Goal: Maintain Water Quality

Information Sources and Updates

Drafted: Karen Price and Dave Daust, November 2004, based on interviews with Dave Wilford[25] and Jim Schwab[26] and documents including a draft Bulkley Aquatic Resources Committee (BARC) Report, Working Paper #57: Watershed Assessment, an expert panel on coastal hydrology[27] and sedimentology and a review paper[28].

Reviewed: Incomplete draft reviewed by Dave Wilford.

Updated:

Land-use Plan Summary

The Bulkley LRMP includes objectives to maintain water quality throughout the Nilkitkwa Landscape Unit, in the Babine River Corridor and in the Babine River SM2 zone of the Babine Landscape Unit. The Nilkitkwa LUP, however only includes objectives for Barbeau Creek SM1 zone, and the Babine LUP does not include objectives for the Babine River SM2 zone. The Kispiox LRMP has objectives to protect water quality in the Babine River; the SRMP includes objectives for sedimentation in three watersheds, including the Babine mainstem. The Babine River Corridor MDS includes a strategy for sedimentation under an objective for fish.

In addition to land-use plans, past provincial regulations have required watershed assessments for watersheds meeting a set of criteria.

Overview of Current Knowledge Relating to Goal

Water quality objectives include maintaining flow levels and quality (sediment levels, temperature, chemical composition) within their natural range. Changes in flow and/or sedimentation can affect channel morphology and substrate. All changes can affect the organisms that rely on hydroriparian ecosystems.

An expert committee has already considered monitoring priorities, indicators and protocols for aquatic resources within the Bulkley portion of the Babine watershed. This section deals with the indicators listed in land-use plans, but refers readers to the more detailed work of the Bulkley Aquatic Resources Committee.

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[25] Research Officer/Hydrologist Team Leader, Ministry of Forests Region, Smithers, BC

[26] Geomorphologist, Ministry of Forests Region, Smithers, BC

[27] Price, K. and Church, M. 2002. Risk to ecosystem functions. Summary of expert workshops. Hydroriparian Planning Guide Background Information. Participants: Gordon Butt (Principal, Madrone Consultants, Duncan); Dan Hogan (Ministry of Forests); Peter Lewis (Ministry of Sustainable Resource Development); Michael Miles (Principal, M.A. Miles and Assoc., Victoria); Kyle Young (Simon Fraser University); Kristie Trainor (UBC); Nick Winfield (Department of Fisheries and Oceans) and Michael Church (UBC).

[28] Church, M and B. Eaton. 2001. Hydrological effects of forest harvest in the Pacific Northwest. Technical Paper #3 for Hydroriparian Planning Guide.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)[29]

Moderate.

Rationale: The objectives to maintain water flow and maintain water quality cover the important facets of the goal. The limited geographic range of the objectives, however, introduces uncertainty that the goal will be achieved throughout the area defined by the LRMPs even if the objectives are achieved.

If the goal is not achieved, recovery potential is variable: while some impacts can be remedied through restoration activities, either catastrophic events or persistent changes can have lasting impacts.

Influence of Goal on Other Goals (Question 2)

High.

Rationale: Loss of water quality carries a probability of a serious consequence for many other goals, including fish, grizzly bears, recreation, tourism and biodiversity.

Objective: Maintain Water Flow

Land-use Plan Summary

The SRMP includes an objective to maintain water quantity within its natural range. No specific objectives are listed in the Bulkley LUPs beyond designation of Barbeau Creek watershed as an SM1 zone.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Although major impacts often follow high flows, sediment plays a larger role in changing system morphology. Most stream systems were developed during higher than current flows.

Recovery Period for Objective (Question 4)

Moderate.

Rationale: Roads do not recover until deactivation. Hydrological recovery occurs in plantations after about 30 years—although full recovery takes longer.

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[29] Questions refer to Procedures of Monitoring Framework

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies maintain water flows within natural ranges.

Indicators in the land-use plans include

- equivalent clearcut area (ECA)

Because trees intercept and use water, flow responses (amount and timing of peak flows, mean flows, low flows) are related primarily to the amount and location, rather than type, of harvesting. Mechanical site preparation also impacts water flow.

In a review of scientific literature for coastal ecosystems, significant changes occur to hydrology with rates of forest harvest higher than 1% of the forested area of a watershed per year averaged over 20 years[30]. Studies have been unable to detect effects below this threshold, but these findings are likely due to statistical ambiguity or precision of equipment (e.g. weirs and climate measures). An expert panel convened to develop risk curves for BC's north and central coast drew two curves (one with, one without, roads) relating hydrologic risk to forest clearance. Because harvesting in the Babine will be roaded, a single curve is appropriate as the initial hypothesis for Babine watersheds (Figure 6.1). The indicator value associated with maximal risk is undefined, but is less than 100%.

[30] Church, M and B. Eaton. 2001. Hydrological effects of forest harvest in the Pacific Northwest. Technical Paper #3 for Hydroriparian Planning Guide.

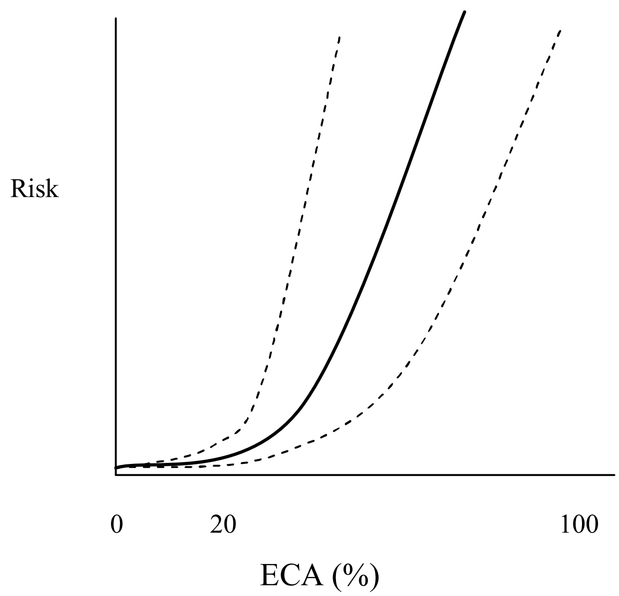

Figure 6.1. Risk to hydrology as a function of forest clearance.

The 20% clearance threshold (at which risk begins to increase) defined by the expert panel matches the 1%/year rate-of-cut threshold averaged over 20 years concluded from the literature review.

ECA (or, similarly, annual rate-of-cut) has a history of being an easy-to-measure planning indicator of changes in water flow. Unfortunately, it is a blunt instrument and cannot represent the complexity of hydrologic responses to harvesting. Uncertainty arises because the indicator does not include location of harvest, roads or watershed size. Location of harvest is important because harvesting in riparian areas, variable source areas (e.g. wet sites linked to streams, alluvial fans) and peak-flow-generating zones (above the snow zone) will have higher impacts than harvesting elsewhere. Roads also impact hydrology—again, location as well as overall density is important. Watershed size is a critical factor. Land-use is more likely to affect water flows in small watersheds; effects in large watersheds may be undetectable because they are swamped by natural variability. The uncertainty associated with this indicator could be reduced by stratifying watersheds by size, looking at small watersheds (e.g. down to 500 ha), examining ECA in sensitive and less sensitive locations, and including a measure of road density and location (on wet sites and slopes). Land-use plans include ECA targets for some watersheds in the Bulkley portion of the Babine that are designed to capture differences in watershed characteristics and sensitivity. Detailed watershed considerations completed by BARC can also reduce uncertainty.

Information on the elevation of the snowline would help to calibrate and refine the ECA indicator for the Babine watersheds by determining peak-flow and low-flow generating areas.

In general, below 20% ECA, uncertainty is relatively low. Elsewhere, uncertainty is high. The expert group did not fix the upper level at which point risk is maximal. Risk functions vary with the location of harvesting and roads, and among watersheds of different size and aspect. The requirement to complete overview watershed assessments when targets are exceeded decreases uncertainty for particular watersheds.

Available Data (Question 6)

Data are available for current and indicator values in the Bulkley and for future values in the Kispiox; but not for future values in the Bulkley or for current indicator values in the Kispiox (Table 6.1). **High priority** for data collection in the Kispiox.

Table 6.1. Current and future indicator values (when known) for ECA.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley (most watersheds)	ECA below trigger	SOFR	No targets listed in LUPs	LUP
Bulkley (Boucher, Nilkitkwa Lake, Nilkitkwa Watershed)	ECA above reassessment trigger	SOFR	No targets listed in LUPs	LUP
Kispiox	Unknown	--	ECA below targets	SRMP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 6.2 are based on the indictor data and the current knowledge about risk and uncertainty described above. Although no targets are listed for the Bulkley Landscape Unit Plans, current provincial regulations stipulate that watersheds with development planned to exceed the target ECA are all subject to overview watershed assessments. Following the transitional period, however, assessments will no longer be regulated.

Table 6.2. Current and future risk and uncertainty for ECA.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley (most watersheds)	Low	Low	Unknown	High
Bulkley (Boucher, Nilkitkwa Lake, Nilkitkwa Watershed)	Moderate	High	Unknown	High
Kispiox	Unknown	High	Low	Low

Key priority watersheds identified in the Bulkley portion of the Babine planning area have had Interior Watershed Assessment Procedures completed.

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data on ECA triggers exist and merely need to be compiled.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to variation among watersheds: **Difficult**.

Rationale: The variation among watershed features makes it difficult to generalise. Even within watersheds, natural annual flood size and low flow varies tremendously, making detection of changes in flow difficult without measurements of precipitation. Resolving uncertainty about the relationship between ECA and flow regimes is not possible within the limited number of watersheds of any type making up the Babine.

If similar sub-watersheds exist within the Babine with different planned rates-of-cut, it would be possible to compare flows. Such a study, however, should be part of a larger, co-ordinated study to be effective.

Uncertainty associated with stratification criteria (peak-flow and low-flow generating areas) for Babine watersheds: **Easy – moderate.**

Rationale: Monitoring snowline elevation is relatively easy.

Ease of Detecting Negative Consequences (Question 17)

Difficult.

Rationale: Although it is easy to detect when a trigger has been exceeded, it is difficult to monitor sufficiently and appropriately over time and space to capture changes in the timing and rates of flow.

Objective: Maintain Water Quality

Land-use Plan Summary

Sedimentation and water temperature are the primary concerns in the Babine. The SRMP includes a general objective to maintain water quality within its natural range. There are no specific strategies to maintain water quality within the Babine River Special Management Zones in either the Bulkley LUPs or the SRMP, although maintenance of water quality in Babine River is listed as a reason for designating the zones in the Kispiox LRMP. Objectives under biodiversity to maintain sensitive riparian ecosystems, and associated strategies to avoid logging on floodplains, also contribute to the maintenance of water quality.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

High.

Rationale: Changes patterns of sedimentation are the primary cause of long-term changes to channel morphology.

Recovery Period for Objective (Question 4)

Moderate.

Rationale: Watershed restoration activities are designed to aid recovery. While many strategies (e.g. road deactivation) can be effective, funding for restoration is not guaranteed, and neither is success. Large wedges of sediment deposited in streams take about 30 – 50 years to recover;

small volumes are flushed out within a year. Active roads continue to deliver sediment until a few years following deactivation; inactive roads recover after 20 – 30 years.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks if the strategies for minimising sediment input and for development of planning activities are successful at maintaining water quality.

Indicators in the land-use plans include

- proportion of landslides related to forestry development that deliver sediment to streams,
- sediment input at road crossings within Nichyeskwa, Babine and Shelagyote watersheds,
- development of stability mapping and management plans for fans and erosion.

Incremental sediment delivered to streams derives from road building and maintenance, from activities in unstable terrain, and from destabilisation of stream banks. The first, landslide, indicator integrates the impacts of road-building and harvesting, and is appropriate for monitoring effectiveness. There are no specific strategies provided in the land-use plans to minimise risk of landslides, although tools exist (e.g. Land Management Handbooks 18 and 56, Terrain Stability Field Assessments, Attribute Studies). It would be possible to examine landslide occurrence in relation to a suite of management activities (e.g. roads in steep terrain, harvesting in steep terrain, harvesting in gentle over steep terrain). The second indicator assumes that point sediment sources are related to changes in sedimentation downstream. The indicator reflects the effectiveness of road design and erosion control at point sources. The final indicator is appropriate for implementation monitoring. Once the mapping and plans are completed, effectiveness monitoring would determine their success. Currently, there are no strategies within land-use plans for managing activities on steep slopes or fans that can be evaluated.

Uncertainty arises because there are no listed indicators relating to sediment derived from streambanks (important along valley-bottom portions of stream systems); neither are there indicators relating to stream temperature. The uncertainty related to streambank sediment can be reduced by source mapping that includes larger features of streambanks. BARC analyses suggest that temperature monitoring would be useful in several Babine watersheds because of the extent of clearcutting without riparian reserves.

BARC considered a set of potential indicators and selected those most appropriate for each watershed, given their geomorphic and hydrologic nature and the location and extent of past and proposed logging, within the Bulkley portion of the Babine.

Landslides

An expert panel convened to develop risk curves for BC's north and central coast[31] drew a single curve relating risk to stream morphology (integrating effects of sediment transfer) to an index of activities on unstable terrain (curve based on index provided in Watershed Assessment Procedures). The panel noted that risks are low for index values of less than 0.8, and high for values above 1.2 (Figure 6.2).

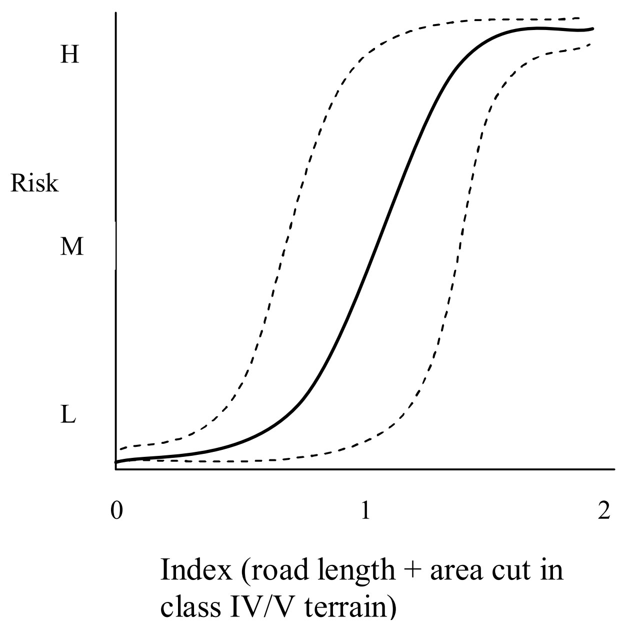

Figure 6.2. Risk to water quality as a function of activities in unstable terrain.

If available tools for reducing risk are not used, uncertainty at the low risk portion of the curve would increase. Uncertainty is high at the moderate risk portion of the curve. The legacy of roads can last many decades, depending upon the quality of design and maintenance. Studies of fine sediment often confound the effects of roads and harvest. The location of Class IV and V terrain determines delivery potential. Lack of consideration of whether hillslopes are coupled or uncoupled to stream systems increases uncertainty. This uncertainty could be reduced fairly easily within the Babine watershed.

Sediment input from road crossings

Variability among systems means that the uncertainty is too high to draw a generic graph. If soil is not erodible, risk is minimal. Fine sediments may cloud the water, but will flush through quickly. Roads through erodible soils, however, have the potential to introduce larger sediment that remains within the system for longer. It is possible to estimate the shape of a risk curve

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[31] Price, K. and Church, M. 2002. Risk to ecosystem functions. Summary of expert workshops. Hydroriparian Planning Guide Background Information. Participants: Gordon Butt; Dan Hogan; Peter Lewis; Michael Miles; Kyle Young; Kristie Trainor; Nick Winfield and Michael Church.

relating roads through erodible soils to water quality (Figure 6.3), although the indicator values on the X-axis are unknown. The uncertainty in the middle of the curve is related to variability among systems. This uncertainty could be reduced through terrain and hazard mapping.

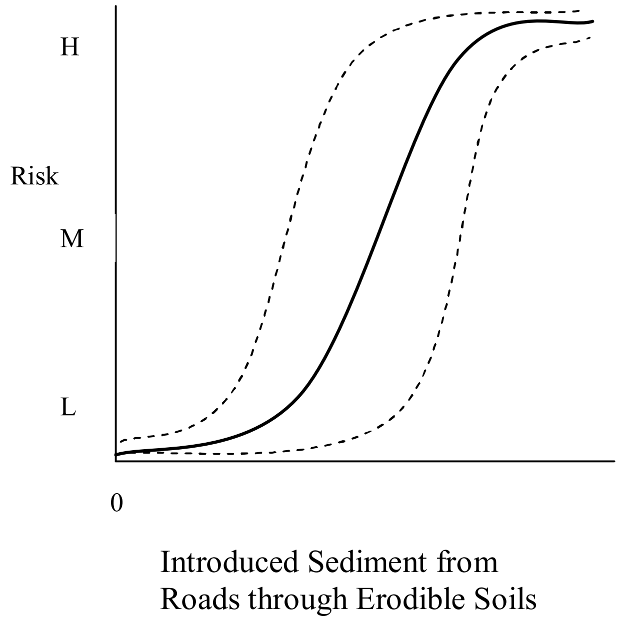

Figure 6.3. Risk to water quality as a function of roads built through erodible soils.

Planning

Risk likely decreases linearly or with diminishing returns with increased planning effort, provided that best management practices are followed (Figure 6.4). Uncertainty is high until specific strategies have been developed for management on steep slopes and fans. Planning effort alone cannot measure success.

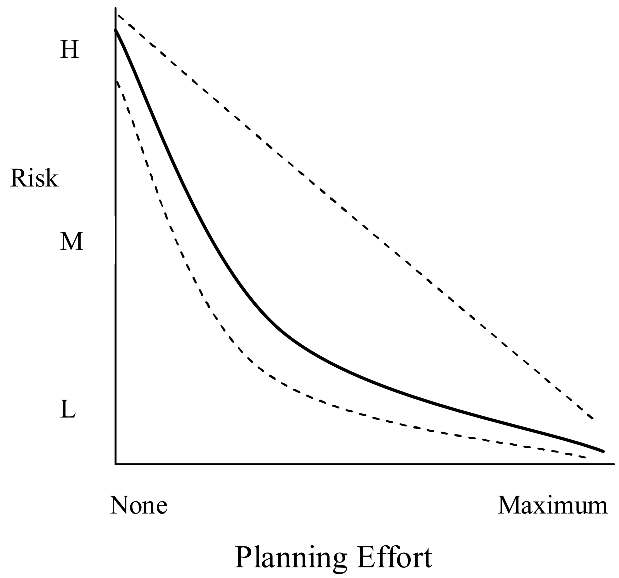

Figure 6.4. Risk to water quality as a function of planning effort.

Available Data (Question 6)

There is a target for no forestry-related landslides in the Kispiox (Table 6.3). There is no target for the Bulkley, and there are no data available for current indicator values anywhere. **High priority** for data collection.

Table 6.3. Current and future indicator values (when known) for landslides.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley	Unknown	--	No targets listed in LUPs	LUP
Kispiox	Unknown	--	Target: no landslides related to forestry	SRMP

Table 6.4. Current and future indicator values (when known) for sediment at stream crossings.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley	Unknown	--	No targets listed in LUPs	LUP
Kispiox	Unknown	--	Target: low risk at particular stream crossings	SRMP

Table 6.5. Current and future indicator values (when known) for planning.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley	Unknown	--	No targets listed in LUPs	LUP
Kispiox	Unknown	--	Target: develop terrain stability mapping on steep slopes, special management for fans, erosion control plans	SRMP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 6.6 - Table 6.8 are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 6.6. Current and future risk and uncertainty for landslides.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	No information	High	No target	High
Kispiox	No information	High	Low	Low*

* Provided that available tools are used to reduce the risk of landslides due to forestry.

Table 6.7. Current and future risk and uncertainty for sedimentation at road crossings.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	No information	High	No target	High
Kispiox	No information	High	Low for targeted watersheds	Low

Table 6.8. Current and future risk and uncertainty for planning.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	No information	High	No target	High
Kispiox	No information	High	Low	High

BARC planning should reduce future risks and uncertainty.

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Moderate (landslides); **easy** (road crossings and planning).

Rationale: Collecting and compiling landslide information requires air photo analysis. Collecting information on road crossings is an easy GIS exercise. Collecting information on planning is a book-keeping exercise.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to sediment input variation among watersheds: **moderate**.

Rationale: Resolvable with careful design and consideration of most appropriate scale for measurement (as in BARC).

Basic information about the sources of sediment within a watershed before and after harvest would identify the sources particular to each watershed and determine if the size and natural amount of sediment sources changes with management. It would allow development of more refined stream quality indicators. Sediment source mapping, erosion mapping and terrain stability mapping have well-established methodologies.

BARC proposes a series of monitoring activities with high probability of success, designed for particular watersheds.

Uncertainty related to X-axis on road risk curve: **very difficult**.

Rationale: Well-designed studies of the effects of sedimentation require costly field equipment.

Ease of Detecting Negative Consequences (Question 17)

Moderate.

Rationale: It would be possible to monitor selected streams at high risk of change either intensively, using repeated photographs, or extensively, using air photos and observation.

7. Goal: Maintain Cultural Heritage

Information Sources and Updates

Drafted: Dave Daust and Karen Price, November 2004.

Reviewed:

Updated:

Land-use Plan Summary

The Kispiox LRMP contains goals to maintain cultural heritage resources, including archaeological sites, traditional use sites and trails, and structural features; and to recognize the significance of House territories and associated resources to First Nations. The Bulkley LRMP contains the goal to minimize the impact of development on both archaeological and traditional use sites. The Forest and Range Practices Act contains the goal to conserve or, if necessary, protect cultural heritage resources that are the focus of traditional use. The Heritage Conservation Act protects archaeological sites. Neither the Kispiox SRMP or the Bulkley LUPs contain specific objectives for cultural heritage resources.

Developing Monitoring Priorities

It is difficult to determine if the priorities identified by the monitoring framework will align with the Gitxsan Houses and Nat'oot'en priorities for monitoring in their territories without further consultation.

8. Goal: Maintain Timber Supply

Information Sources and Updates

Drafted: Dave Daust and Karen Price, based on interview with Dave Coates[32], September 2004.

Reviewed: Dave Ripmeester[33], and an anonymous reviewer[34], December 2004.

Updated:

Land-use Plan Summary

Maintaining timber supply is a goal of the Forest and Range Practices Act (FRPA) and of both the Kispiox and Bulkley LRMPs. FRPA indicates that timber supply should be economically valuable; the Kispiox LRMP indicates that it should be economically viable. The Kispiox SRMP contains one objective for the timber supply goal, but no specific strategies. Objectives and strategies in the Bulkley LUPs mainly address timber volume (see Table 8.1 below), but not the economic aspects of timber supply.

Economic value can be considered at two spatial scales. Economic value at the stand scale is not addressed by any specific objectives (although reduced rotation age can reflect increased value), but several strategies in the enhanced timber development areas (Babine LUP) influence timber quality and hence value.

Economic value at the landscape scale is partially determined by the amount of timber available for harvest. Objectives in the Bulkley LUPs indicate that the timber supply should be economically achievable and secure. Achievability (associated with cost-effective regulations and policies) and security are defined in the introductions to the Babine LUPs which note the aim to limit the impacts of land-use decisions on timber supply (< 10% impact). No specific strategies address these broader economic objectives, however, thus, assessing risk related to strategies and monitoring the consequences of strategies is not possible. Timber supply analysis is the best tool to show the effects of land-use decisions and their associated harvesting restrictions on timber supply and consequently on long-term economics and security.

Overview of Current Knowledge Relating to Goal

Timber supply, the volume of wood that can be harvested yearly, reflects four factors: size of timber harvesting landbase, mean annual growth rate per unit area, unsalvaged timber mortality and forest age-class distribution (an uneven age-class distribution leads to harvesting at sub-optimum growth rates).

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

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[32] Research Silviculturalist, Ministry of Forests Region, Smithers, BC
[33] Pacific Inland Resources, Smithers, BC
[34] Ministry of Forests, Victoria, BC

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)

Low (in Bulkley); **moderate** (in Kispiox).

Rationale: Objectives in the land-use plans and FRPA address two of the four factors affecting timber supply (Table 8.1): growth rate and unsalvaged timber mortality. The Babine LUP includes an additional growth rate objective for enhanced timber development areas. Although the Kispiox SRMP does not include objectives relating to timber growth or unsalvaged loss, FRPA provides the general goals of maintaining timber supply (which implies maintaining growth rates) and of maintaining forest health. Objectives in the Kispiox SRMP and Bulkley LUPs to maintain access to timber supply and to provide a secure timber supply partially address the landbase and age-class factors. The plans, however, provide no specific strategies. Decisions regarding the timber harvesting landbase and age-class distribution are largely determined during land-use planning and timber supply analysis, considering a variety of resource values. Specific strategies in LUPs may not be appropriate.

Lack of explicit objectives for the timber harvesting landbase and the age-class distribution generate low uncertainty about maintaining timber supply. The timber harvesting landbase reflects land-use zoning, terrain limitations and losses of productive ground to roads and trails. Changes in zoning, new markets for “marginal timber”, new technology allowing economic access to steeper terrain and systems that limit road density and site damage can alter the landbase. Policies and legislation (e.g., seral-stage targets and green-up heights) influence the age-class distribution. Large natural disturbances can also influence age-class distributions, causing consequences beyond unsalvaged loss. Weaker objectives for timber growth and salvage in the Kispiox lead to moderate uncertainty about achieving the goal.

Table 8.1. Summary of objectives and factors addressed and relative importance of each objective.

Objective Class	Factor addressed	Importance
Promote rapid timber growth	growth rate per unit area	Moderate
Minimize unsalvaged timber mortality	unsalvaged timber loss	High
Intensively manage enhanced timber development areas	growth rate per unit area	Low
Maintain access to timber supply/ provide a secure timber supply	size of timber harvesting landbase	High
Maintain access to timber supply/ provide a secure timber supply	age-class distribution	Low

If the goal is not achieved, the recovery potential is moderate: harvestable timber will grow back in less than 100 years, unless land is permanently removed from timber production.

Influence of Goal on Other Goals (Question 2)

Low.

Rationale: Loss of timber supply may detrimentally affect production of, and access to, some botanical forest products.

Objective: Promote Rapid Timber Growth

Land-use Plan Summary

Babine and Nilkitkwa LUPs include objectives to promote rapid timber growth and include strategies to replace poor-quality balsam and hemlock stands on productive sites with managed stands, to reforest backlog not satisfactorily restocked (NSR) areas and to encourage reduction in the time required to regenerate harvested areas. The last two strategies can be combined into a single prompt reforestation indicator. Although rapid timber growth is not specifically mentioned as an objective in the Kispiox land-use plans, these indicators may serve in the Kispiox to address the timber supply goal described in FRPA.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative influence of objective on goal (Question 3)

Moderate.

Rationale: While mean annual growth rate can be approximately doubled by practicing basic silviculture and more than doubled by harvesting old stands (where growth is minimal), the size of the timber harvesting landbase and salvaging dead timber have greater effect (Table 8.1).

Recovery period for objective (Question 4)

Short to moderate.

Rationale: Growth rate can recover rapidly when slow-growing stands are harvested and when basic silviculture is applied. Limits to the rate at which slow-growing stands can be harvested and difficulty in restoring brushy sites to conifer dominance can lead to a moderate recovery period.

Information to Determine Monitoring Priority for Objective

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether harvesting of slow-growing stands on productive sites and prompt reforestation successfully promote rapid timber growth.

Indicators in the land-use plans include

- % of old, slow-growing stands on high productivity sites
- % of disturbed sites promptly reforested (addresses NSR and prompt reforestation strategies)

Two risk curves apply to the rapid timber growth objective. First, risk increases in direct proportion to the percentage of old stands on high productivity sites (Figure 8.1) because young managed stands are expected to grow more rapidly. Uncertainty, related to the effects on timber growth of harvesting old stands on high productivity sites, is moderate at all risk levels. Minor uncertainty is associated with growth rates in managed and unmanaged stands. The main source of uncertainty relates to the limited scope of the indicator—it only addresses high productivity sites.

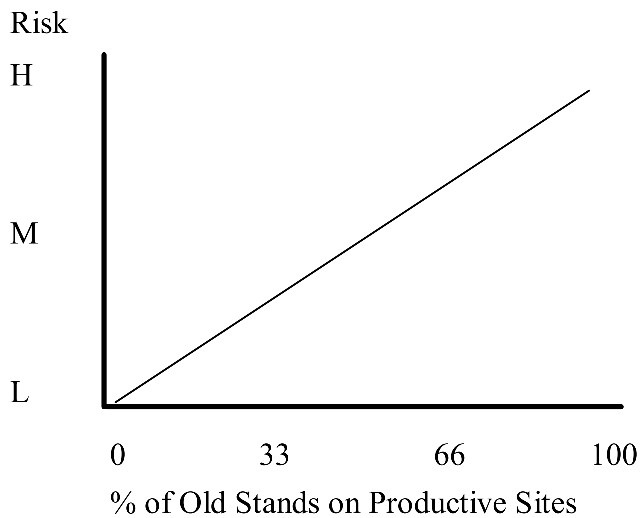

Figure 8.1. Risk to timber growth versus percentage of old, slow-growing stands on high productivity sites.

Second, risk decreases in direct proportion to the percentage of disturbed stands reforested (Figure 8.2). Risk is highest when disturbed sites are not reforested. Risk is low when disturbed sites are promptly reforested. Assuming a hypothetical 100-year rotation, each year of regeneration delay on a site reduces mean annual growth rate by approximately one percent.

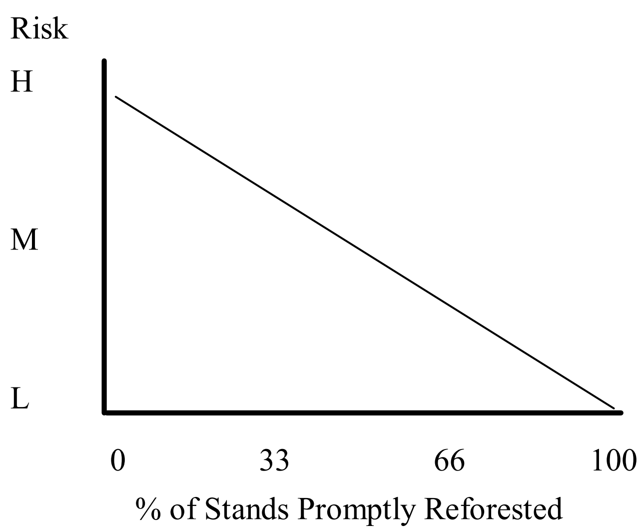

Figure 8.2. Risk to timber growth versus % of disturbed sites that are promptly reforested.

Uncertainty related to prompt reforestation is low at low and moderate risk and moderate at high risk. Prompt reforestation through planting is the best way to increase the conifer domination—"stocking"—of a site. Next to stand age, stocking is the most important factor influencing tree growth (poor stocking can easily cut conifer growth rates in half). Moderate uncertainty exists at high risk levels because of variation in natural stocking. Regenerated stands (as measured by regeneration surveys) provide an early estimate of area stocked. Free-growing stands provide a better estimate of regeneration success in the face of brush competition, but include a delay. A more direct measure might tally poorly-stocked sites, including stands that have not been planted or that have not achieved free-growing status within a reasonable period. Climate change could affect growth rates and ease of achieving stocking.

Available Data (Question 6)

No data describe current and future values for old, slow-growing stands in the Bulkley or Kispiox (Table 8.2). In the Bulkley, rough estimates, based on the percentage of marginal sawlog and pulp quality timber in the entire Bulkley TSA (41%, currently, approx. 5% in the future) suggest that current risk is moderate and that future risk is low. **Medium priority** for collecting data for old, slow-growing stands on high productivity sites in the Bulkley. **High priority** for collecting data in the Kispiox.

No data are available for prompt reforestation in the Kispiox (Table 8.3). In the Bulkley, current data describing the proportion of recent harvesting that is either suitably restocked or free growing provide a reasonable estimate of prompt reforestation. No specific future targets are provided for the Bulkley. A rough estimate, based on current reforestation practices, suggests that future risk in the Kispiox and Bulkley is low and that current risk in the Kispiox is low. **Medium** priority for collecting future values for prompt reforestation in the Kispiox and Bulkley. **Medium** priority for collecting current values in the Kispiox.

Table 8.2 Current and future indicator values (when known) for old, slow-growing stands.

	Current		Future	
	Indicator Value (%)	**Source**	**Indicator Value (%)**	**Source**
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

Table 8.3 Current and future indicator values (when known) for prompt reforestation.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley (TSA)	95%	SOFR	Unknown	--
Kispiox	Unknown	--	Unknown	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 8.4 - Table 8.5) are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 8.4 Current and future risk and uncertainty for old, slow-growing stands.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Medium *	Medium	Low *	Medium
Kispiox	Unknown	--	Unknown	--

* Estimated

Table 8.5 Current and future risk and uncertainty for prompt reforestation.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Low	Low	Low *	Low
Kispiox	Low *	Low	Low *	Low

* Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy for old, slow-growing stands

Rationale: Requires GIS analysis of age and productivity classes.

Easy for prompt reforestation

Rationale: Requires summaries of regeneration and free-growing surveys.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to focussing on high productivity sites for old, slow-growing stands: **easy**.

Rationale: The old, slow-growing stands indicator could easily be increased in scope to include the full range of site classes. Area of old forest should be stratified by site type and age class because different sites and ages have different potential growth rates. An alternative approach would calculate the difference between actual mean growth rate and maximum mean growth rate for each stand and tally these growth differences.

Uncertainty associated with natural stocking related to prompt reforestation: **medium.**

Rationale: Need to measure stocking in field at selected intervals following disturbance; studies would need to stratify different site types.

Ease of Detecting Negative Consequences (Question 17)

Moderate.

Rationale: The permanent sample-plot methodology necessary to measure growth rates is well established. Field sampling is relatively straightforward; however, long term studies are needed to provide good results.

Objective: Minimize Unsalvaged Timber Mortality

Land-use Plan Summary

The Babine and Nilkitkwa LUPs include objectives to maintain the health and productivity of the timber resource. This objective focuses on damage caused by insects and disease. Strategies include preferentially harvesting beetle-susceptible stands, limiting the spread of disease and pests, and promptly salvaging damaged timber. Although unsalvaged mortality is not specifically mentioned as an objective in the Kispiox land-use plans, these indicators may serve in the Kispiox to address the forest health goal in the Kispiox LRMP.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative influence of objective on goal (Question 3)

High.

Rationale: Unsalvaged mortality is a direct loss of potential timber supply (Table 8.1 above).

Recovery period for objective (Question 4)

Moderate.

Rationale: After several years, unsalvaged trees deteriorate and are no longer salvageable. The effect on timber supply depends on volume lost, growth rates before disturbance and after disturbance and on the age-class distribution of the forest. Impacts will be greatest in the mid-term when the unsalvaged stands were scheduled for harvesting.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether preferentially harvesting beetle-susceptible stands, limiting the spread of disease and pests, and promptly salvaging damaged timber minimizes unsalvaged mortality.

Indicators in the land-use plans include

- % of landbase susceptible to beetles
- % of insect and disease damage controlled
- % of natural mortality salvaged (salvage efficiency)

Risk of unsalvaged mortality increases sigmoidally as the percentage of the landbase susceptible to beetles increases (Figure 8.3). Relatively low percentages of susceptible stands do not provide enough habitat for an outbreak; relatively high percentages do. Uncertainty is moderate over the time scale considered in timber supply analyses. Uncertainty reflects the limited scope of the indicator, which omits other disturbance agents (e.g., disease, fire). Uncertainty also reflects stochastic variation in beetle outbreaks (e.g., susceptible stands may never be attacked). Such stochastic uncertainty is irresolvable.

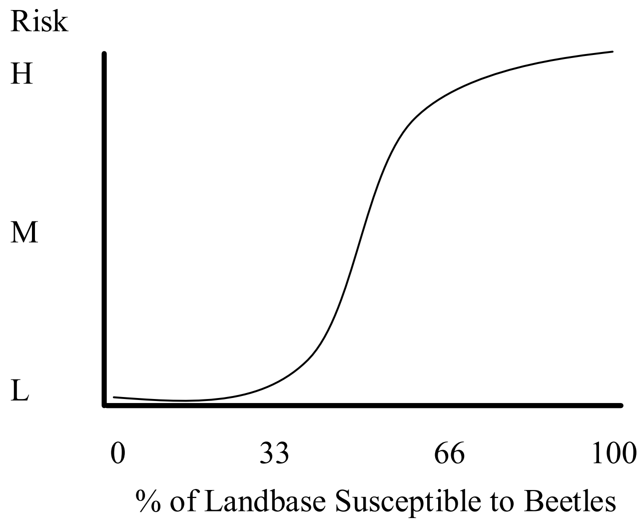

Figure 8.3. Risk of unsalvaged mortality versus percentage of landbase susceptible to beetles.

Risk of unsalvaged mortality decreases sigmoidally as the percentage of insect and disease damage detected and controlled increases (Figure 8.4). The sigmoidal shape is intended to reflect the influence of control on population size and hence on the chance of an outbreak. Estimates of control should account for detection success. Uncertainty is high at all risk levels. First , control is likely only important at critical junctures where disturbance agents are about to shift from endemic populations to outbreaks. Control of endemic populations having natural limitations is unnecessary. Control of outbreaks is not effective. Whether or not uncontrolled infestations in the Babine River Corridor Park are critical (i.e., will lead to an outbreak if not controlled) is a particularly politically-sensitive uncertainty and perhaps of immediate relevance given beetle infestations in nearby areas. Second, the scope of the indicator omits some disturbance agents (e.g., fire).

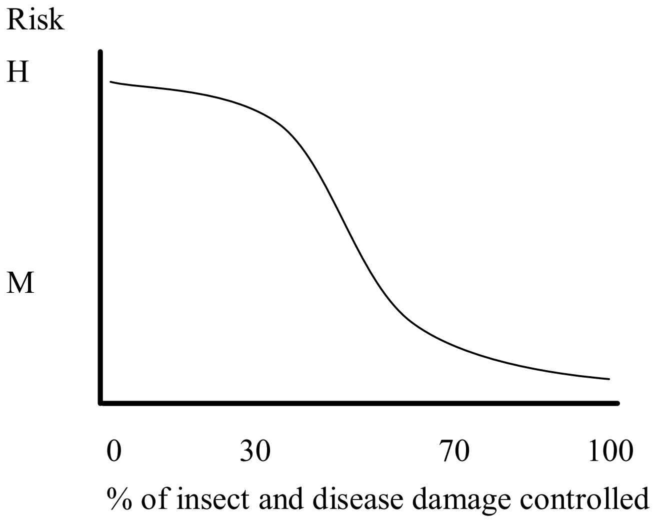

Figure 8.4. Risk of unsalvaged mortality versus percentage of insect and disease damage detected and controlled.

Risk of unsalvaged mortality decreases as salvage efficiency (% of mortality salvaged) increases (Figure 8.5). Mortality should include volume that cannot be salvaged (e.g., due to catastrophic fire). Salvaging naturally-killed trees reduces the amount of live trees that are harvested for milling, retaining stock for future harvest. Low uncertainty is associated with all current risk levels. Minor uncertainty arises because long-term harvest schedules are altered by salvage harvesting, affecting timber supply.

Predicting future salvage efficiency is difficult, leading to uncertainty in the X-value in Figure 8.5. Uncertainty arises because salvage is difficult when the natural disturbance is scattered or when the amount of natural disturbance is high, exceeding salvage capacity. Uncertainty in the X-value translates to uncertainty in the Y-value. Thus, uncertainty should be considered moderate for future risk estimates.

Figure 8.5. Risk of unsalvaged mortality versus salvage efficiency

Available Data (Question 6)

Indicator data should cover the entire landbase, not just the timber harvesting landbase.

Existing data describe the current susceptibility (moderate to extreme hazard is considered susceptible) of the landbase to mountain pine, spruce and fir beetles in the Bulkley (Table 8.6). No other data exist. Estimated future risk is low in the Bulkley and Kispiox, based on age-class distributions projected in Timber Supply Reviews. **High priority** for collecting current indicator data in the Kispiox. **Moderate priority** for collecting future indicator data in the Bulkley and Kispiox.

No data describe current and future values for insect and disease control in the Kispiox or Bulkley portions of the Babine River Watershed (Table 8.7). In the Bulkley TSA, about ¼ to $^1/_3$ of the detected beetle infestations were treated (by the Small Business Forest Enterprise Program; SOFR). Inaccessible and inactive (no beetle population) sites were not treated. Detection was probably relatively good given the aerial survey methodology. Estimated current risk in the Bulkley portion of the Babine River Watershed is low to moderate. **High priority** for collecting current indicator data in the Kispiox and future indicator data in the Kispiox and Bulkley. Large beetle infestations in nearby areas suggest a **High priority** for collecting current indicator data in the Bulkley.

No data describe current and future values for salvage efficiency (Table 8.8). In the Bulkley TSA, about 5% of detected beetle infestations were harvested (by the Small Business Forest Enterprise Program; SOFR). **High** priority for collecting current and future indicator data in the Kispiox and Bulkley.

Table 8.6. Current and future indicator values (when known) for percentage of landbase susceptible to beetles.

	Current Indicator Value (%)	Source	Future Indicator Value (%)	Source
Bulkley	~85%*	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

*moderate to extreme hazard for at least one beetle species

Table 8.7. Current and future indicator values (when known) for percentage of insect and disease damage detected and controlled.

	Current Indicator Value (%)	Source	Future Indicator Value (%)	Source
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

Table 8.8. Current and future indicator values (when known) for salvage efficiency.

	Current Indicator Value (%)	Source	Future Indicator Value (%)	Source
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 8.9 - Table 8.11) are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 8.9. Current and future risk and uncertainty for percentage of landbase susceptible to beetles.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	High	Medium	Low *	Medium
Kispiox	Unknown	--	Low *	Medium

* Estimated

Table 8.10. Current and future risk and uncertainty for percentage of insect and disease damage detected and controlled.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Low to Moderate *	High	Unknown	--
Kispiox	Unknown	--	Unknown	--

* Estimated

Table 8.11. Current and future risk and uncertainty for salvage efficiency.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy for percentage of stands susceptible to beetles

Rationale: Requires simple GIS analysis

Moderate – difficult for percentage of insect and disease damage controlled

Rationale: Determining incidence of insects and disease requires airplane surveys to identify large patches and fairly extensive field sampling to determine scattered damage within stands; it should be relatively easy to tally percentage of identified occurrences treated (information may be available from Defined Forest Area Management Committee).

Moderate – difficult for salvage efficiency

Rationale: Same rationale as above.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to the limited scope of the stands susceptible to beetles indicator: **difficult to not resolvable**.

Rationale: While the susceptibility of stands to some disturbance agents can be estimated, some significant disturbance agents such as wildfire are not well correlated with stand character.

Uncertainty associated with stochastic variation in beetle outbreaks: **not resolvable.**

Rationale: Uncertainty reflects unpredictable variation in beetle outbreaks, which is compounded by global warming.

Uncertainty associated with effectiveness of controlling different population sizes: **very difficult.**

Rationale: Populations of some disturbance agents (e.g., beetles) are influenced by many factors other than mortality due to control; assessing the efficacy of control requires that other variables be accounted for, necessitating a huge study.

Uncertainty associated with effectiveness of controlling populations in park: **moderate to very difficult.**

Rationale: Same as above, however, a detailed risk assessment may provide useful information relatively easily.

Uncertainty associated with the limited scope of percentage detected and controlled: **easy.**

Rationale: Adding control success for wildfire could expand the scope of this indicator.

Uncertainty associated with predicting future salvage efficiency: **not resolvable.**

Rationale: large catastrophic disturbances that exceed salvage capacity occur unpredictably.

Ease of Detecting Negative Consequences (Question 17)

Moderate – difficult.

Rationale: determining natural mortality requires airplane surveys to identify large patches and fairly extensive field sampling to determine scattered mortality within stands; determining volume salvaged is relatively easy from maps and scaled volume.

Objective: Reduce Rotation Age or Increase Yield in Enhanced Timber Development Areas

Land-use Plan Summary

The Babine LUP includes an objective to intensively manage the timber resource in all enhanced timber development areas to reduce the rotation and/or increase yield over time (subject to available funding). Strategies include using improved planting stock, brushing and weeding, thinning, pruning and fertilizing. This objective aims to influence the economically valuable volume (and hence rotation age) of the stand. Part of economic value is determined by growth rate; part is determined by piece size and the amount of clear wood. Improved stock, brushing and weeding and fertilizing mainly affect growth rate. Thinning mainly affects piece size; thinning only increases the growth rate of excessively dense stands. Commercial thinning harvests thinned stems and thus increases yield over the rotation. Pruning affects the amount of clear wood. Below, strategies are grouped as follows into three indicators: using improved stock and/or brushing and weeding to affect growth rate, using thinning and/or pruning (and possibly fertilization) to affect piece size and using commercial thinning (and possibly fertilization) to affect timber yield. Brushing and weeding, improved stock and commercial thinning have the greatest effects. Fertilization provides only a minor increase.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative influence of objective on goal (Question 3)

Low.

Rationale: Intensive silviculture has the least influence on timber supply (i.e., approx. 25% increase in yield) of the factors considered (Table 8.1).

Recovery period for objective (Question 4)

Moderate.

Rationale: Reducing rotation age or increasing yield requires action early in the rotation, while benefits occur at harvest.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether using improved stock and/or brushing and weeding, using thinning and/or pruning, and using commercial thinning will reduce rotation age or increase timber yield.

Indicators in the land-use plans include

- % of landbase treated with improved stock and/or brushing and weeding
- % of landbase treated with thinning and/or pruning (and possibly fertilization)
- % of landbase commercially thinned

Risk to rotation age and timber yield decreases as the percentage of the landbase treated with improved stock and/or brushing and weeding increases (Figure 8.6). Uncertainty is low. The benefits of improved stock and brushing and weeding are fairly well established. Improved stock contains most of the genetic variation of trees native to a site, thus the risk of catastrophic loss of plantations is not greatly higher than with regular stock.

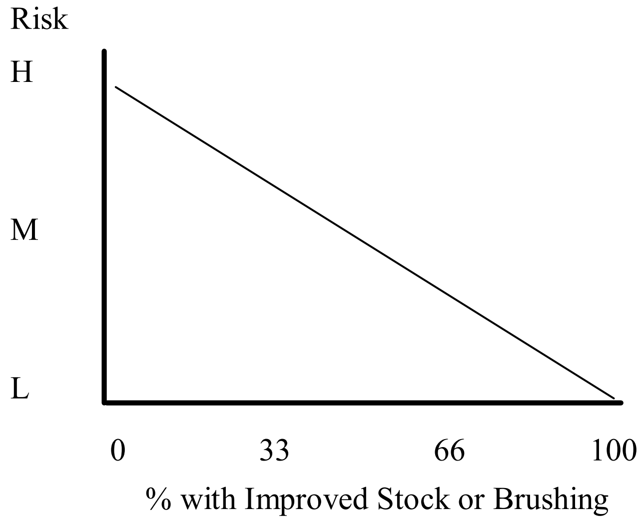

Figure 8.6. Risk to rotation age and yield versus percentage of landbase with improved stock and/or brushing and weeding

Risk to rotation age and timber yield decreases as the percentage of the landbase thinned and pruned increases (Figure 8.7). Uncertainty is moderate. The effects of thinning and pruning on piece size and clear wood (and consequently rotation age) are fairly well established, however, uncertainty remains moderate because the long-term demand for large, clear lumber products is unknown. Additionally, insects and disease damage following thinning can reduce stocking to sub-optimal levels.

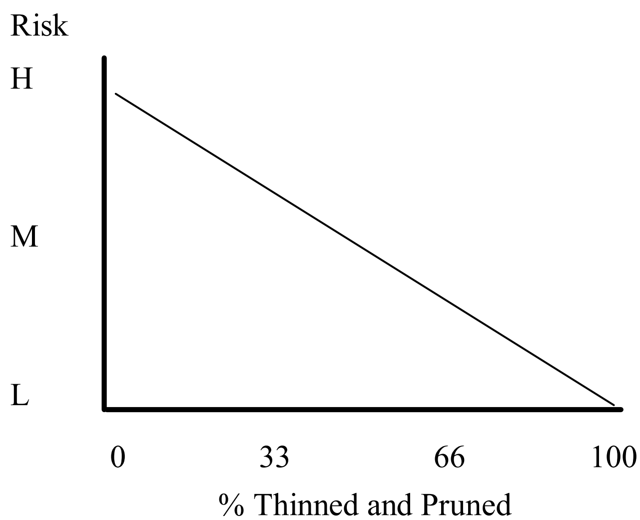

Figure 8.7. Risk to rotation age and yield versus percentage of landbase thinned and pruned.

Risk to rotation age and timber yield decreases as the percentage of the landbase commercially thinned increases (Figure 8.8). Uncertainty is low. Commercial thinning harvests volume and reduces competition among remaining trees. Some uncertainty exists because damage to trees caused during thinning may lead to reduced yield due to increased insect and disease damage.

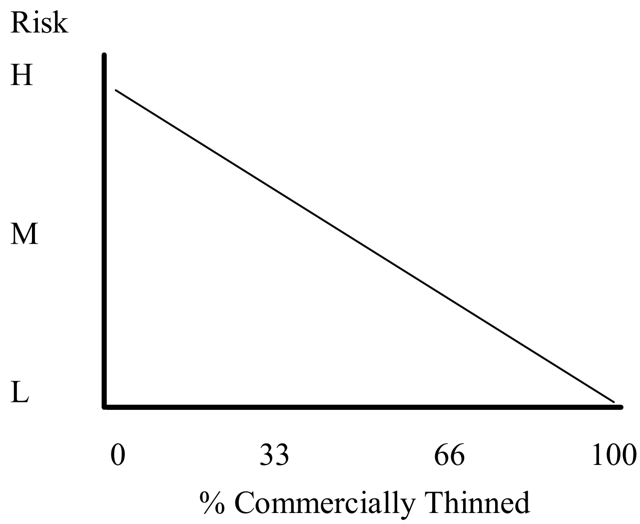

Figure 8.8. Risk to rotation age and yield versus percentage of landbase commercially thinned.

Available Data (Question 6)

No data describe current or future indicator values in Bulkley (Table 8.12 - Table 8.14; objective does not apply to Kispiox). Estimated current risk is high for all indicators because little intensive silviculture is conducted. Future risk is unknown because no specific targets are provided in land-use plans. **Moderate priority** for collecting current indicator data in the Bulkley. **High priority** for determining future indicator targets in the Bulkley.

Table 8.12 Current and future indicator values (when known) for percentage of landbase treated with improved stock or brushing and weeding.

	Current Indicator Value	Source	Future Indicator Value	Source
Bulkley	Unknown	--	Unknown	--

Table 8.13 Current and future indicator values (when known) for percentage of landbase thinned and pruned.

	Current Indicator Value	Source	Future Indicator Value	Source
Bulkley	Unknown	--	Unknown	--

Table 8.14 Current and future indicator values (when known) for percentage of landbase commercially thinned.

	Current Indicator Value	Source	Future Indicator Value	Source
Bulkley	Unknown	--	Unknown	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 8.15 - Table 8.17) are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 8.15 Current and future risk and uncertainty for percentage of landbase treated with improved stock or brushing and weeding.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	High *	Low	Unknown	--

* Estimated

Table 8.16 Current and future risk and uncertainty for percentage of landbase thinned and pruned.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	High *	Medium	Unknown	--

* Estimated

Table 8.17 Current and future risk and uncertainty for percentage of landbase commercially thinned.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	High *	Low	Unknown	--

* Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy for all indicators.

Rationale: Silvicultural treatments are already recorded—they require summarizing to determine current values; future indicator values require targets to be set.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to improved stock and brushing and weeding: **unnecessary**.

Rationale: Response to improved stock and brushing and weeding is already well studied.

Uncertainty related to long-term demand for large, clear timber created by thinning and pruning: **not resolvable**

Rationale: The potential to use alternative construction materials makes future demand uncertain.

Uncertainty related to damage following commercial thinning: **moderate – difficult.**

Rationale: requires long term, controlled study of yield following commercial thinning. Natural variation in insect and disease incidence may necessitate numerous replicates.

Ease of Detecting Negative Consequences (Question 17)

Easy.

Rationale: Requires simple field sampling of growth rates, piece size and timber quality.

9. Goal: Conserve Soil

Information Sources and Updates

Drafted: Dave Daust and Karen Price, November 2004.

Reviewed: Marty Kranabetter[35] January 2005.

Updated:

Land-use Plan Summary

Neither Kispiox nor Bulkley land-use plans address soil conservation. FRPA contains an objective to conserve soil productivity and hydrological function

Overview of Current Knowledge Relating to Goal

Soil productivity depends on a biologically and chemically active layer of soil near the surface of the ground. This layer can be removed or damaged during forest operations by purposeful excavation, machinery traffic and dragging logs. Exposed substrates and damaged soils can have reduced porosity and in combination with altered micro-topography (e.g., road cuts) lead to altered water flow patterns. Changes in water flow patterns can cause surface erosion. Changes in water flow and micro-topography can lead to landslides. The probability of different types of soil degradation (including soil displacement, compaction, erosion and landslides) also depends on the sensitivity of the site[36].

Over several rotations, harvesting tree biomass has the potential to reduce soil organic matter and consequently soil productivity. The abundance of organic matter also affects the overall carbon budget of the site.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)[37]

Low.

Rationale: The objectives to conserve soil productivity and soil hydrological function cover important facets of soil. A regulation preventing activities that cause landslides serves as a third, legally-enforceable objective.

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[35] Research Pedologist, Ministry of Forests, Smithers, BC,

[36] Lewis, T and W. Carr. 1989. Developing timber harvesting prescriptions to minimize site degradation—interior sites. Land Management Handbook Field Guide Insert. BC Ministry of Forests.

[37] Questions refer to Procedures in Monitoring Framework

Table 9.1. Summary of objectives and factors addressed and relative importance of each objective.

Objective Class	Factor addressed	Influence on Goal
• Conserve soil productivity	soil productivity	Moderate
• Conserve soil hydrological function	soil hydrologic function	Moderate
• Prevent landslides	soil stability	Moderate

Objectives related to hydrological function and landslides are covered under the goal to Maintain Water Quality.

If the goal is not achieved, recovery potential is variable: while some impacts can be remedied through restoration activities or time, roads, for example, can have lasting effects.

Influence of Goal on Other Goals (Question 2)

Moderate.

Rationale: Loss of soil productivity carries a probability of a serious consequence for biodiversity and forestry.

Objective: Conserve Soil Productivity

Land-use Plan Summary

Land-use plans do not address soil productivity. FRPA includes an objective to conserve soil productivity.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Sole objective under this goal.

Rationale: Landslides and hydrological function are included under Water Quality (Table 9.1).

Recovery Period for Objective (Question 4)

Moderate to Long.

Rationale: Compacted soil may recover in less than 100 years. Exposed substrate, due to displacement, erosion or landslides will take greater than 100 years to recover. Roads do not begin to recover until deactivation. Depleted nutrients from repeated harvests will have a long recovery.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,

- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether management strategies conserve soil productivity. No indicators are included in the land-use plans. Indicators in FRPA include

- area occupied by permanent access structures
- area degraded (displaced, eroded or compacted soil) in cutblock

Risk to soil productivity increases in direct proportion to the amount of permanent access in an area (Figure 9.1). Permanent access structures have essentially zero soil productivity. Uncertainty is very low.

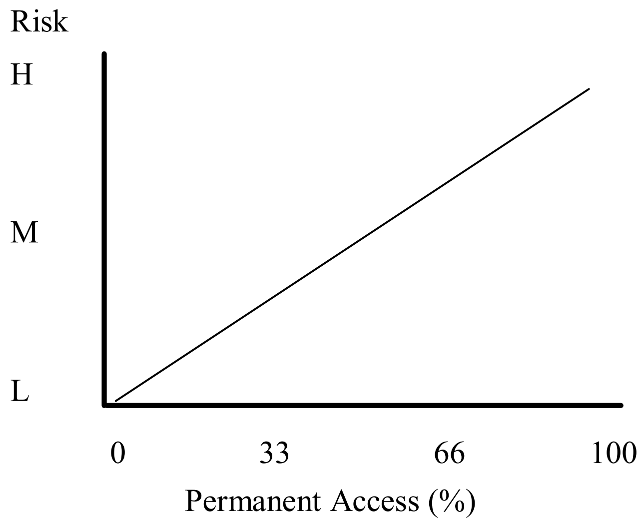

Figure 9.1. Risk to soil productivity versus percent of area covered in permanent access.

Risk to soil productivity increases in direct proportion to the amount of degradation in a cutblock (Figure 9.2). Temporary access structures cause degradation. Using machinery on wet, sensitive soils can cause degradation. Degraded areas have significantly reduced soil productivity for decades or until effective mitigation occurs (mitigated areas are not counted as degraded when the indicator is measured). Although some degraded soils may not be completely unproductive, they generally do not grow trees well. Uncertainty is low in the short term and moderate in the long term. Some uncertainty reflects variation in soil productivity associated with landings and access trails having partial disturbance (e.g., because of winter harvesting), with scattered disturbance that is too small to measure and with rehabilitated landings and trails that may not have returned to full productivity. In the long term, moderate uncertainty arises because the indicator does not consider the consequences of repeated harvesting on soil productivity.

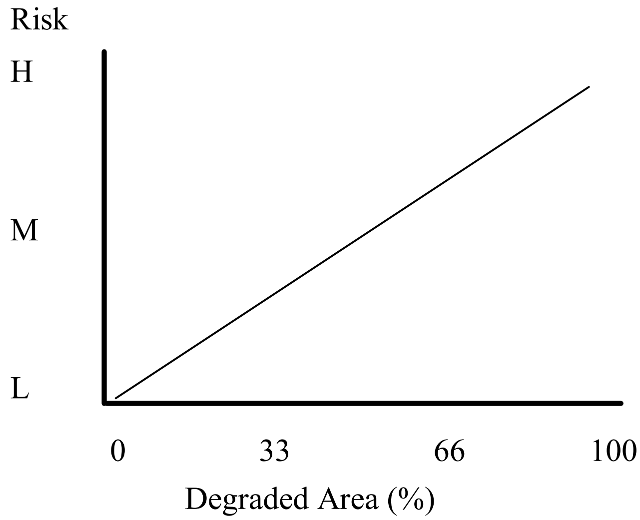

Figure 9.2. Risk to soil productivity versus percent of harvested area degraded.

Available Data (Question 6)

Although no indicator values have been measured and no indicator targets are listed in land-use plans, legislation provides maximum current and future indicator values for both permanent access and degradation (Table 9.2 - Table 9.3). Because the maximum indicator values are "default", they may be altered in the future to reflect specific management objectives. Thus, some uncertainty is associated with default future values. The risk analysis assumes that legislated targets will be met and that future objectives will not lead to large increases in access or degradation. Ideally, access and soil degradation should be measured and recorded.

Table 9.2. Current and future indicator values (when known) for permanent access (% of area).

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley and Kispiox	< 7%	FRPA regulations	< 7%	FRPA regulations

Table 9.3. Current and future indicator values (when known) for degradation (% of area).

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley and Kispiox	< 5% on sensitive soils	FRPA regulations	< 5% on sensitive soils	FRPA regulations
Bulkley and Kispiox	< 10% on non-sensitive soils	FRPA regulations	< 10% on non-sensitive soils	FRPA regulations

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 9.4 - Table 9.5) are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 9.4. Current and future risk and uncertainty for permanent access.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley and Kispiox	Low	Low	Low	Low

Table 9.5. Current and future risk and uncertainty for degradation.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley and Kispiox	Low	Low	Low	Low

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Access can be measured from maps and confirmed with field sampling. Degradation is already estimated by Compliance and Enforcement staff. Field sampling should be used to confirm estimates.

Ease of Improving Risk Curve (Question 16)

Uncertainty about permanent access: **unnecessary**.

Rationale: Uncertainty is very low.

Uncertainty associated with degradation: **moderate – difficult.**

Rationale: Monitoring requires mapping degraded areas (and rehabilitated areas) and monitoring vegetation growth and vigour over longer time frames.

Uncertainty about affects of repeated harvesting on soil productivity: **difficult**.

Rationale: Requires long-term studies across a range of site types and treatments.

Ease of Detecting Negative Consequences (Question 17)

Moderate – difficult.

Rationale: Monitoring requires mapping degraded areas (and rehabilitated areas) and monitoring vegetation growth and vigour over longer time frames.

Objective: Conserve Soil Hydrological function

Indicators of soil hydrological function, including equivalent clearcut area and sediment input into streams are addressed under the Maintain Water Quality goal.

Objective: Maintain Soil Stability

Indicators of soil stability, including activities in unstable terrain and plans for unstable areas, are addressed under the Maintain Water Quality goal.

10. Goal: Maintain Opportunities for Tourism and Recreation

Information Sources and Updates

Drafted: Karen Price and Dave Daust, September 2004 based on discussion with Len Vanderstar[38], and on Recreation Capacity Study completed for BC Parks[39].

Reviewed: Alison Davies[40] in December 2004.

Updated:

Land-use Plan Summary

General objectives for tourism and recreation include maintenance of fish, wildlife and cultural heritage features over the entire plan area; specific objectives include maintenance of wilderness values and opportunities for backcountry recreation in target areas. An additional objective for recreation is to maintain access to recreational opportunities. The Babine River Corridor is the current focus of recreation and tourism activities based on wilderness values.

The Kispiox LRMP includes objectives to maintain wilderness-based opportunities as well as public access to recreational opportunities; the Bulkley LRMP focuses on maintaining angling values within the Babine River. The Kispiox SRMP includes several objectives concerned with maintaining wilderness experience, but does not include objectives ensuring public access. The Babine LUP and the Babine River Corridor MDS include maintaining wilderness experience as objectives within the park. The Babine LUP also includes objectives to maintain access to existing features.

Overview of Current Knowledge Relating to Goal

The Babine River Corridor forms the heart of the Babine Watershed, ecologically and recreationally. A wilderness experience is critical to the recreation and tourism values of the corridor. Three factors affect this experience: ecological integrity (reflected primarily by the presence of water quality within natural limits, healthy fish populations and grizzly bears), aesthetics (both visual and auditory), and levels of use by other people (which in turn can affect ecology and aesthetics). Without fish and the wilderness setting, recreation and tourism on the Babine River would be limited primarily to floatcraft, and concerns over the levels of use would decrease.

Park status for the Babine River Corridor protects the values immediately adjacent to the river. Many issues, however, transcend park boundaries and cover the entire watershed or further. Management of the entire watershed can affect the ecology—and hence wilderness value—of the corridor.

Maintaining a wilderness setting for Gunanoot Lake has a lesser influence on the goal.

An objective to maintain access to recreational opportunities influences local recreation.

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[38] Ecosystem Specialist, Ministry of Water, Land and Air Protection, Smithers, BC, and frequent visitor to Babine River Corridor

[39] Hillcrest Recreation Consulting, Chipeniuk, R., and Davis, Lack and Associates. 2001. Recreation capacity in Babine River Corridor Provincial Park. Report to BC Parks Skeena Region.

[40] Principal, Helios Tourism Planning Group, Smithers, BC

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)[41]

Moderate.

Rationale: Protection of the Babine River Corridor does much to protect wilderness setting. However, the wilderness values of the Babine River Corridor depend upon the ecological integrity of a much larger area. If the objective to maintain fish and wildlife within the corridor are achieved, the goal could be achieved with moderate uncertainty. However, uncertainty about achieving this objective is very high. Water is influenced by factors outside the park (see water section) and fish and bear populations are influenced by factors within and outside the Babine Watershed, including climate change and roads (see respective sections).

Most objectives apply to the Babine River Corridor—the biggest draw for tourists and local recreationists alike (Table 10.1). An additional objective under the tourism goal applies to Gunanoot Lake. Two further objectives under recreation apply to backcountry recreation and to identified recreation features.

Table 10.1. Summary of objectives for tourism and recreation and relative importance of each objective.

Objective Class	Goal	Influence on Goal
Maintain wilderness value of Babine River Corridor (BRC)	tourism and recreation	High
Maintain fish and wildlife in the BRC	tourism and recreation	High
Maintain aesthetic qualities of BRC	tourism and recreation	High
Maintain sustainable levels of use in the BRC	tourism and recreation	Medium
Maintain wilderness value of Gunanoot Lake	tourism	Low
Maintain backcountry opportunities	recreation	Medium
Maintain access to recreational opportunities	recreation	Medium

If the goal is not achieved, recovery potential is very low: loss of species and genes is irreversible; loss of populations is difficult to reverse. Without fish and a wilderness setting, tourism and recreation opportunities in the Babine Watershed will be severely reduced.

Influence of Goal on Other Goals (Question 2)

Low.

Rationale: Achieving this goal does not help to achieve other goals.

[41] Questions refer to Procedures in Monitoring Framework

Objective: Maintain Wilderness Value of Babine River Corridor

This objective is essentially a compilation of the three more specific objectives described below: maintain fish and wildlife in the Babine River Corridor, maintain the aesthetic quality of the Babine River Corridor, and maintain sustainable levels of use. Achieving this objective requires that the three specific objectives are all achieved.

Land-use Plan Summary

The Babine River Corridor Park and Special Management Zones in both the Kispiox and Bulkley were created in part to achieve this objective. Both the SRMP and Babine LUP include objectives to maintain a wilderness setting or experience within the park.

Objective: Maintain Fish and Wildlife in the Babine River Corridor

Land-use Plan Summary

The Babine River Corridor Park and Special Management Zones in both the Kispiox and Bulkley were created in part to achieve this objective. Objectives under water, fish and grizzly bears were also designed to maintain the fish and wildlife within the corridor. Strategies in Special Management Zones adjacent to the park were designed in part to maintain grizzly bear habitat and movement corridors to the river.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

High.

Rationale: The steelhead, salmon, grizzly bears and other wildlife of Babine River Corridor are major attractions for tourism and recreation within the Babine Watershed. Without fish and wildlife, most river-based recreation and tourism—with the possible exception of floatcraft—would decline precipitously.

Recovery Period for Objective (Question 4)

Long.

Rationale: It is very difficult to reverse loss of a population. Loss of species or genes is irreversible.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain the fish and wildlife of Babine River Corridor are successful.

Indicators for fish and wildlife in the land-use plans are listed under objectives to maintain fish, maintain grizzly bears and maintain wildlife. Risk analyses are included under each relevant section.

In addition to the information included in other sections, information gathered from a sample of park users suggests that there is no consistent perception that bears, steelhead or salmon populations in Babine River Corridor have changed over recent time. Hence, based on this indicator (not included in the land-use plans), current risk would be low.

Objective: Maintain the Aesthetic Quality of the Babine River Corridor

Land-use Plan Summary

The Babine River Corridor Park and Special Management Zones in both the Kispiox and Bulkley were created in part to achieve this objective. The SRMP includes a specific objective to maintain aesthetic quality, while the Babine LUP is more general, with objectives to protect the wilderness setting and river-based tourism and recreation values. The park MDS includes strategies to reduce noise.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

High.

Rationale: The wilderness aesthetics of Babine River Corridor is an important attraction for tourism and recreation within the Babine Watershed. Without wilderness, recreation and tourism based on floatcraft or steelhead fishing would decline precipitously, although local residents would still fish for salmon and paddle the challenging waters.

Recovery Period for Objective (Question 4)

Medium.

Rationale: Visual quality recovers over decades. Auditory disturbances are short-term, but can have lasting impacts on future tourism.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies for limiting disturbance maintain satisfactory aesthetic quality. Indicators in the land-use plans include

- Cutblock patch-size distribution in Special Management Zones (Babine River SM2, Babine River SMZ)
- Rotation length in Special Management Zones
- Viewscape quality within mapped Tourism Node
- Perceptible industrial activity within Babine River SMZ during peak season (August – October)
- Permanent roads within Special Management Zones
- Increased access to park
- Non-industrial motorised use of the Shelagyote Bridge
- Operational activity from July 31 – November 15 across Shelagyote Bridge

Aesthetic quality includes both visual quality (perceived human-related alteration of landscapes) and auditory disturbance (industrial activity, engine noise etc.). It is difficult to estimate the impact of visual alteration relative to auditory disturbance. Initially, they are assumed to be equally important.

Visual Quality

Principal strategies for achieving visual quality are to use long rotations, partial cutting and small clearcuts in the Special Management Zones adjacent to Babine River Corridor Park. Some uncertainty is associated with this indicator because similarly-sized patches can have very different appearances. Using a measurement of visual quality for all areas within and outside the mapped Tourism Node would reduce this uncertainty. The relationship between harvesting design (patch size, leave strips, block design, harvesting system etc.) and visual quality is fairly well established and can be simulated digitally. The curve below shows that risk to wilderness aesthetic quality increases abruptly as visual quality class moves from partial retention to modification (Figure 10.1).

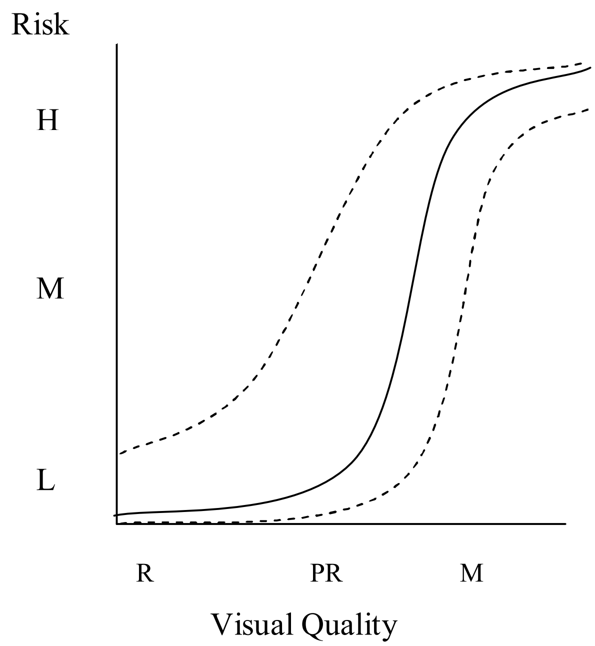

Figure 10.1. Risk to aesthetic quality of Babine River Corridor as a function of visual quality class.

Perception varies among people based on their previous experience and expectations. However, because the Babine River Corridor is marketed as a pristine wild river, tolerance for visual or auditory disturbance is likely low. This low tolerance for disturbance is consistent with the user survey. The uncertainty around the risk curve related to different perceptions is low for retention, low for modification and moderate for partial retention visual qualities.

<u>Auditory Disturbance</u>

The risk to wilderness auditory aesthetics increases exponentially with increased perceived industrial activity (Figure 10.2). The risk likely increases rapidly with any perceived activity. The point of maximum risk is not defined.

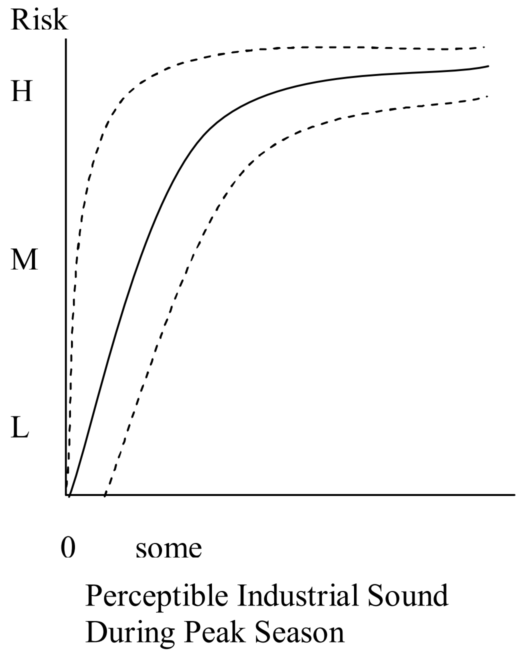

Figure 10.2. Risk to aesthetic quality of Babine River Corridor as a function of perceptible industrial sound during peak season.

The uncertainty due to difference in perception by different people is low at high levels of auditory disturbance and moderate at low levels of disturbance. Additional uncertainty in relation to auditory disturbance arises because no strategies consider recreational activities (e.g. aircraft above the river, motorised boats on the river), and no strategies consider activities outside the Special Management Zones. Hence, uncertainty increases to high, even at low levels of disturbance.

Similar exponential risk curves would apply to increased access to the park or the presence of permanent roads in Special Management Zones.

Available Data (Question 6)

Data on whether visual quality targets have been met are available for the Bulkley (Table 10.2). Because there are no targets beyond the weir, however, there is little information for the rest of the Babine River Corridor, although visual landscape inventory has been completed for the corridor. There are no data available for visual quality for Kispiox, although there are targets for viewpoints along the Babine River Corridor. Priority to collect indicator data is **moderate** in both the Kispiox and Bulkley.

Data on auditory disturbance are not compiled for either the Bulkley or Kispiox (Table 10.3). Priority to collect indicator data is **moderate** in both the Kispiox and Bulkley.

Table 10.2. Current and future indicator values (when known) for visual quality.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Babine River Corridor Park: Tourism Node and weir	Some pre-LRMP harvest not yet greened up	SOFR	Partial Retention at weir, Retention within Tourism Node	Babine LUP; SRMP
Babine River Corridor Park: Bulkley	Some logging is visible from the river, but most is recovering visual quality	Len Vanderstar	No targets, but small patches and long rotations will decrease visual modification	--
Babine River Corridor Park: Kispiox	Unknown		Partial Retention and Modification targets at visible locations	SRMP

Table 10.3. Current and future indicator values (when known) for auditory disturbance.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Babine River Corridor Park	River users have noticed increased sound from the river	Len Vanderstar	No perceptible industrial activity within Babine SMZ during peak season; no permanent roads within Babine River Special Management Zones; controlled operational activity across Shelagyote Bridge	SRMP, Babine LUP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 10.4 - Table 10.5 are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 10.4. Current and future risk and uncertainty for visual quality.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Babine River Corridor Park: Tourism Node and weir	Low – Moderate	Low	Low	Low
Babine River Corridor Park: Bulkley	Low – Moderate*	Moderate	Moderate – High	Moderate
Babine River Corridor Park: Kispiox	Low – Moderate*	Moderate	Moderate – High	Moderate

* Estimated

Table 10.5. Current and future risk and uncertainty for auditory disturbance.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Babine River Corridor Park	Low – Moderate*	High	Low	High

* Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated

using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy – moderate.

Rationale: Data on road location and harvest location and timing are available digitally. Compiling visual quality maps from harvest locations requires a digital elevation model and is moderately difficult.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to the effectiveness of block-size strategies in achieving appropriate visual quality: **moderate.**

Rationale: Compiling visual quality maps from harvest locations requires a digital elevation model and is moderately difficult.

Uncertainty related to different perceptions by different user groups: **moderate – difficult**.

Rationale: The moderate uncertainty associated with relatively low levels of auditory disturbance could be resolved through interviews with visitors. However, due to different perceptions, different groups of visitors may fall on different curves.

Uncertainty related to auditory disturbance from recreational activities or activities outside the Special Management Zones: **moderate – difficult**.

Rationale: Interviews with visitors can provide information on whether activities outside Special Management Zones are perceived within the park. Uncertainty about the disturbance from recreational activities within the park could be resolved, although different groups of visitors will likely have different perceptions

Ease of Detecting Negative Consequences (Question 17)

Moderate.

Rationale: Analysis of user satisfaction surveys over time can show how perceptions change.

Objective: Maintain Sustainable Levels of Use

Land-use Plan Summary

The Babine River Corridor MDS includes strategies for maintaining sustainable levels of use. The SRMP and Babine LUP simply include objectives to control access within the Babine River Special Management Zones in order to maintain status quo patterns of access.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Sustainable levels of use have less impact on the goal than the presence of fish, wildlife and a wilderness setting. However, high levels of use could impact the other objectives.

Recovery Period for Objective (Question 4)

Short – long.

Rationale: Limiting recreational use would have an immediate effect. Mitigation is potentially possible through a number of options discussed in the recreation capacity report. Options include encouraging users to modify the timing and location of various activities to minimise contact with other users. However, if road access to Babine River changes, it will be difficult to reverse the change.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether the strategies to avoid changing access achieve sustainable levels of use.

The Babine River Corridor MDS includes a strategy to develop a Recreation Management Plan to encourage sustainable levels of use. To date, this plan has not been completed, and management follows the interim strategies included in the MDS (which are reasonably complete for floatcraft and camping but insufficient for motorised boats and angling). Indicators of sustainable levels of use, or of limits of acceptable change in different portions of the park, must be developed in conjunction with park users during the Recreation Management Planning process. A report on recreation capacity, based on a user questionnaire, provides information that can be used to develop preliminary risk curves relating levels of use to perception of wilderness value.

This section concentrates on socially sustainable levels of use. The impacts of levels of use on ecological integrity are included in the relevant sections.

Indicators in land-use plans include

- permanent road access within the Babine River SMZ and SM2.

There are currently no listed indicators of the risk to levels of use (beyond development of a Recreation Management Plan). An interim indicator from the recreation capacity study can provide initial risk curves:

- cumulative frequency distribution of people who have exceeded their limit for wilderness experience for different zones and activities.

Road Access

Maintaining a single road access point to the Babine River Corridor will control the level of access to much of the corridor. Foot trails traverse the uppermost 3 km of the river. Travel downstream is usually by raft or kayak. Angling guides and their clients travel to lodges by jet-boat or helicopter.

Any increase in road access carries a high risk to sustainable use (given current levels of use; Figure 10.3).

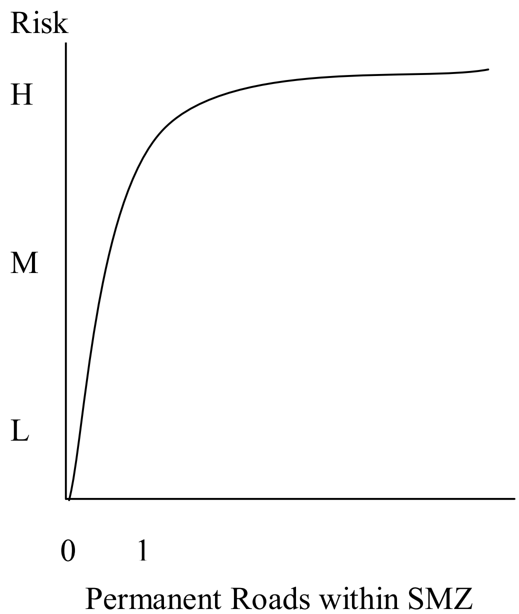

Figure 10.3. Risk to sustainable use of Babine River Corridor as a function of increased access in Special Management Zones.

Increased road access is a good indirect indicator of increased access. Because increased road access to the park would potentially change the levels of use considerably, risk associated with any change is high and uncertainty is low.

Some uncertainty is associated with the effectiveness of access control measures preventing access along temporary roads within Special Management Zones or along permanent roads near to the park. Direct measures of increased access by land could pinpoint locations where access control is ineffective.

Wilderness experience and other users

Interviews conducted for BC Parks' Recreation Capacity Study[42] identified the number of other parties that a park user could meet and still have a wilderness experience. On these graphs, the Y-axis measures the risk to socially sustainable levels of use as the cumulative frequency of

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[42] Hillcrest Recreation Consulting, Chipeniuk, R., and Davis, Lack and Associates. 2001. Recreation capacity in Babine River Corridor Provincial Park. Report to BC Parks Skeena Region.

people who no longer experience wilderness because of the number of other parties they meet. For example, in Figure 10.4, about 50% of people floating in the Wilderness Recreation zone of the park feel that the appropriate number of other parties they meet should be less than 1-2 to ensure a wilderness experience and about 95% feel that the number should be less than 3-5. For floatcraft users, then, the risk increases steeply with increased encounters. Conversely, for all park users in the Natural Environment zone of the park, risk increases linearly with increased encounters. Nobody has a wilderness experience when they meet 6 or more other parties.

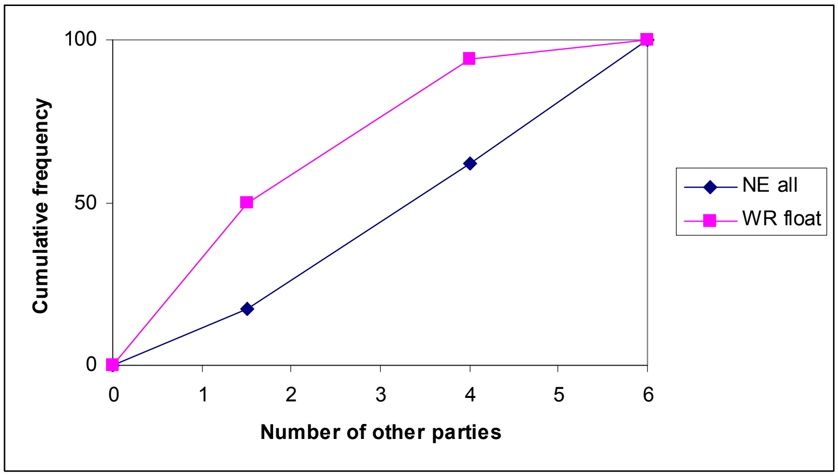

Figure 10.4. Risk to wilderness experience of Babine River Corridor as a function of the number of parties met. The lower curve (NE all) represents all park users in the Natural Environment zone of the park. The upper curve (WR float) represents floatcraft users in the Wilderness Recreation zone of the park.

Uncertainty around the curve relating risk to wilderness experience to encounters is moderate in the middle portion of the curve because perceptions of acceptable levels of contact vary among user groups. Within floatcraft users, uncertainty is low around the high risk portion of the curve (almost all users agree that 3 – 5 encounters destroys a wilderness experience). Risk is high and uncertainty low beyond 6 encounters for all users.

Almost all people camping within the park felt that sharing a campsite for 1 – 2 days was too much; that is, risk to wilderness experience increases rapidly if campers meet anybody (Figure 10.5).

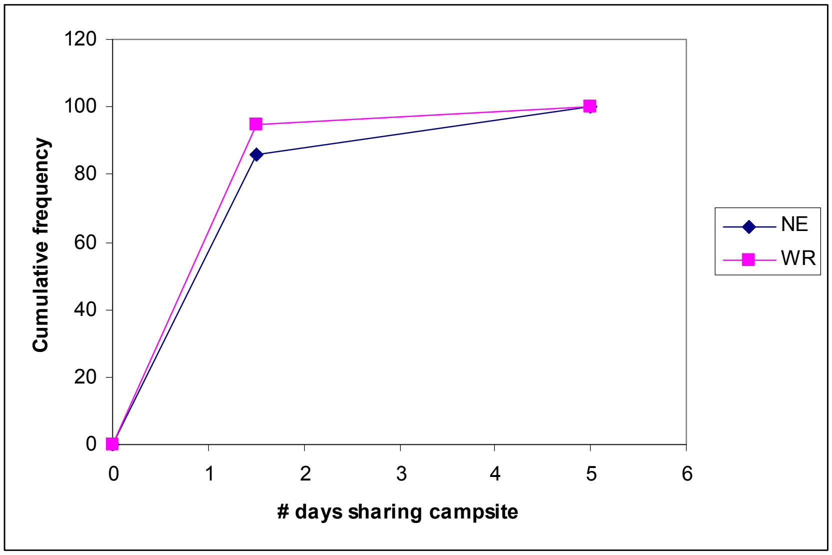

Figure 10.5. Risk to wilderness experience of Babine River Corridor as a function of the number of days spent sharing a campsite. The lower curve (NE) represents users in the Natural Environment zone of the park. The upper curve (WR) represents users in the Wilderness Recreation zone of the park.

The uncertainty around this curve is low—campers within both zones share their perceptions.

Available Data (Question 6)

Data on access control are available for the Bulkley (Table 10.6). Priority to collect indicator data on access control is **moderate** in the Kispiox. Data on recreation capacity are available in a Recreation Capacity Study completed for Babine River Corridor Park (Table 10.6). There are, however, no targets for levels of sustainable use.

Table 10.6. Current and future indicator values (when known) for sustainable use in Babine River Corridor Park.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Roads	Access control mostly successful, although vandalism has occurred repeatedly at a gate south of the Babine River	SOFR	No permanent roads in SMZ	Babine LUP; SRMP
Encounters with other users	People are already meeting more parties than expected for a wilderness experience	Recreation Capacity Study	No targets or strategies	--
Floatcraft	Use at capacity	Recreation Capacity Study	No targets or strategies	--
Camping	Most people are meeting their expectations that they will not have to share a camping site	Recreation Capacity Study	No targets or strategies	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 10.7 are based on the indicator data and the current knowledge about risk and uncertainty described above. Estimates of future risk are also based on the analyses and projections described in the Recreation Capacity Study[43].

Table 10.7. Current and future risk and uncertainty for sustainable use in Babine River Corridor Park.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Roads	Low	Low	Low – Moderate	Low
Encounters with other users	High	Low	High	Low
Floatcraft	Moderate	Low	High	Moderate
Camping	Low	Low	Moderate	Moderate

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data on road location are available digitally. Records of access control are also available.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to the risk to wilderness experience based on encounters with other parties: **moderate – difficult.**

Rationale: Because this uncertainty arises because people hold different perceptions, it is difficult to resolve completely. Interviewing users and grouping people by their activity, as done in the Recreation Capacity Study, however, is possible and useful.

Uncertainty related to effectiveness of access control: **moderate**.

Rationale: Field studies, or interviews, would be necessary to determine new access routes to the Babine River.

Ease of Detecting Negative Consequences (Question 17)

Moderate.

Rationale: Analysis of user satisfaction surveys over time can show how the situation changes.

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[43] Hillcrest Recreation Consulting, Chipeniuk, R., and Davis, Lack and Associates. 2001. Recreation capacity in Babine River Corridor Provincial Park. Report to BC Parks Skeena Region.

Objective: Maintain a Wilderness Setting for Gunanoot Lake

Land-use Plan Summary

The SRMP includes this objective for Gunanoot Lake.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Low.

Rationale: Gunanoot Lake is the focus of a proposed tourism initiative, but is not the principal attraction of the area.

Recovery Period for Objective (Question 4)

Long.

Rationale: It would take over 100 years for forest to redevelop a wilderness setting.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether the strategies to avoid changing access achieve a wilderness setting. Indicators in land-use plans include

- number of permanent roads within 1km
- visual quality around Gunanoot Lake

Roads within 1 km change the Recreation Opportunity Spectrum class from semi-primitive to roaded. Any road within 1 km poses a high risk to the wilderness setting (Figure 10.6).

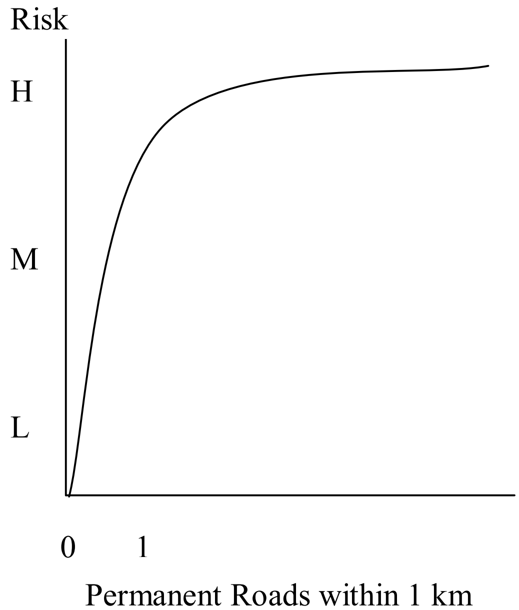

Figure 10.6. Risk to wilderness setting of Gunanoot Lake as a function of permanent roads within 1 km.

The uncertainty around this curve is moderate at low – medium risk and low at high risk. Uncertainty exists because 1 km is too short a barrier to protect a perceived wilderness setting for some people.

The objectives designed to protect the visual quality around Gunanoot Lake call for partial retention or modification. Risk is moderate – high with high uncertainty for these objectives (see Visual Quality Objective goal).

Available Data (Question 6)

No data are available for Gunanoot Lake (Table 10.8). **High priority** for indicator data collection in the Kispiox.

Table 10.8. Current and future indicator values (when known) for Gunanoot Lake.

	Current		**Future**	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Gunanoot Lake: roads	No information	--	No permanent roads within 1 km	SRMP
Gunanoot Lake: visual quality	No information	--	Partial retention and modification	SRMP

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 10.9 are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 10.9. Current and future risk and uncertainty for Gunanoot Lake.

	Current		**Future**	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Gunanoot Lake: roads	Low*	Low	Low	Moderate
Gunanoot Lake: visual quality	Unknown	Unknown	Moderate - high	High

*Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data on road location are available digitally.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to distance from roads: **moderate – difficult**.

Rationale: Interviews could decrease uncertainty about the sufficiency of the barrier for this particular area. General results would require a large-scale experimental approach that be difficult to design and analyse because perceptions will differ among different groups of visitors.

Uncertainty related to visual quality objectives: **moderate**.

Rationale: See Visual Quality section.

Ease of Detecting Negative Consequences (Question 17)

Easy.

Rationale: Tourism operator will be in contact with visitors.

Objective: Maintain Backcountry Opportunities

Land-use Plan Summary

The Kispiox LRMP calls for maintenance of primitive, semi-primitive and wilderness opportunities. The SRMP protects these opportunities in the Atna/Shelagyote SMZ. On the Bulkley side, the Nilkitkwa LUP protects wilderness recreational opportunities in Barbeau Creek SM1.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: The Babine River Corridor draws most recreational visitors, but as primitive recreational opportunities decline, backcountry areas will likely become more important.

Recovery Period for Objective (Question 4)

Long.

Rationale: Once an area is roaded and/or harvested industrially, the backcountry opportunities take over 100 years to recover.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether the strategies to maintain backcountry opportunities are successful. Backcountry recreational opportunities require unroaded areas. Primitive zones are more than 8 km from a road; semi-primitive are more than 1 km. The land-use plans protect special management zones in both the Kispiox and Bulkley from roads associated with forestry, but not for development associated with mining.

Indicators in land-use plans include

- forestry activities within Special Management zones

The risk to backcountry opportunities within Special Management zones increases exponentially with management activities within the zones (Figure 10.7).

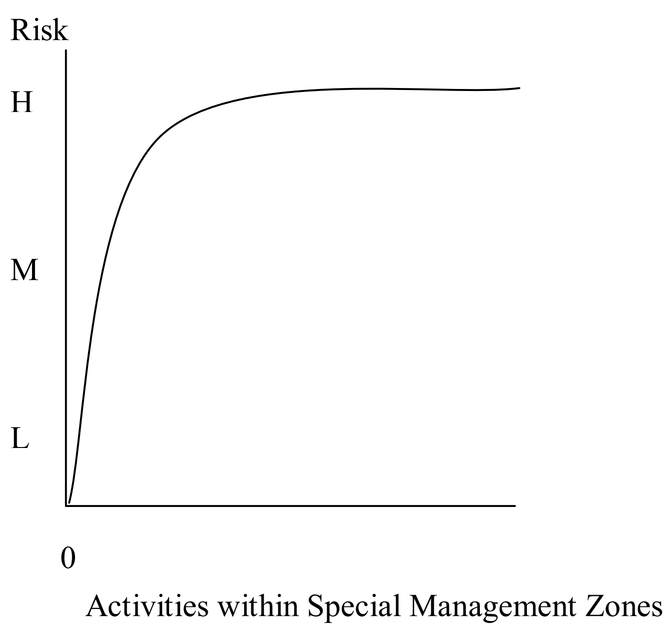

Figure 10.7. Risk to backcountry opportunities in Special Management Zones.

Uncertainty is low around the high risk portion of the curve. Uncertainty, however, is high around the low risk portion because only forestry activities are included in the indicator. Roads associated with mining will also influence the backcountry opportunities of an area. Including all management activities and/or roads within the indicator will reduce this uncertainty to low.

Over the entire Babine watershed, uncertainty about backcountry recreational opportunities arises because there are no indicators or targets for areas outside the designated special management zones. The State-of-the-Forest Report uses the % of each zone as an indicator and notes that the area classified as primitive backcountry has declined from 11 to 3% over the past 20 years in the Bulkley. No risk curve is developed for this indicator because it is not currently included in the land-use plans.

Additional uncertainty is associated with the indicator, because location of unroaded areas influences the opportunity for recreational activities.

Available Data (Question 6)

Within Special Management Zones, targets exist, but current data are not compiled (Table 10.10). It is possible to estimate that there are no forestry activities within these zones. **Medium priority** for indicator data collection. Within the entire area, however, there are no targets. **High priority** to develop targets.

Table 10.10. Current and future indicator values (when known) for primitive backcountry opportunities.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Within Special Management Zones	No information		No forest management activities	LUPs, SRMP
Bulkley	3% of Bulkley in primitive condition	SOFR	No target	
Kispiox	No information		No target	

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 10.11 are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 10.11. Current and future risk and uncertainty for primitive backcountry opportunities.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Special Management Zones	Low	Low	Low	Low
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data on backcountry recreation classification are collected as standard practices.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to mining activities: **easy**.

Rationale: Including all roads within the indicator would reduce this uncertainty.

Ease of Detecting Negative Consequences (Question 17)

Easy.

Rationale: Changed patterns of backcountry opportunities can be easily detected.

Objective: Maintain Access to Recreational Opportunities

Land-use Plan Summary

The Babine LUP identifies recreation destinations that should remain accessible. Although the Kispiox LRMP includes an objective to maintain access, the SRMP does not include any specific objectives or strategies.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Access is important for local residents but less of an issue for destination tourists.

Recovery Period for Objective (Question 4)

Short.

Rationale: Opening up existing access can generally be achieved quickly.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether the strategies to maintain access are successful. Indicators in land-use plans include

- number of inaccessible recreation destinations

The risk to accessibility increases linearly with the number of inaccessible destinations (Figure 10.8).

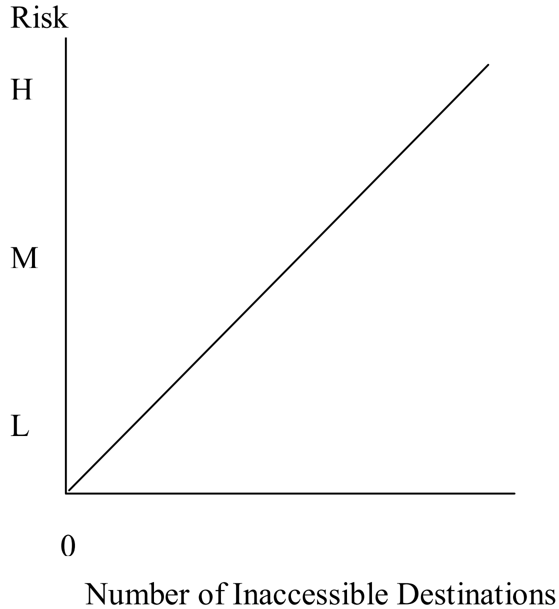

Figure 10.8. Risk to accessibility of recreation destinations.

Uncertainty is moderate around this curve because only listed destinations are included. Maintaining access to the Babine River Corridor is not included in the land-use plans.

Available Data (Question 6)

Data are available for the Bulkley but not for the Kispiox (Table 10.12). **High priority** for indicator data collection in the Kispiox.

Table 10.12. Current and future indicator values (when known) for inaccessible destinations.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley	All known sites and trails remain accessible		All known sites and trails remain accessible	Babine LUP
Kispiox	No information		No target	

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

The estimates in Table 10.13 are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 10.13. Current and future risk and uncertainty for access to recreational destinations.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley	Low	Low	Low	Low
Kispiox	Unknown	--	Unknown	--

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Data on road location are available digitally.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to unlisted destinations: **moderate**.

Rationale: Interviews with local residents would locate less-known sites.

Ease of Detecting Negative Consequences (Question 17)

Easy.

Rationale: Changed patterns of access can be easily detected.

11. Goal: Maintain Visual Quality in Scenic Areas

Information Sources and Updates

Initial draft by Dave Daust and Karen Price, November 2004 based on Visual Impact Assessment Guidebook and a study of visual impacts[44].

Reviewed: Jane Lloyd-Smith, January 2005.

Updated:

Land-use Plan Summary

Kispiox and Bulkley land-use plans include the goal to maintain visual quality in scenic areas. The Kispiox SRMP provides objectives to maintain the scenic value of the Babine River Corridor and the Atna/Shelagyote SMZ. The Kispiox SRMP and the Bulkley LUPs provide objectives describing the degree to which forest operations should be visible in different types of scenic areas.

Overview of Current Knowledge Relating to Goal

Although termed a "goal", maintaining visual quality would be better described as an objective under the goal of Maintaining Opportunities for Tourism and Recreation.

The visibility of forest operations depends on the location of the viewpoint, the amount of alteration (% of harvesting visible from the viewpoint), the amount of in-block retention and the quality of the cutblock design. The amount of harvesting required to cause a given alteration (in perspective view) depends on the slope and roughness of the terrain in the scenic area.

Visual landscape inventories in the Kispiox and Bulkley have identified viewpoints that are important because of such factors as high traffic or recreation use (e.g., Babine River). The area visible from a viewpoint is referred to as a scenic area or viewscape. Depending on the amount and type of human activity at viewpoints, specific visual quality objectives (VQOs) are set for the associated scenic area. Visual quality objectives have standard definitions describing the degree to which forest operations should be visible; they are given the following names: preservation, retention, partial retention, modification and maximum modification.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)

Moderate.

Rationale: Uncertainty comes from two sources. First, some error arises when mapping scenic areas and assigning appropriate visual quality objectives. Consequently, some visible landscapes

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[44] Linnell Nemec, A.F. 2002. Predicting visual impacts of variable retention harvesting. Report to Forest Practices Branch, Ministry of Forests.

may not have appropriate visual quality objectives. Second, and more importantly, visual quality objectives (Table 11.1) may not match public perceptions of acceptable scenery.

Objectives are fairly comprehensive. They cover different classes of scenic areas (retention, partial retention and modification) defined by visual landscape inventories. They also address two special areas (Atna/Shelagyote, Babine River Corridor). The Babine River Corridor is particularly important because of high tourism and recreation use. The Atna/Shelagyote SMZ is managed to provide backcountry recreation opportunities but receives less use. Retention and partial retention zones are more important to the public than modification zones.

Table 11.1. Summary of objectives and factors addressed and relative importance of each objective.

Objective Class	Factor addressed	Influence on Goal
Manage viewscapes zoned as retention so that alterations are not visually apparent	visual quality	Moderate
Manage viewscapes zoned as partial retention so that alterations remain visually subordinate and blend with dominant landscape elements	visual quality	Moderate
Manage viewscape zoned as modification so that alterations are comparable to natural occurrences (Kispiox)	visual quality	Low
Maintain scenic resources in Atna/Shelagyote SMZ (Kispiox)	visual quality	Moderate
Maintain the aesthetic quality of the Babine River Corridor (Kispiox)	visual quality	High

If the goal is not achieved, recovery potential is relatively good: denuded areas will green up and visual quality will improve in two or three decades.

Influence of Goal on Other Goals (Question 2)

Low.

Rationale: Visual quality affects tourism and recreation, but not ecological values or other resource uses.

Objective: Manage Scenic Areas to Achieve Visual Quality Objective

Land-use Plan Summary

The Kispiox SRMP contains the objective to maintain the aesthetic quality of the Babine River Corridor and to maintain scenic resources in the Atna/Shelagyote SMZ. Scenic areas have been established around the Babine River Corridor in both the Kispiox and Bulkley portions (primarily at the weir within the Bulkley) of the watershed and in the Atna/Shelagyote SMZ. In addition, the Kispiox SRMP and Bulkley LUPs identify other scenic areas and assign a visual quality objective to each one.

Land-use plans describe three visual quality objectives that may be assigned to scenic areas: manage viewscapes zoned as retention so that alterations are not visually apparent; manage viewscapes zoned as partial retention so that alterations remain visually subordinate and blend with dominant landscape elements; manage viewscapes zoned as modification so that alterations are comparable to natural occurrences.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Visual quality in the Babine River Corridor is more important, because of high use (Table 11.1). Retention and partial retention are more important than modification objectives.

Recovery Period for Objective (Question 4)

Moderate.

Rationale: Visual quality recovers when cutblocks achieve "visually effective green-up" (approx 20 to 30 years after harvest.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether harvesting achieves the desired perceptions in scenic areas. Indicators in land-use plans include

- amount and type of alteration in retention areas
- amount and type of alteration in partial retention areas
- amount and type of alteration in modification areas

Risk to achieving any visual quality objective increases sigmoidally as the amount of alteration increases (Figure 11.1). The low-risk inflection points are based on the Visual Impact Assessment Guidebook. The sigmoidal shape of each curve is based on a study of partial retention[45]. The uncertainty bands reflect the quality of cutblock design and the proportion of the stand retained in the block. Uncertainty bands for modification objectives are tighter because block design and in-block retention are likely less important on these landscapes (whereas errors in block design can greatly impact a retention or partial retention objective).

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[45] Linnell Nemec, A.F. 2002. Predicting visual impacts of variable retention harvesting. Report to Forest Practices Branch, Ministry of Forests.

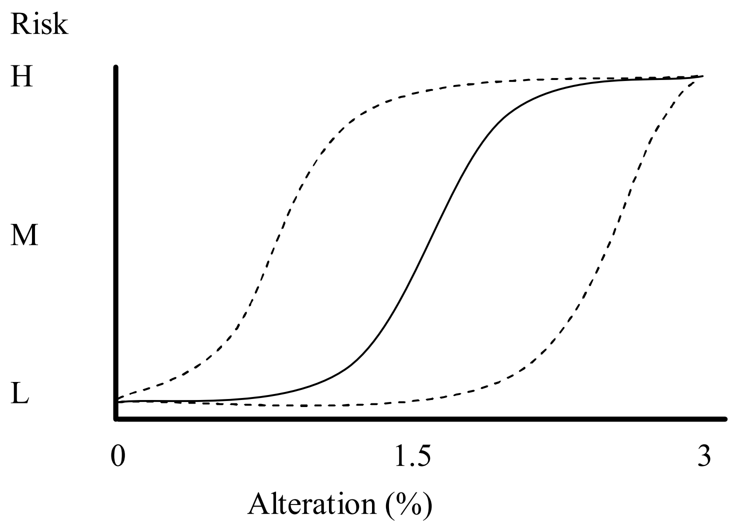

Figure 11.1. Risk to the retention objective versus percent alteration. Uncertainty shown with dashes.

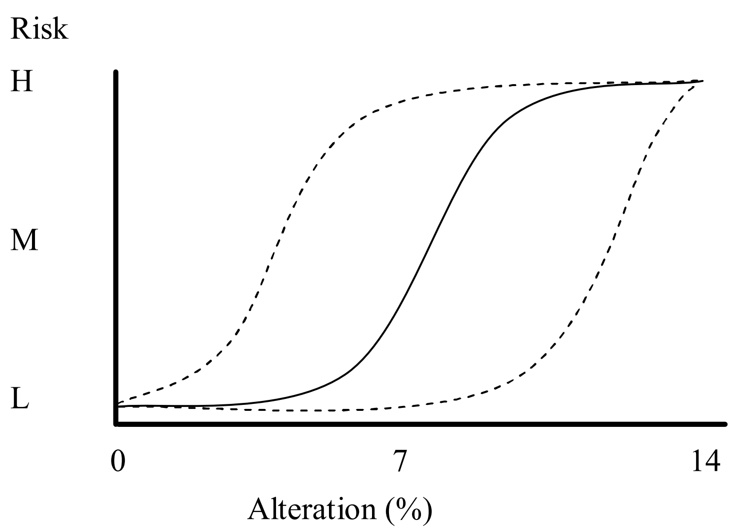

Figure 11.2. Risk to the partial retention objective versus percent alteration. The solid line indicates good block design and approx. 15% in-block retention. The upper confidence line represents either poor design or little in-block retention. The lower line represents good design and high in-block retention (about 25%).

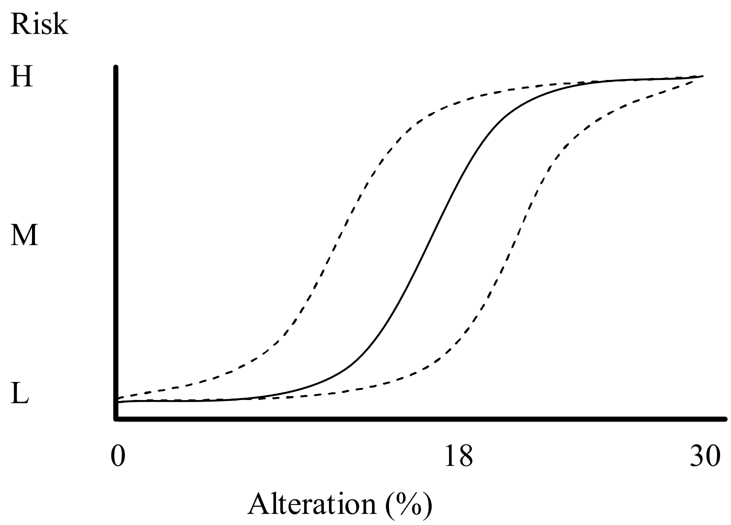

Figure 11.3. Risk to the modification objective versus percent alteration. Uncertainty shown with dashed line.

Additional uncertainty (not shown on the graphs) is associated with road design: for example, road cuts and large landings can be obvious. Minor uncertainty exists about the tree height perceived to provide visually effective greenup.

Available Data (Question 6)

No current or future indicator data are available for any objective in the Kispiox or Bulkley (Table 11.2). Although guidebooks provide information about ranges of alteration that are likely to achieve objectives, no alteration targets are specifically identified in land-use plans. Because visual impact assessments are typically conducted, current and future risks are assumed low. **Moderate priority** for collecting current and future indicator data.

Table 11.2. Current and future indicator values (when known) for alteration in retention, partial retention and modification VQOs.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Bulkley	Unknown	--	Unknown	--
Kispiox	Unknown	--	Unknown	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 11.3) are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 11.3. Current and future risk and uncertainty for retention, partial retention and modification VQOs.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Bulkley; retention and partial retention	Low *	High	Low *	High
Bulkley; modification	Low *	High	Low *	Medium
Kispiox; retention and partial retention	Low *	High	Low *	High
Kispiox; modification	Low *	High	Low *	Medium

* Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Methods for assessing alteration and design quality are well established. Alteration targets can be based on guidebooks.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to mapped scenic areas and established visual quality objectives (discussed under uncertainty about achieving goal): **easy - moderate**.

Rationale: Requires surveys of users (e.g., at fishing spots and campsites along Babine River) to determine if important viewpoints have been identified.

Uncertainty related to varying public perceptions (discussed under uncertainty about achieving goal): **moderate to very difficult**.

Rationale: Public perception has already been studied; perception varies among user groups; improving the general relationship will be very difficult, however, it may be possible to develop more accurate profiles for specific user groups.

Uncertainty related to "visually-effective green-up": **probably unnecessary**.

Rationale: Would require study of perceptions of landscapes with similar visual quality but different ages (or heights) of regenerating stands, however, this uncertainty is minor.

Uncertainty related to influence of roads: **moderate.**

Rationale: Requires study of perceptions of landscapes with similar alteration and cutblock design but different road patterns.

Uncertainty related to cutblock design and in-block retention: **probably unnecessary.**

Rationale: Report used to create risk curves already assess various cutblock design variables; difficult to get better estimates.

Ease of Detecting Negative Consequences (Question 17)

Easy – moderate.

Rationale: Established methods can be used to determine whether visual quality objectives have been met; surveys of users can further assess effectiveness.

Objective: Maintain Scenic Resources in Atna/Shelagyote SMZ

Land-use Plan Summary

The SRMP contains an objective to maintain provincially-significant scenic resources in the Atna/Shelagyote SMZ.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Moderate.

Rationale: Atna/Shelagyote SMZ is of secondary importance as a recreation destination (Table 11.1).

Recovery Period for Objective (Question 4)

Moderate.

Rationale: Visual quality recovers when cutblocks achieve "visually effective green-up" (approx 20 to 30 yr after harvest.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether resource development maintains scenic resources in the Atna/Shelagyote SMZ. Indicators in the Kispiox SRMP include

- amount of development activity in the Atna/Shelagyote SMZ

Risk to scenic value in the Atna/Shelagyote SMZ increases as visual quality (from any viewpoint along a route) decreases. This curve is based on the curve derived for the Babine River Corridor (see Maintain Opportunities for Tourism and Recreation). Visual quality ratings can be roughly translated into amount of development activity, assuming that good visual design principles will be used and that only 50% of development will be visible as alteration from viewpoints. Uncertainty is low at low and high risks and high at moderate risk.

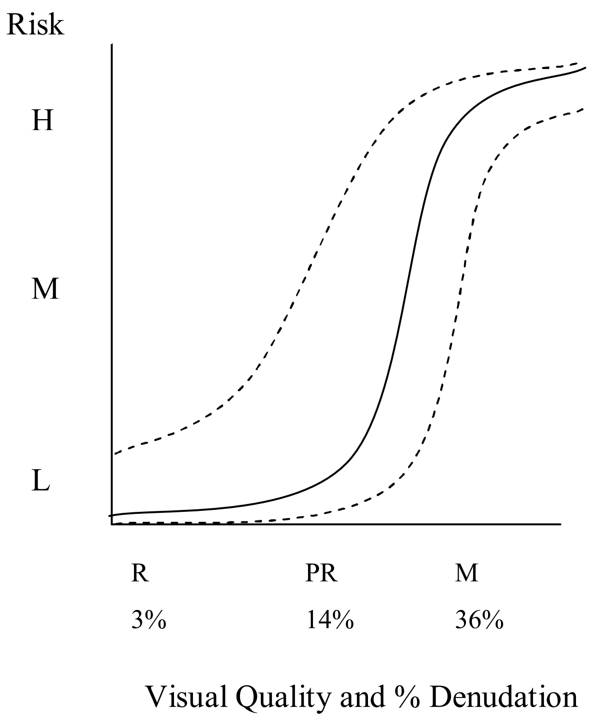

Figure 11.4. Risk to scenic resources in the Atna/Shelagyote SMZ as a function of visual quality class and development (% of area denuded).

Available Data (Question 6)

No current indicator values are available for the Kispiox (Table 11.4; objective does not apply to Bulkley). Estimated current risk is low based on visual inspection of maps. **Moderate priority** for collecting current indicator data. The indicator target is no development. Some uncertainty exists around the future indicator value because the no development target does not strictly apply to mineral development.

Table 11.4. Current and future indicator values (when known) for development the Atna/Shelagyote SMZ.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Kispiox	Unknown	--	0	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 11.5) are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 11.5. Current and future risk and uncertainty for alteration in retention VQOs.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Kispiox	Low *	Low	Low	Low

* Estimated

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy.

Rationale: Development is shown on maps.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to perceptions of visual impact: **moderate-very difficult**.

Rationale: Requires study of perceptions of landscapes with different types and levels of development; because perceptions vary, may be impossible to further reduce uncertainty. It may be possible to develop more accurate profiles for specific user groups.

Ease of Detecting Negative Consequences (Question 17)

Easy – moderate.

Rationale: Established methods can be used to assess visual quality; surveys of users can further assess effectiveness.

Objective: Maintain the Aesthetic Quality of the Babine River Corridor

This objective is discussed under the Maintain Opportunities for Tourism and Recreation goal.

12. Goal: Maintain and Use Botanical Forest Products

Information Sources and Updates

Drafted: Dave Daust and Karen Price, November 2004, based on interviews with Phil Burton[46] and Doug Donaldson[47].

Reviewed: Marty Kranabetter[48] and Phil Burton December 2004.

Updated:

Land-use Plan Summary

The Kispiox LRMP includes the goal to maintain and use botanical forest products. The Kispiox SRMP includes objectives to maintain high-value pine mushroom sites and to maintain or enhance the productivity of berry habitat within berry management areas. An objective in the Kispiox LRMP to maintain sites that are important for medicinal plants falls under another goal: Conserve and Respect Cultural Heritage. The Bulkley LRMP and LUPs do not address botanical forest products.

Overview of Current Knowledge Relating to Goal

Edible mushrooms and wild berries are two of several classes of botanical forest products (Table 12.1). Pine mushrooms (*Tricholoma magnivelare*) and black huckleberries (*Vaccimium membranaceum*), in particular, are important crops in the Babine River Watershed for local Gitxsan and non-Gitxsan residents.

High-productivity pine mushroom sites occur frequently in mature forest stands (> 75 years)[49] with submesic soil moisture and poor-medium soil nutrients (01b sites in the ICHmc1 and mc2)[50]. The extent of submesic habitat in the ICH, as determined through air photo interpretation, ranges from 4 to 20% of the forested landscape. Clearcut logging produces unsuitable conditions for pine mushroom colonization of tree roots and fruiting. Partial harvesting (any retention of mature trees) maintains mushroom fruiting but will also alter crop abundance[51].

Berry species harvested in the Kispiox include soapberry, high-bush cranberry, oval-leafed blueberry and black huckleberry; black huckleberry is particularly important. Management direction in the Kispiox SRMP pertains mainly to black huckleberries. Black huckleberry plants are most vigorous and productive in open, early seral stands, but persist in the understory of older forests (or grow vigorously in some, open, old stands). Maximum berry productivity occurs

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[46] Ecologist, Canadian Forest Service, University of Northern British Columbia, Prince George, BC
[47] Consultant, Hazelton, BC
[48] Research Pedologist, Ministry of Forests, Smithers, BC
[49] Kranabetter, J.M., Friesen, J., Gamiet, S., and Kroeger, P. 2004. Ectomycorrhizal mushroom distribution by stand age in western hemlock-lodgepole pine stands of northwestern British Columbia. Can. J. For. Res. In review.
[50] Kranabetter, J.M., R. Trowbridge, A. Macadam, D. McLennan and J. Friesen. 2002. Ecological descriptions of pine mushrooms (*Tricoloma magnivelare*) habitat and estimates of its extent in Northwestern British Columbia. Forest Ecology and Management 158:249-261
[51] Kranabetter, J.M., and Kroeger, P. 2001. Ectomycorrhizal mushroom response to partial cutting in a western hemlock-western redcedar forest. Can. J. For. Res. 31: 978-987.

at 90% exposure to sunlight; berry yield decreases significantly at exposure levels below 60% of full sunlight[52]. Pruning of woody old-growth huckleberry plants can enhance berry production.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)[53]

Moderate.

Rationale: The objectives for pine mushrooms and berries cover only a portion of potential botanical forest products. In particular, several species of mushrooms are collected commercially in the Kispiox in addition to pine mushrooms, and management direction for berries focuses mainly on black huckleberries. Additionally, the scope of the pine mushroom objective is limited to high-value sites and the scope of the berry objective is limited to berry management areas. Although other botanical forest products are not considered, the Kispiox LRMP indicates that pine mushrooms and black huckleberries have the greatest local importance, so a limited focus is somewhat appropriate.

Table 12.1 Summary of objectives and factors addressed and relative importance of each objective.

Objective Class	Factor addressed	Influence on Goal
• Maintain high-value pine mushroom habitat	wild edible mushrooms	High
• Maintain or enhance the productivity of berry habitat within berry management areas (focus on black huckleberries)	wild berries and fruits	High
	floral greenery	Medium
	herbs and vegetable products	Medium
	landscaping products	Medium
	craft products	Medium

Influence of Goal on Other Goals (Question 2)

Low.

Rationale: Principal influence is on cultural heritage. Potentially minor influences on grizzly bears (however, crops outside of berry management areas also need to be accounted for) and timber (pine mushrooms are mycorrhizal and may play an important role—yet undocumented—in maintaining timber productivity on submesic and shallow-soiled sites).

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52 Burton, P.J. 1998. Inferring the Response of Berry-Producing Shrubs to Different Light Environments in the ICHmc. Final Report to Forest Renewal B.C. for Project Number SB96030-RE , Symbios Research & Restoration, Smithers, B.C. 44 p.

53 Questions refer to Procedures for Monitoring Framework

Objective: Maintain High-value Pine Mushroom Sites

Land-use Plan Summary

The Kispiox SRMP includes the objective to maintain high-value pine mushroom sites and a single strategy to maintain a minimum amount of mature (> 80 yr), high value pine mushroom sites (01b sites in the ICHmc1 and ICHmc2).

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Equivalent to other objective.

Rationale: Pine mushrooms grow only in certain parts of BC and bring higher economic returns than other botanical forest products (and than timber over a rotation). Pine mushrooms are an important component of the local economy.

Recovery Period for Objective (Question 4)

Moderate.

Rationale: Mushroom sites take approximately 75-100 years to recover following denudation.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty target amounts of 01b site series (ICHmc1 and mc2) in a mature forest condition will maintain high value pine mushroom sites over time.

Indicators in the land-use plans include

- % of 01b site series (ICHmc1 and mc2) older than 80 years.

Assuming a relatively distinct productive window (80 – 200 yr), a 200-year disturbance interval provides the maximum amount of mushroom habitat over the long term. A 200-year disturbance interval (i.e., average ½ % per year natural plus human disturbance) leaves 60% of the forest greater than 80 years old.

Risk to mushroom productivity (on high-value sites) increases when the amount of mature forest (> 80 yr) on 01b site series falls below the 60% optimum as calculated above (Figure 12.1). Partial harvests of less than 50% should still be counted as mature forest (alternatively, the value of partial harvests could be based on volume retained).

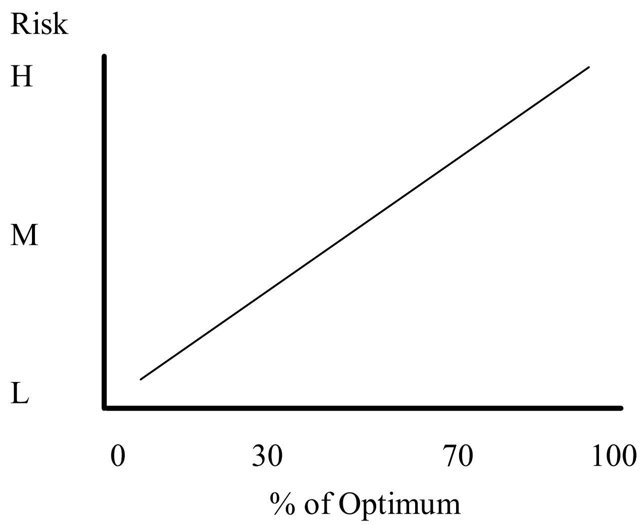

Figure 12.1 Risk to pine mushroom productivity versus percentage of optimum amount of mature 01b sites.

The limited scope of the indicator, the assumed productivity-window, map inaccuracy and potential site damage from harvesting leads to moderate uncertainty. First, the indicator does not actually determine how much forest exists within the optimum age class (80 – 200 yr.), because it does not account for old, low productivity forest (> 200 yr). Harvesting strategies may target mature stands rather than old stands, keeping > 60 % over 80 yr., but not keeping much forest < 200 yr. Second, uncertainty exists because non-mature forests (i.e., < 80 yr. or > 200 yr.) can still produce mushrooms. In particular, the upper-limit for pine mushroom productivity may be closer to 250 yr. and the lower limit closer to 75 yr.[54] (yielding an optimum long-term age class of 70% > 75 yr.). Third, uncertainty about the extent and location of 01b site series of appropriate age arises because of the methodology used to map site series (predictive ecosystem mapping) and uncertainty in stand ages. Fourth, some mushroom harvesting practices may affect mushroom productivity. Note that uncertainty due to the limited scope of the objective (only 01b sites) is considered under uncertainty relating to the goal above.

Available Data (Question 6)

No data describe current indicator values in the Kispiox (Table 12.2; indicator does not apply to Bulkley). **High priority** for data collection in the Kispiox.

Table 12.2 Current and future indicator values (when known) for percent of optimum amount of mature 01b sites.

	Current Indicator Value	Current Source	Future Indicator Value	Future Source
Kispiox	Unknown	--	100%	SRMP

[54] Kranabetter, J.M., Friesen, J., Gamiet, S., and Kroeger, P. 2004. Ectomycorrhizal mushroom distribution by stand age in western hemlock-lodgepole pine stands of northwestern British Columbia. Canadian Journal of Forest Research. In review.

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 12.3) are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 12.3 Current and future risk and uncertainty for ECA.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Kispiox	Unknown	--	Low	Moderate

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy to moderate.

Rationale: Requires GIS analysis of PEM and age-class data for a rough estimate; field verification of PEM would provide more accurate results; some photo interpretation of submesic habitat is underway[55].

Ease of Improving Risk Curve (Question 16)

Uncertainty related to limited scope of the indicator (i.e., it only considers forest < 80 yr.): **easy**

Rationale: GIS analysis can calculate amount of forest between 80 and 200 yr.

Uncertainty related to productivity of non-optimum ages (i.e., < 80 and > 200 yr.) and sites series (i.e., not 01b): **easy to moderate**

Rationale: Considerable information exists[56]; requires further study of productivity in older forests and other site series.

Uncertainty related to inaccurately mapped site series and stand ages: **moderate**

Rationale: Requires field verification of site series and stand ages; some photo interpretation of submesic habitat is underway.

Uncertainty related to mushroom harvesting practices: **moderate to difficult**

Rationale: Requires controlling the amount, type and intensity of harvesting and assessing mushroom productivity. Lack of regulations makes such control difficult.

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[55] Personal communication Marty Kranabetter, Ministry of Forests, Smithers, BC.

[56] Kranabetter, J.M., Friesen, J., Gamiet, S., and Kroeger, P. 2004. Ectomycorrhizal mushroom distribution by stand age in western hemlock-lodgepole pine stands of northwestern British Columbia. Canadian Journal of Forest Research. In review.

Ease of Detecting Negative Consequences (Question 17)

Difficult.

Rationale: Assessing declines in mushroom productivity as a result of mushroom harvesting requires field sampling that controls mushroom harvest intensity. Stochastic variation in crops among years makes such studies difficult. Secure monitoring sites (free of undocumented harvesting) are also difficult to arrange.

Objective: Maintain or Enhance Productivity of Berry Habitat Within Berry Management Areas

Land-use Plan Summary

The Kispiox SRMP includes the objective to maintain or enhance the productivity of berry habitat within berry management areas. It includes strategies to expose at least 60% of each cutblock within berry management areas to high levels of sunlight, and to minimise disturbance of soils and vegetation. It also includes an indicator measuring the productivity of berry shrubs; this indicator is an effectiveness indicator and inappropriate for use as an X-variable in risk curves (because it is not a measurable strategy).

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Equivalent to other objective.

Rationale: Berries have high importance to local communities and a high cultural significance as well as being important to wildlife. (Table 12.1).

Recovery Period for Objective (Question 4)

Short to moderate.

Rationale: harvesting appropriate sites can create new berry habitat fairly rapidly; burning can re-invigorate existing habitat.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to provide sunlight on harvested sites and to limit site disturbance will maintain or enhance berry productivity, within berry management areas.

Indicators in the land-use plans include

- % of cutblock exposed to full sunlight (in berry management areas)
- % of cutblock with soil or vegetation disturbance (in berry management areas)

Risk to berry productivity decreases as the percentage of the cutblock exposed to full sunlight increases (Figure 12.2). The curve is sigmoidal indicating that full productivity can occur in less than full sunlight and that productivity remains minimal over a range of low light conditions. This curve represents an average over all cutblocks. Following disturbance, a site provides suitable huckleberry habitat until canopy closure. Long-term berry management suggests that harvesting should create an even-flow of berry habitat.

Uncertainty is moderate. Other factors such as site type, aspect and disturbance type (e.g., burn) influence berry production. Access influences ease of use.

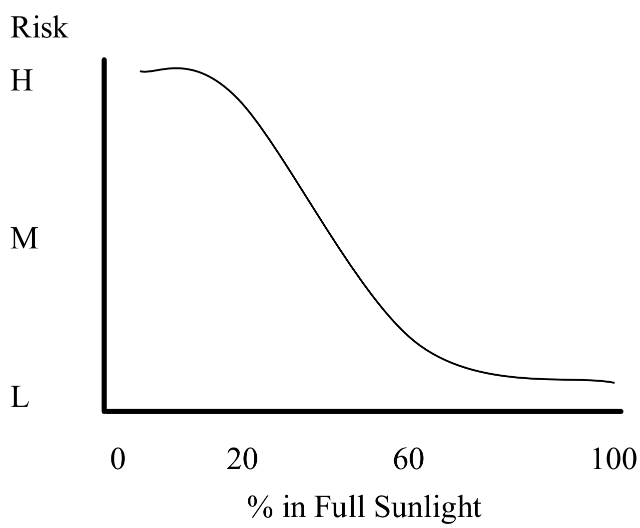

Figure 12.2 Risk to berry productivity versus percentage of cutblock in full sunlight.

Risk to berry productivity increases in direct proportion to the area disturbed(Figure 12.3).

Uncertainty is moderate. Other factors such as site type, aspect and disturbance type and severity (e.g., intense burn) influence berry production. Brushing treatments damage berry plants. Loss of vegetation may be temporary, followed by recovery of berry plants[57]. Access influences ease of use.

[57] Haeussler, S., D. Coates, and J. Mather. 1990. Autecology of Common Plants in British Columbia: A Literature Review. FRDA Report 158. Forestry Canada and B.C. Ministry of Forests, Victoria, B.C. 272 p.

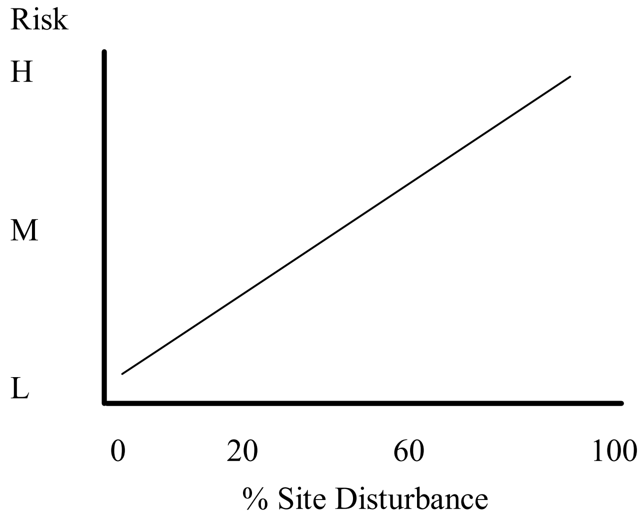

Figure 12.3 Risk to berry productivity versus percentage of cutblock with soil or vegetation disturbance.

Available Data (Question 6)

No data describe current indicator values in the Kispiox (Table 12.4 - Table 12.5; indicator does not apply to Bulkley). The Kispiox SRMP provides a target only for full sunlight. **High priority** for collecting current indicator values in the Kispiox and for establishing future targets for soil and vegetation disturbance.

Table 12.4 Current and future indicator values (when known) for percent of cutblock in full sunlight.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Kispiox	Unknown	--	60%	SRMP

Table 12.5 Current and future indicator values (when known) for percent of cutblock with soil or vegetation disturbance.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Kispiox	Unknown	--	Unknown	--

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 12.6 - Table 12.7) are based on the indicator data and the current knowledge about risk and uncertainty as described above.

Table 12.6 Current and future risk and uncertainty for percent of cutblock in full sunlight.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Kispiox	Unknown	--	Low	Moderate

Table 12.7 Current and future risk and uncertainty for percent of cutblock with soil or vegetation disturbance.

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Kispiox	Unknown	--	Unknown	--

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Easy for percent of cutblock in full sunlight**.**

Rationale: Requires either GIS analysis of block size or more sophisticated analysis that also includes slope and aspect from digital elevation model.

Easy for percent of cutblock with soil or vegetation disturbance**.**

Rationale: Requires straight forward field sampling; soil disturbance should fall within targets prescribed in forest stewardship plans.

Ease of Improving Risk Curve (Question 16)

Uncertainty related to other factors such as site type, aspect and disturbance type: **easy – moderate**.

Rationale: Requires estimates of productivity and a field study with stratification and several replicates.

Ease of Detecting Negative Consequences (Question 17)

Moderate.

Rationale: Reports of picking success (litres/hour) and visual estimates could provide a rough estimate of productivity.

13. Goal: Maintain Opportunities for Mineral and Energy Development

Information Sources and Updates

Drafted: Dave Daust and Karen Price, November 2004.

Reviewed:

Updated:

Land-use Plan Summary

The Kispiox and Bulkley LRMPs contain goals to maintain opportunities for mineral and energy development. Access to mineral resources outside of protected areas is provided for under the Mineral Tenures Act. The Kispiox SRMP contains the objective to provide certainty of access for exploration and development (with consideration of other resource values).

Overview of Current Knowledge Relating to Goal

Mineral and energy potential ranges from moderately-high to very-high in the Kispiox portion of the Babine River Watershed. Mineral potential is mostly moderate in the Bulkley portion, with some high and low. Protected areas are unavailable for development. Road access increases ease of exploration.

Information to Assess Goal

This section provides two types of information about the goal. Uncertainty about achieving the goal is used to determine the need for studies that are broader in scope. Influence of goal on other goals contributes to the secondary monitoring score for each objective.

Uncertainty About Achieving Goal if Objectives are Achieved (Question 1)

Low.

Rationale: The objective to provide certainty of access maintains opportunities for development.

Influence of Goal on Other Goals (Question 2)

Low.

Rationale: Mineral development may have a minor positive impact on forestry by providing increased access. Increased access may either positively or negatively influence recreation and tourism.

Objective: Provide Access for Exploration and Development

Land-use Plan Summary

The Kispiox SRMP includes the objective to provide certainty of access for exploration and development (with consideration of other resource values). Although the Bulkley LUPs do not provide specific objectives, this access objective is implied by the Mineral Tenures Act and hence applies to the Bulkley also.

Information to Assess Objective

This information, together with information assessing the goal, determines the secondary monitoring score for each objective.

Relative Influence of Objective on Goal (Question 3)

Sole objective.

Rationale: Access to the landbase is one of the key factors affecting exploration and development opportunity.

Recovery Period for Objective (Question 4)

Short.

Rationale: Access recovers immediately when land alienation is reversed.

Information to Determine Monitoring Priority for Objective Based on Risk and Uncertainty

This information, based on the risk and uncertainty associated with the relationship between indicators and the objective, determines priority for monitoring to

- collect indicator data,
- improve the risk relationship and
- detect consequences.

Overview of Current Knowledge of Risk and Uncertainty

Effectiveness monitoring asks whether strategies to maintain access to all crown land outside of protected areas will provide sufficient access for exploration and development.

Indicators in the land-use plans include

- % of crown land available for exploration and development

Risk to access for exploration and development increases as the percent of crown land available for exploration and development decreases (Figure 13.1). Uncertainty is low. Some minor uncertainty exists because road density influences ease of access, but it is not a strict limitation.

Figure 13.1 Risk to exploration and development versus percentage of landbase accessible.

Available Data (Question 6)

The Babine River Corridor Park is the only protected area in the Babine River Watershed. It covers a similar proportion of the Kispiox and Bulkley sides, thus, one indicator is used for both sides (Table 13.1). The future indicator value is assumed to be the same as the current; although protected areas may be added or rules preventing exploration in protected areas may change, it is highly unlikely that risk will increase to medium (i.e. > 33% of area unavailable). Hence uncertainty remains low.

Table 13.1. Current and future indicator values (when known) for percentage of landbase accessible.

	Current		Future	
	Indicator Value	**Source**	**Indicator Value**	**Source**
Kispiox and Bulkley	96.3%	SRMP, LUPs, MDS	96.3%	SRMP, LUPs, MDS

Estimated Current and Future Risk and Uncertainty (Questions 7 – 8)

Risk estimates (Table 13.2) are based on the indicator data and the current knowledge about risk and uncertainty described above.

Table 13.2. Current and future risk for percentage of landbase accessible..

	Current		Future	
	Risk	**Uncertainty**	**Risk**	**Uncertainty**
Kispiox	Low	Low	Low	Low

Information to Assess Costs and Benefits of Monitoring Projects

Benefits of monitoring are determined by the monitoring priority—for collecting missing indicator data, for improving risk curves or for detecting consequences—and by secondary monitoring score. General costs are estimated by the ease of collecting indicator data, or of monitoring to improve the risk curve or to detect consequences. Relative benefits are calculated

using the information provided in the sections above; the information below gives preliminary costs.

Ease of Collecting Indicator Data (Question 15)

Unnecessary.

Ease of Improving Risk Curve (Question 16)

Unnecessary.

Rationale: Existing curve has very low uncertainty.

Ease of Detecting Negative Consequences (Question 17)

Easy to moderate.

Rationale: Requires surveys of exploration effort.

14. Goal: Maintain Opportunities for Agriculture and Range Use

Information Sources and Updates

Drafted: Dave Daust and Karen Price, November 2004.

Reviewed:

Updated:

Land-use Plan Summary

The Kispiox LRMP contains goals to conserve range resources and to maintain and enhance range use. It includes the goal to maintain and enhance agriculture use of crown land within the Agricultural Land Reserve. The Bulkley LRMP contains the weaker goal of encouraging full use of existing range tenures. It includes a goal to promote agricultural development. No objectives pertain to range use or agriculture in the SRMP or LUPs, because these resource uses do not occur there.

Overview of Current Knowledge Relating to Goal

No agricultural or range land occurs in the Babine River Watershed. The Kispiox LRMP shows a small area of potential agricultural land occurring at the old village site of Kisgegas in the Babine River Watershed, however, decisions about appropriate use of this land rest with Gitxsan Houses. The Bulkley LRMP shows no suitable agricultural land in the Babine River Watershed, considering the Agricultural Land Reserve and other factors. No range tenures occur in the Kispiox or Bulkley portions of the Babine River Watershed.

If agriculture or range use occurs in the Babine River Watershed in the future, objectives and strategies should be developed.

15. Goal: Maintain Special Areas, Features and Species

Information Sources and Updates

Drafted: Dave Daust and Karen Price, November 2004.

Reviewed:

Updated:

Land-use Plan Summary

Legislation (Government Actions Regulation) allows representatives of the Ministry of Forests, Ministry of Water Land and Air Protection and the Ministry of Sustainable Resource Management to identify areas (e.g., wildlife habitat areas, lakeshore management zones), features (e.g., mineral licks, recreation trails, permanent sample sites) or species (e.g., species at risk, ungulates) that have special ecological or resource value. For some areas, features and species, specific objectives or guidelines can be created. Land-use plans do not contain goals to maintain special areas, features or species; however, many special areas, features and species fall under broad goals specified in land use plans (e.g., maintain biodiversity, maintain wildlife, maintain opportunities for tourism and recreation)

Overview of Current Knowledge Relating to Goal

Currently, the only special areas identified in the Babine River Watershed are scenic areas with visual quality objectives (see the Maintain Visual Quality in Scenic Areas goal).

16. List of Acronyms

BARC	Bulkley Aquatic Resources Committee
BEC	Biogeoclimatic Ecosystem Classification System
ECA	Equivalent Clearcut Area
ETD	Enhanced Timber Development Area
FRPA	Forest and Range Practices Act
GIS	Geographic Information System
LRMP	Land and Resources Management Plan
LUP	Landscape Unit Plan
MDS	Management Direction Statement
NSR	Not Suitably Restocked
SMZ	Special Management Zone (Kispiox)
SM1	Special Management Zone: Type 1 (Bulkley)
SM2	Special Management Zone: Type 2 (Bulkley)
SOFR	State-of-the-Forest Report
SRMP	Sustainable Resource Management Plan
PEM	Predictive Ecosystem Mapping