Environmental Risk Assessment: Base Case

COARSE FILTER BIODIVERSITY

FINAL REPORT SUMMARY

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Executive Summary

An Environmental Risk Assessment (ERA) was performed for the North Coast LRMP planning area, in order to assess the implications of the current forest management scenario (the 'Base Case') on coarse filter biodiversity values.

ERA involves a number of general tasks, in particular

- identifying appropriate indicators for the environmental value
- identifying an ecological benchmark against which risk can be measured
- identifying risk relationships and thresholds
- and summarising trends through time

We use the abundance and extent of old forest (>250 years) ecosystems, by ecosystem type, as our basic indicators of the probability of maintaining coarse filter biological diversity, ecosystem function and ultimately ecological integrity in the planning area over time. These were considered appropriate indicators for the planning landscape because the natural disturbance patterns in the North Coast LRMP area primarily result in old forest dominating the landscape.

In order to identify an ecological benchmark, we predict the mean and standard deviation in stand-replacing natural disturbance frequency based on the current seral stage frequency of Analysis Units in the North Coast area, combined with expert opinion where data are lacking (A. Banner and J. Pojar pers. comm.). The negative exponential equation was then used to predict the mean (and range) percent of old forest that would occur naturally in these ecosystems. Sensitivity analysis shows that predicted old forest abundance is relatively insensitive to variation in stand-replacing disturbance frequency within the range of estimates considered appropriate for these ecosystems (700 – 3000 years).

Output from NC Landscape Model (SELES; D. Morgan et al. 2002) was used to provide data on the projected abundance and distribution of old forest within different ecosystems (defined by Analysis Units within biogeoclimatic variants), through time from 0 – 250 years. Comparing predicted natural abundance of old forest within ecosystems to that from the modeling scenario at each time period is our primary indicator of risk for each ecosystem.

We further modify this base risk level for each ecosystem as appropriate by three factors: Representation of Ecosystems in Protected Areas, Ecosystem Conservation Value (a relative value identifying analysis units with higher potential for rare ecosystems or higher influence on surrounding ecosystems etc.), and Trends in area covered by Old Large Forest Patches through time. Precise relationships between risk and each of these modifiers are poorly documented. However, there is extensive theoretical rationale to support the concept that each of these factors does in fact modify levels of risk to coarse filter biodiversity. We used what we considered to be conservative ratings to modify risk.

For each modifier, patterns were examined for that variable, and risk modified as appropriate:

a) poor ecosystem representation in Protected Areas in the North Coast (most ecosystems have <2% representation) resulted in higher risk. Lack of Protected Areas results in a lack of certainty about future protection, (being located outside the current timber harvesting landbase does not afford certain future protection), and fails to provide representative and reference ecosystems;

b) large changes in the numbers of large old forest patches through time resulted in higher risk. The area of forest covered in large (>500ha) old forest patches declined by more than 30% (moderate change) or 70% (large change), for approximately 2/3rd of the ecosystems. Although the links between patch size/ fragmentation and ecological integrity are unquantified, there is evidence that vertebrate species are adapted to natural disturbance patterns (Bunnell 1995), and so a substantial decline in numbers of large patches will likely result in increased risk to ecological integrity;

c) impacts on high value ecosystems resulted in higher risk. Ecosystem Conservation Values were assigned to ecosystems and risks modified for those with high designations (high ECV is a combination of high probability for unique/ rare systems and high likelihood of influence on other ecosystems e.g. the hydroriparian types).

Identifying risk thresholds is a key element of any risk analysis. As a base set of thresholds, we interpreted percent deviation from natural (0 –100%) to correspond linearly to 5 equal risk classes from very low to very high (0-20% deviation is considered very low risk; 80-100% deviation is considered very high risk). Sensitivity analyses for this model showed that the risk outputs were quite insensitive to the risk categories used. This gives us increased confidence in the relative risk rankings estimated from the assessment model.

Modeling techniques used include graphical assessment of trends of old forest abundance through time, in addition to a modeling process using a Bayesian Belief Network Model (BBN). The BBN allowed us to incorporate expert opinion and uncertainties into the model, and also presents output in terms of probabilities. This approach will be useful in assessing future scenarios (as the Table develops them) likely including the implications of partial harvesting for coarse filter biodiversity.

Overall, there was high divergence from the naturally predicted percent of old forest both currently and into the future, for all high productivity ecosystems, and for most medium productivity ecosystems. There was little or no deviation from predicted natural abundance of old forest for low productivity ecosystems. We interpret the extent of the deviation from natural for the high and medium productivity systems to indicate that most of these units are at high risk, and that the risk increases through time. The number of ecosystems considered at high risk using the Base Risk scenario was 8 of 47 at time zero, and 19 of 47 in 250 years. Using Modified Risk the number of ecosystems at high risk at time zero was 9 of 47 and 24 of 47 after 250 years.

This work was performed as one component of a team approach to ERA on the North Coast. Background on the team can be found in the Introductory Report (Reid and Holt 2002).).

This summary report is designed to provide a summary of key elements of this work, and particularly builds on a draft report released for comment in September 2002. A full final report is also available (Holt and Sutherland 2003).

1.0 Introduction

Management to maintain general environmental values such as ‘biodiversity’ and ‘ecosystem function’ generally uses what is known as a ‘coarse filter’ approach. ‘Coarse filters’ are used primarily because it is not possible or even desirable to attempt to manage all species individually – numbers of species are too numerous and the vast majority of species and their requirements are unknown in most ecosystems. A number of approaches to designing a coarse filter strategy have been developed, for example using a wide-ranging species such as a grizzly bear to act as an ‘umbrella’ or ‘focal’ species. However, using representative ecosystems as the basis for a coarse filter strategy is perhaps the best supported approach (Franklin 1993; Noss 1996a, b; Nally et al. 2002).

In this Environmental Risk Assessment (ERA), we use the abundance, extent of representation and landscape patterning of old forest ecosystems as our basic indicators of the probability of maintaining coarse filter biological diversity, function and ultimately ecological integrity in the North Coast Land and Resource Management Plan (LRMP) area.

The goal for this “Base Case[1]” ERA is to identify the risks to coarse filter biodiversity associated with the current management scenario planned for the North Coast (the Base Case scenario), through the planning horizon from now (Time 0) to 250 years into the future (Time 250) and for different locations in the plan area (e.g. Landscape Units, Analysis Units and BEC variants). For the coarse filter biodiversity assessment we use outputs from the timber supply model used for the ERA Base Case to determine how much, where and which old forest ecosystems are present on the landscape today and may be present in the future if current management continues.

In order to determine the risks associated with the harvest of different areas of the landscape, we predict how much of each forest ecosystem would be present under ‘natural’ conditions, and use this as a benchmark against which to reference how divergent the current and future landscapes are from a natural condition. We will interpret the current and projected trends in old forest through time in terms of the risk levels, presented as very low to very high.

The ‘risks’ presented and discussed in this report are the risks that ecological integrity will not be maintained in the geographic area, and <u>are not</u> to be translated as ‘acceptable’ or ‘unacceptable’ levels of risk.

2.0 Methodology Outline

The detailed methodology is found in the full report (Holt and Sutherland 2003).

Following the approach outlined by others (MoE 2000; Utzig and Holt 2002), the ERA for Coarse Filter Biodiversity involves the following specific steps:

- Identify appropriate indicators and project their abundance and distribution through time.
- Identify the natural benchmark for the comparison for each ecosystem (based on ‘range of natural variability’ – RONV).
- Identify appropriate risk classes for interpreting the deviations between ‘natural’ conditions and projected future trends.
- Examine trends in old forest abundance for each ecosystem through time in relation to mean predicted natural levels of old forest – using a static analysis of current data and projected values for indicators.

[1] We have worked with ecological experts (A. Banner and J. Pojar) to identify recovery curves for individual ecosystems that will be used in assessing the implications of partial harvest in future scenarios.

- Combine the basic projected outcomes for amounts of old forest with additional parameters (e.g. patch metrics, ecosystem recovery, younger forest in protected areas) – using static analysis and BBN models.
- Summarise results and repeat for each scenario (as developed by the Table in future).

A previous version of this report was released as a draft in September 2002. As a result of comments from external reviewers, part of the ERA Team (A. Banner, J. Pojar, D. Reid, D. Steventon, D. Morgan) reconvened with a number of reviewers to determine solutions to various data and model issues:

Two types of changes were made:

1. External Input Changes

a. Range of Natural Variability. In the Draft Report, the base units for application of natural disturbance types were applied by biogeoclimatic variant. However, after review, and on the basis of Dorner and Wong (2003), the ERA team determined it would be more ecologically appropriate to identify natural disturbance units on the basis of Analysis Units because these better reflect physiogeographic units, which change disturbance intervals. The methodology used to produce the disturbance rates was similar in each process. A comparison of the Current and Draft disturbance intervals are shown in the table below.

CURRENT UNITS:	Range of Mean disturbance intervals	General Description
AU: CH High, HB High, S High, Cottonwood,	600 – 800	Floodplain/ productive on steep ground/ cottonwood
AU: S Medium, S Low, HB Medium	900 – 1100	Moderate productivity Upland
AU: CH Low; CH Medium, HB Low, Pine	1500 – 5000	Other Upland
PREVIOUS DRAFT UNITS:	Mean and SD (years) Disturbance intervals	General Description
BEC: CWHvh2	3027 +/- 1323	Hecate Lowland
BEC: CWHvm; CWHvm1; CWHvm2; CWHws1; CWHws2	892 +/- 145	Kitimat Ranges
BEC: ESSFwv; MHmm1	858 +/- 65	Kitimat Ranges
BEC: MHmm2	3088 +/- 1214	Hecate Lowland, higher elevation

Implications of change: altering application of disturbance intervals results in changed risk for individual units (e.g. high productivity units within the CWHvh2 would now have lower risk because of the application of disturbance intervals by AU). However, the overall number of ecosystems in each risk category did not change substantially because all disturbance intervals considered reasonable for the North Coast are relatively high and result in relatively high predicted levels of old forest (>66% < 93%). Units that have or are being harvested often retain considerably less old forest than either of these values, so tend to result in high risk whichever value is used.

b. **Forest Cover Data.** During the work of the ERA team, it was determined that problems with the base Forest Cover layers were resulting in interpretation difficulties for levels of risk for some ecosystems. In particular, it is well recognised that the projected age of some forest cover types is incorrect (A. Banner pers. comm.). The methodology for assigning forest cover ages is to use photo-interpretation associated with field checks. However, in the past, this work has focused on productive stands in the timber harvesting landbase, and has been less concerned with non-commercial stands outside the timber harvesting landbase. Examination of the forest cover data suggested that a substantial area of the landbase was incorrectly labeled as age class 7 and 8 (between 120 and 250 years in age), when this is extremely unlikely – in fact the forest stands are likely in excess of 500 or 1000 years old but are generally scrubby and without a closed canopy, and so have been identified as 'younger' by photo-interpreters. Although a known problem, efforts to fix this problem have been slow because this part of the landbase is outside the timber harvesting landbase. However, in our analysis, it is key to correctly interpret the age class of these forest types. Since it was not possible to reinventory the coast, expert opinion was used to rectify this problem as much as possible. To this end, the following data changes were made to the Forest Cover data prior to running the SELES model.

AU	Data Solution	Rationale
Cedar / hemlock – high Hemlock/ balsam – high	No data lumping	Large structured stands, usually in the THLB. Good inventory, plus easy to photo-interpret.
All Spruce All cottonwood	No data lumping	Disturbance regimes relatively frequent, so current canopy tree age most closely represents actual stand age
Cedar/ hemlock – medium Hemlock/ balsam – medium Hemlock/ balsam – low	Lump AC 8 and 9 as 9	Intermediate productivity stands: Some units have much higher apparent AC8 and lower AC9 than predicted. Difficult to photo-interpret among these age classes.
Cedar/ hemlock – low Pine	Lump AC 7, 8 , 9 as 9	Very unproductive stands. Very difficult to photo-interpret; tends to be outside THLB (so low effort)

Implications of change: in the draft report (2002), there was apparent high risk for some units that have not been harvested because the inventory said there was a low level of old forest. We did not allow the model to classify this as high risk for the obvious cases, however, we could not modify all results, so some units remained at apparent high or moderate risk even though we suspected this was due only to inventory. The inventory change resulted in this problem being fixed, and now, for all units where harvesting has not occurred, there is reasonable or good correlation between the predicted and actual amounts of old forest.

2. Internal Model Changes

a. **Increased the # of categories in % Old Forest table.** Step-by-step examination of the calculations for individual BECxAUxLU units revealed that the Aug 2002 base risks calculated by the BBN tended to jump almost discontinuously from low to high risk levels. This was caused in part by too few categories in % old forest table. As a result, high levels of uncertainty were included in the calculated divergence from RONV, resulting in higher risk (which is influenced by uncertainty). **Implications of change:** Increasing the # of categories has evened out the uncertainty and lowered risk for those affected units.

b. **Reduced uncertainty in the Base Risk tables**. The base risk calculation takes a result from an equation and assigns it to one of 5 states. In principle there are three sources of uncertainty here: 1) it is possible that errors could occur in "discretizing" the results of an calculation (especially complex calculations) ; the calculation might lead to fine-scale "peaks" or "valleys" below the level that the resolution of the discrete states can capture; and 2) uncertainty in what the discrete states should be; 3) uncertainty created by combinations of ecosystems (e.g. BECxAU) for which no probabilities are specified, but which occur in the model output. This should occur only infrequently. To deal with uncertainties 1 and 2 the model originally used the Netica defaults to assign the probabilities. However, neither of these sources of uncertainty is very high in the case of this calculation (one could reasonably argue that the calculation is perfectly certain), so in the final model total uncertainty was limited to 5% over all states. To deal with uncertainty type 3, a default state with high probabilities was specified (rather than leaving all states as possible with equal probability). **Implications of change:** Reducing uncertainties 1) and 2) reduces the probability of misclassifying risk values. Reducing uncertainty 3) may reduce risk values in rare cases where unusual combinations of ecosystems occur, but probably does not change overall results very much.

c. **Revision of Modifiers on Risk**. Both the “Ecosystem Influence” and “Biological value” tables were reviewed. Not all probabilities for the PinexBEC states had been entered (about 40%), and this would be a major reason why Pine ecosystems were given counter-intuitively moderate / high risk values in the Draft report. **Implications of change:** completing the tables results in risk levels are now much lower for pine.

d. **Presentation of Results re Partial Harvest.** In the previous version of this report, we included reference to preliminary work done to aid in assessment of partial harvesting scenarios – in particular, recovery curves were developed for each ecosystem, and included into a Bayesian Belief Network submodel. In that Sept 2002 report we did not allow these recovery curves to influence risk (since only clearcut harvest techniques were being assessed), but present the information solely as preparation for future work. However, in this final Base Case Report version we do not include the recovery work at all, in order to simplify this final report. A future report will provide the results of this work.

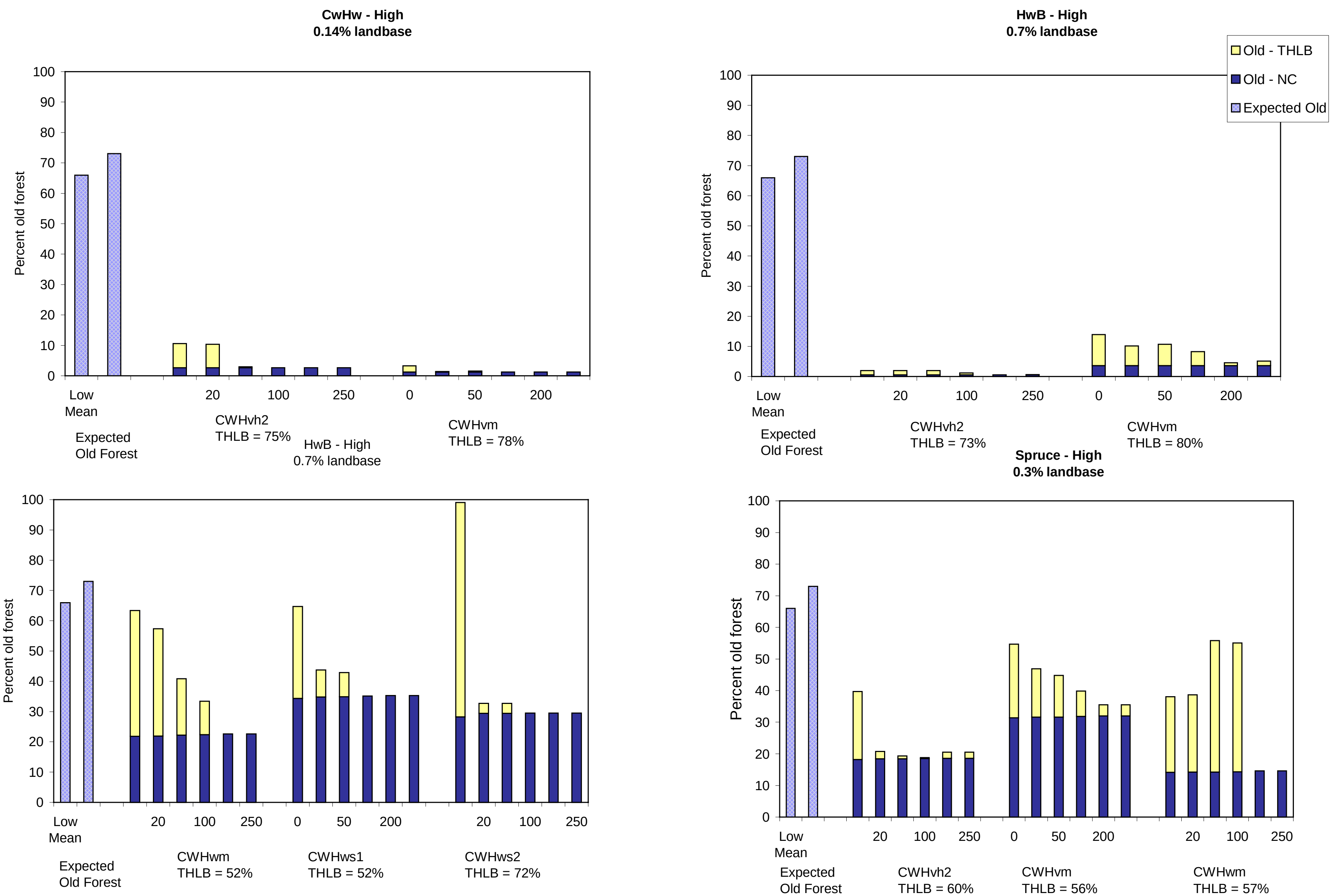
3.0 Results

Trends of projected old forest abundance through time for a selection of ecosystems are presented graphically (Figure 1) Data are shown for all high productivity ecosystems, and for typical examples of medium and low productivity ecosystems.

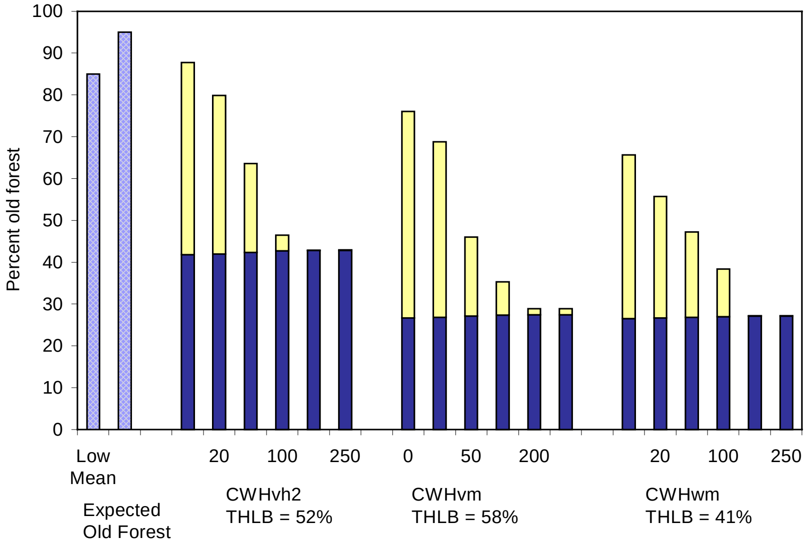
Data for individual ecosystems (AU x BEC) are summarised for the entire region (i.e. are not separated into geographically distinct areas). This approach provides a broad assessment of the ecosystems that may generally be at the highest risk through time. Multiple ecosystems are shown on each graph for brevity, grouped by Analysis Units. For each ecosystem (AU x BEC) the predicted range of old forest is compared with the current (time 0) and future (time 20, 50, 100, 200, 250 years) old forest in that unit. Old forest is further separated into two strata: (i) percent in the Timber Harvesting Landbase (THLB) and (ii) percent in the Non-contributing (NC) Landbase[2]. Because much of the landscape is physically inoperable, this separation gives an indication of physical distribution of old forest on the landbase through time. As an indication of the extent and rarity of each AU in the landscape, the percent of the AU (including all BECs) in the LRMP area is shown in each graph title.

[2] THLB – is the operable forest land base. The NC is the remainder of the forested land base excluding protected areas, and is primarily the physically and economically inoperable areas, plus other retention areas (riparian zones etc.).

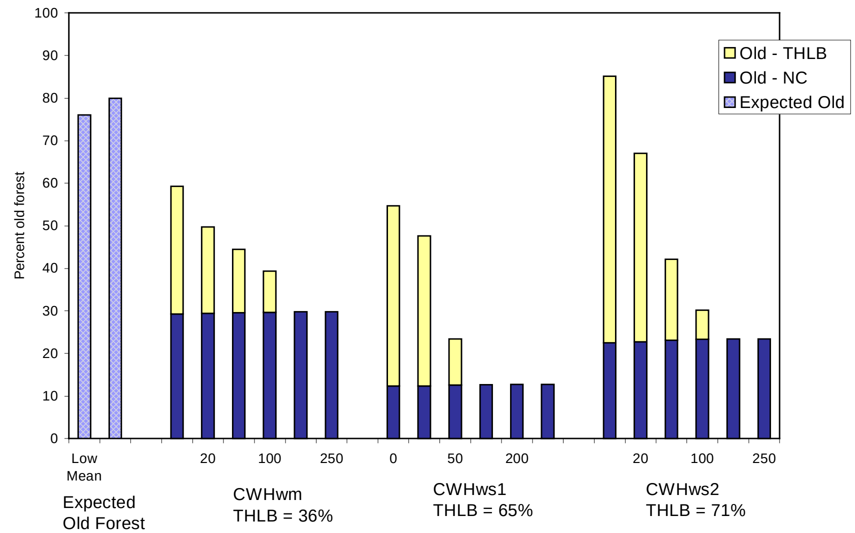
Figure 1. Percent old forest predicted (RONV) and occurring through time for example AU's within BEC variants.



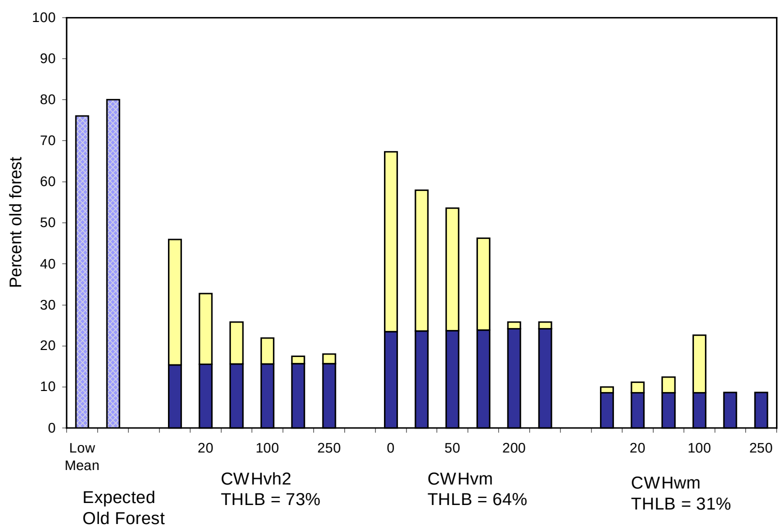
CwHw - Medium
2.1% landbase



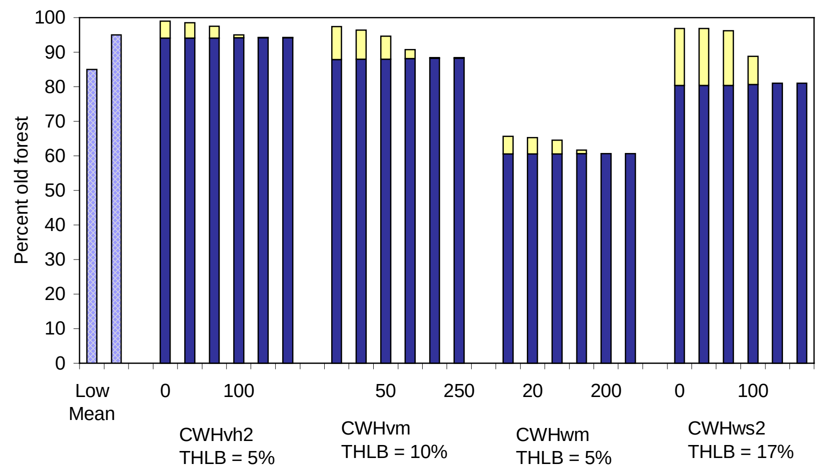
HwB - Medium
4.3% landbase



Spruce Medium
0.7% landbase



CwHw - Low
63.9% landbase



3.1. Base Risk: Model Results

As outlined in the conceptual model, base risk is defined as the amount of deviation between the amount of old forest and the predicted old forest, and can be modified by a number of factors including the representation of Protected Areas, the Ecological Conservation Value of the ecosystem, and the trends in large Patches for the ecosystem.

Base risk – which is the percent deviation from the mean predicted natural old forest abundance for each ecosystem – was calculated using the BBN and is presented for each ecosystem (AU x BEC) inTable 3. Most high productivity ecosystems and in addition a number of medium and a low (S) ecosystem are at high risk at time zero. Most low productivity ecosystems are at very low, or low risk, and remain so over the 250 years. Many moderate productivity (and some high and low) ecosystems begin at low risk, but become high or moderate risk over time.

3.2. Risk Modifiers

The base risk level represents the percent deviation from natural conditions expected from current and projected levels of old forest. However, other factors influence overall risks to ecosystem integrity and biodiversity. The following risk factors were used to modify the base risk level: a) Ecosystem Conservation Value, b) Patch Size Trends, and c) Percent in Protected Areas. The quantitative science available for determining the extent to which these factors should modify risk is weak. However, we have used available theoretical rationale for each variable to alter the levels of risk within each ecosystem (see sections below). We did not modify any Base Risk in excess of 1/3rd of a risk class (i.e. 7 points out of 20 for a risk class), and modifications were generally lower than this. We also allowed the modification to vary with respect to our assumption of importance of each modifier, and feel that our modifiers are relatively conservative.

Base and modified risk levels for each ecosystem (AU x BEC) greater than 100 ha are presented in Table 9 for three time periods (time 0, 50 and 250 years). Table 2 summarizes the percentage points used as risk modifiers for Ecosystem Conservation Value, Patch Size Trends, and Protected Areas.

3.2.1. Ecosystem Conservation Value

All ecosystems have value, however it is widely recognised that certain types of ecosystems contribute higher ‘biodiversity values’ than others. For example, the loss of a unique ecosystem or one containing rare elements would significantly reduce biodiversity values of a given area. The North Coast region includes a wide variety of different ecosystems, some of which are extensive and common, and others that tend to be localised and perhaps more unique. To address these values, experts on the North Coast ecosystems (A. Banner and J. Pojar) were asked to rate the ecosystems used in this analysis in terms of their “Biological Importance” and “Biological Influence”. These two terms were defined as:

Biological Importance: A relative measure of the overall biodiversity value (per unit area) of an ecosystem, classified as ‘high, medium and low’. High value systems will tend to have some combination of high species richness or productivity, high rarity or high distinctiveness.

Biological influence: The influence of the ecosystem on surrounding ecosystems estimated as ‘low’, ‘medium’, or ‘high’. The loss of a given area of an ecosystem with high influence value would have tend to have cascading effects higher than that predicted by the area of ecosystem alone.

Each ecosystem (AU x BEC) was classified as very high, high, medium or low for each of these two variables (see Appendix 3 for values). In the BBN model, the two values were then combined in a single Ecosystem Conservation Value Index which, when extracted from the BBN, was quantified as very high, high, moderate and low. As Table 2shows, ecosystems with very high conservation values were given an additional 7 percentage points to their base risk score to reflect the significance of altering these systems, while ecosystems with low conservation value were not given an increase.

3.2.2. Trends in Large Old Forest Patches

Although we are uncertain about their role in each of the ecosystems outlined here, large areas of interior forest habitat are believed to provide important conditions for many species (Noss 1996a). For the purpose of assessing risks to coarse filter biodiversity, we defined a large old forest patch as a contiguous area of forest greater than 250 years in age.

The SELES model was used to output data on patch sizes for old forest patches through time. Figure 1 summarises the output for the trends in large (>500ha) patches by Analysis Unit through time. A considerable decrease in large patches over time is evident for all Cedar/ Hemlock, Hemlock/ Balsam, and Spruce units, although the Cedar/ Hemlock – High unit currently has very few patches. A similar pattern was observed for almost all variants when large patch frequency was summarized by BEC unit (not shown).

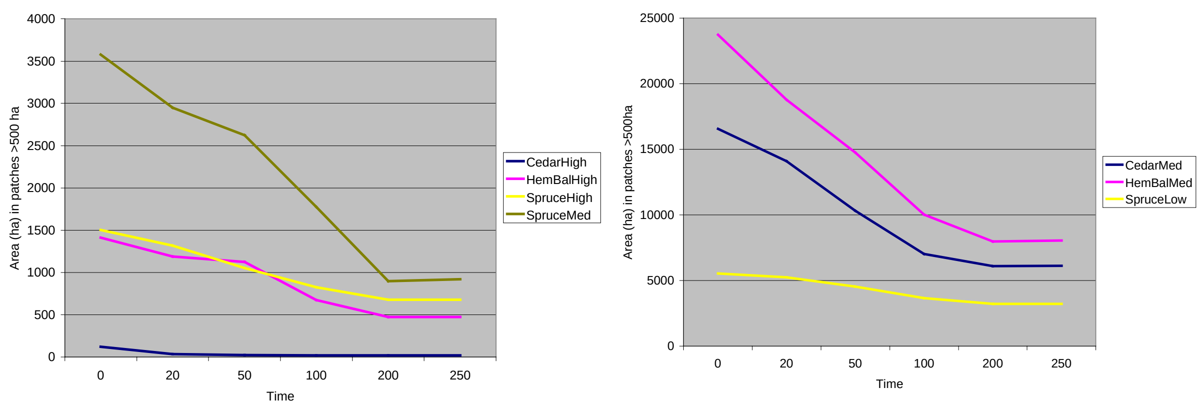


Figure 2. Trends in old forest large patch size frequency through time (for high / moderate risk analysis units)

The changes in the availability of large patches were summarised for each AU x BEC ecosystem as the percent change in large old patches over the time period (0 to 250 years). The percent change was categorised as: *high change* = >70% change in area in large patches; *moderate change* = 30-70% change in large patches; *low/ no change* = <30% change in large patches. The base risk levels were modified using these categories (as shown in Table 2). Ecosystems with high predicted changes in large patch frequency were given an additional 7 percentage points to their Base Risk scores while those with moderate changes were given an additional 3.5 points.

3.2.3. Abundance and Representation in Protected Areas

The amount of old forest in Protected Areas is included with other forests (in the THLB and NC) in the calculation of base risk. However, Protected Areas *potentially* provide additional coarse filter benefits (depending on the specific management regimen), including:

- Maintaining natural disturbance regimes and rates
- No roads
- Managed access control (including hunting / disturbance)

- No resort development
- Natural regeneration of young forest areas (no species conversion)
- Natural forest patch mosaic
- Reduced potential for 'mistakes' causing ecological damage

The need for adequate protected areas is known to play a key role in maintaining ecological values through time (e.g. Noss 1996b). Thus, existing Protected Areas could potentially help reduce risk to biodiversity over and above their contribution of old forest. In addition, Protected Areas provide some level of certainty that an area (and its associated ecosystems) will not be harvested in future. This is particularly relevant on the North Coast where much of the area is currently considered unharvestable due to economic reasons. However, if economic conditions change, the current area of 'non-contributing' landbase may be harvested. The extent (in ha) of protected area within an ecosystem (AU x BEC) is accounted for through risk modifiers based on low (<5%), medium (5-12%) and high (>12%) levels of Protected Areas. Four percentage points were *subtracted* from the base risk levels (% deviation from natural) for ecosystems with a high amount of protected area resulting in lower risk. However, for ecosystems with few Protected Areas, 4 percentage points were *added* to the base risk levels to account for the added risk to biodiversity due to potential habitat changes across a broader portion of the landbase[3].

The area and percent of Protected Area for each AU is shown for the LRMP area (Table 1). The amount that is THLB gives an indication of the extent of harvest that may occur in the near future[4]. The distribution of Protected Areas for smaller ecosystems (AU x BEC) were used to modify risk inTable 3. Note that we did not assess the efficiency of management regimes, although a lack of adequate protection – or mismanagement – is likely to increase risk, so it is important that protected areas be managed in order to maintain ecosystem integrity.

Table 1. Area, percent and land status of analysis units in the North Coast region*.

Analysis Units	Area THLB	Area PA	Other Crown Forest	Total	Percent Parks
CedarHigh	1125	16	366	1508	1.1
CedarLow	35847	9585	639947	685380	1.4
CedarMed	11467	380	10272	22120	1.7
Cottonwood	281	45	581	908	4.9
HemBalHigh	5680	102	1859	7642	1.3
HemBalLow	29769	9058	182466	221294	4.1
HemBalMed	27432	1783	17325	46541	3.8
OtherDecid		208	4730	4938	4.2
Pine		144	60692	60836	0.2
SpruceHigh	1989	515	1029	3534	14.6
SpruceLow	2605	580	5172	8358	6.9
SpruceMed	4665	594	1986	7246	8.1
Grand Total	122208	23010	926668	1071887	2.15

* Data output from SELES. THLB = timber harvesting land base. PA = Protected Areas.

3.2.4. Risk Modification

The level of modification for each risk factor is summarized above and shown in Table 8. Quantitative science to determine appropriate levels of modification is lacking - there is little understanding of the specific effects of each of these values. However, the intent of risk modifiers is to stress that the base

[3] note that the 'modifier' shown for PA (H, M, L) highlights *the amount of Protected Area, not the risk level.* In this case, H (PA) = Low Risk. For the other modifiers a H rating = High Risk.

[4] THLB is determined from economics – so radical changes in timber price could expand or collapse the size of the THLB, hence it provides only a short term indication of the potential for harvest in a particular area.

risk level is dependent on other landscape attributes, and should be interpreted with care. The risk effect ranged from 0 to 7 percentage points for Ecosystem Conservation Value, Protected Areas and Patch Size Trends (Table 2), and was applied to each ecosystem (AU x BEC) for three time periods (0, 50, 250 years) as shown in Table 9. Actual values applied for each ecosystem are shown in Appendix 6.

Table 2. Risk Modification Values.

Modifier	Value	Effect on Risk	Risk effect (percentage points)
Ecosystem Conservation Value	VH	VH	+ 7
	H	H	+ 6
	M	M	+ 3
	L	L	+ 0
Protected Areas	L (<5%)	H	+ 5
	M (5 – 12 %)	M	+ 0
	H (>12%)	L	- 5
Patch Size Trends	H (>70% change)	H	+ 7
	M (30 – 70% change)	M	+ 3.5
	L (0-30% change)	L	+ 0

Table 3. Base and modified risk for all ecosystems > 100 ha, at each of three time periods (0, 50 and 250 years). (High and Very High risk ecosystems are shaded grey.)

This table shows the Base Risk Groups at three times intervals (0, 50 and 250 years) for each ecosystem. Risk Modifiers: Ecosystem Conservation Value, Protected Areas, and Patch Trends are shown categorically. The resulting Modified Risk is then shown for three time intervals. Modifiers are simply added to scores for Base Risk to produce Modified Risk. (see Appendix 6 for numerical details).

		BASE RISK GROUPS AT TIME 0, 50, 250			*MODIFIER RISK LEVEL*			MODIFIED RISK GROUPS AT T = 0, 50, 250		
AU	BEC	BR_G_0	BR_G_50	BR_G_250	*ECV*	*PA*	*PATCH*	MR_G_0	MR_G_50	MR_G_250
CedarHigh	CWHvm	VH	VH	VH	*H*	*H*	*H*	VH	VH	VH
HemBalHigh	CWHvh2	VH	VH	VH	*M*	*H*	*H*	VH	VH	VH
CedarHigh	CWHvh2	VH	VH	VH	*H*	*H*	*H*	VH	VH	VH
SpruceMed	CWHwm	H	H	VH	*VH*	*H*	*M*	VH	VH	VH
HemBalHigh	CWHvm	H	VH	VH	*M*	*H*	*M*	VH	VH	VH
SpruceLow	CWHwm	H	H	VH	*M*	*H*	*M*	VH	H	VH
SpruceHigh	CWHvh2	H	H	H	*VH*	*H*	*M*	H	VH	VH
SpruceHigh	CWHwm	H	L	VH	*VH*	*H*	*H*	H	M	VH
SpruceMed	CWHvh2	M	H	H	*H*	*H*	*M*	H	VH	VH
SpruceLow	MHmm1	M	M	M	*L*	*L*	*L*	M	M	M
SpruceHigh	CWHvm	M	M	M	*VH*	*L*	*M*	M	M	H
HemBalMed	CWHvh2	M	M	H	*M*	*H*	*M*	M	H	H
HemBalHigh	CWHws2	L	M	H	*H*	*H*	*M*	M	H	H

		BASE RISK GROUPS AT TIME 0, 50, 250			*MODIFIER RISK LEVEL*			MODIFIED RISK GROUPS AT T = 0, 50, 250		
AU	BEC	BR_G_0	BR_G_50	BR_G_250	*ECV*	*PA*	*PATCH*	MR_G_0	MR_G_50	MR_G_250
HemBalLow	CWHws1	L	M	M	*L*	*H*	*M*	M	M	H
HemBalLow	CWHwm	L	L	L	*L*	*H*	*L*	L	L	M
CedarLow	CWHwm	L	L	L	*M*	*H*	*L*	M	M	M
SpruceMed	CWHvm	L	M	H	*H*	*L*	*H*	L	M	H
HemBalMed	CWHwm	L	M	H	*M*	*H*	*M*	M	M	H
HemBalMed	CWHvm	L	M	H	*M*	*M*	*H*	M	H	H
CedarMed	CWHwm	L	M	H	*M*	*H*	*M*	M	M	VH
HemBalMed	CWHws1	L	H	VH	*M*	*H*	*H*	M	H	VH
SpruceLow	MHwh1	L	L	L	*L*	*H*	*L*	L	L	L
HemBalMed	MHmm1	L	L	M	*M*	*H*	*M*	L	L	M
HemBalHigh	CWHwm	L	M	H	*M*	*H*	*M*	L	M	VH
SpruceLow	CWHvm	L	L	M	*H*	*L*	*M*	L	L	M
CedarMed	MHwh1	L	L	M	*M*	*H*	*M*	L	L	M
CedarMed	CWHvm	L	M	H	*M*	*H*	*H*	L	H	VH
CedarMed	MHmm1	VL	L	L	*M*	*H*	*M*	L	M	M
SpruceLow	CWHvh2	VL	L	L	*H*	*H*	*L*	L	L	L
HemBalMed	MHmm2	VL	M	M	*M*	*H*	*M*	L	M	H
CedarMed	CWHvh2	VL	L	M	*M*	*H*	*M*	L	M	H
HemBalMed	CWHws2	VL	M	H	*M*	*H*	*H*	L	M	VH
HemBalLow	MHmm1	VL	VL	VL	*L*	*M*	*L*	VL	VL	VL
HemBalHigh	CWHws1	VL	L	M	*M*	*H*	*H*	L	M	H
CedarLow	MHmm1	VL	VL	VL	*M*	*H*	*L*	VL	VL	VL
HemBalLow	CWHws2	VL	VL	L	*L*	*H*	*M*	VL	VL	L
CedarLow	MHwh1	VL	VL	VL	*M*	*H*	*L*	VL	VL	VL
Pine	CWHvh2	VL	VL	VL	*M*	*H*	*L*	VL	VL	VL
Pine	MHwh1	VL	VL	VL	*M*	*H*	*L*	VL	VL	VL
HemBalLow	CWHvm	VL	VL	VL	*L*	*M*	*M*	VL	VL	L
HemBalLow	CWHvh2	VL	VL	VL	*L*	*H*	*L*	VL	VL	VL
CedarMed	CWHws2	VL	VL	M	*M*	*H*	*H*	L	L	H
HemBalLow	MHwh1	VL	VL	VL	*L*	*H*	*L*	VL	VL	VL
CedarLow	CWHvm	VL	VL	VL	*M*	*H*	*L*	VL	VL	VL
CedarLow	CWHws2	VL	VL	VL	*M*	*H*	*L*	VL	VL	VL
HemBalLow	MHmm2	VL	VL	VL	*L*	*H*	*L*	VL	VL	VL
CedarLow	CWHvh2	VL	VL	VL	*M*	*H*	*L*	VL	VL	VL

BR_G = Base Risk Group; MR_G = Modified Risk Group. ECV = Ecosystem Conservation Value; PA = Protected Areas, Patch = trends in patch size. Values are shown in Table 8.

4.0 Geographic location of risks

This work is intended to inform the North Coast LRMP Table land use decision-making process. In order to understand the potential implications of the results, it will help the Table to understand the geographic locations of particular ecosystems that are at high risk. Due to the large and complex nature of the landscape, it is very difficult to locate areas of high risk on a map. Instead, the area of each analysis unit present in each landscape unit across the region is listed in and can be used to identify areas of highest risk. The table in Appendix 1 shows two shaded columns with the additive sum of high productivity (high risk) ecosystems, and high plus moderate productivity ecosystems. This table can be used to assess the implications for reducing the risk by setting aside a particular landscape unit, and also demonstrates the complexity of landscape variability.

5.0 Conclusions

The Base Risk to coarse filter biodiversity interpreted from an assessment of the abundance and distribution of old forest through time on the North Coast is highly variable with respect to different ecosystems (Appendix 6; Table 9). In general, the abundance of old forest in high productivity ecosystems within all BEC variants is currently much lower than that expected to occur under natural disturbance processes - which we interpret as meaning there is a high or very-high risk to coarse filter biodiversity within these ecosystems. The abundance of old forest in medium productivity ecosystems suggests a generally moderate risk to those systems currently, but predicted harvesting pressure increases the risk to high in most variants over the short term (the next 20 – 50 years). Low productivity ecosystems are generally (except spruce and cedar/ hemlock leading ecosystems in 3 landscape units) at very low or low risk through time.

Reporting on Base Risk, 8 of 47 ecosystems were at high or very high risk at time zero, and this increased to 19 of 47 ecosystems after 250 years. Note that although these high risk ecosystems actually represent a relatively small physical area within the entire North Coast (see Appendix 4), the biological values represented within them are likely very high.

A number of Risk Modifiers were used outside the BBN model to examine the potential impact of additional factors on coarse filter risk, in particular: Representation of Ecosystems in Protected Areas, Ecosystem Conservation Value, and Patch Size Trends. The potential modifiers were categorised (see Section 5.3), and allowed to modify Base Risk levels up or down. Although the science is largely unavailable to understand the specific implications of reducing the number of large patches, or of having a very small percent represented in Protected Areas, there is however substantial theoretical literature that supports the rationale allowing these parameters to modify risk levels. We used what we consider to be quite conservative levels of modification: risk was allowed to change a maximum of 1/3rd of a risk class (7 percentage points).

Reporting on Modified Risk, 9 of 47 ecosystems were at high or very high risk at time 0, (an increase of 1 over base risk), and 24 of 47 ecosystems were at high or very high risk at time 250 (an increase of 5 over base risk). This is a moderate increase in the number of units at high risk, but could substantially increase the amount of area at high risk over time.

In addition, the intention is to stress the need for comprehensive planning and to suggest that managing to maintain ecological integrity is a complex process, and is only generally represented by this modeling exercise.

Ecological thresholds for ecosystem-based analyses such as this have a relatively weak scientific background. However, in this case, the number of ecosystems in each risk class was quite insensitive to changing the risk probability functions, which increased our confidence that they represent a reasonable picture of the ecological risks to the LRMP area in relation to the Base Case management regime.

5.1. Future Land Use Scenario Developments

This model assumes that the abundance, distribution and pattern of old forest on the landscape is the key factor influencing risk to 'ecological integrity' in this landscape. Scenarios for this value should therefore vary these parameters in order to view the potential alternative land use scenarios. In brief, this can be achieved in a number of ways:

- Vary the abundance and distribution of old forest maintained on the landscape. Use Appendix 1 to locate areas with high densities of at risk ecosystems
- Apply patch size requirements to old forest
- Vary the area and distribution of Protected Areas
- Apply partial harvest to areas to increase recovery rate of old forest values
- Apply long rotations to improve extent of recovery through time

The results from this report provide guidance as to which ecosystems are at most risk, during the short, mid and long-term. This should aid in assessing how the above scenarios can be applied to maximise ecological benefit at the coarse filter level.

It may be appropriate to add additional indicators during scenario assessment, in particular, site series mapping will allow direct assessment of rare ecosystems, and partial harvest scenarios may require additional consideration of road density information.

6.0 References

A full reference list is available in the main report (Holt and Sutherland 2003).

Holt, R.F. and G. Sutherland. 2003. Environmental Risk Assessment Base Case: Coarse Filter Biodiversity. Prepared for the North Coast LRMP, MSRM, Smithers. BC.

Appendix 1. Area of Analysis Units within Landscape Units.

Shaded columns show total area of higher risk and medium risk landscape units.

LU	CedarHigh	HemBalHigh	SpruceHigh	SUM High	SpruceMed	CedarMed	Sum Medium S and C	SpruceLow	HemBalMed	CedarLow	Pine	Cottonwood	HemBalHighThinned	HemBalLow	HemBalMedThinned	OtherDecid	Grand Total
Big Falls	119	795	469	1,383	377	628	1,005	290	1,832	5,123	27			6,266		50	15,976
Kitsault		1,051	27	1,078	73	138	211	57	4,109	2,029	1	367		27,189		151	35,192
Bishop	151	564	151	866	267	1,390	1,657	42	1,687	14,722			134	2,566	197	54	21,925
Somerville	155	518	131	804	300	447	747	314	3,438	11,741				10,167		99	27,310
Kumealon	153	502	121	776	328	1,365	1,693	381	1,807	22,497	666			5,133	48	185	33,186
Scotia	4	496	269	769	332	494	826	155	2,852	10,284	13		4	6,664	135	61	21,763
Kwinamass	1	363	374	738	333	152	485	244	1,605	5,953		16		10,093		119	19,253
Kitkiata		626		626	90	223	313	150	969	9,554				10,755		72	22,439
Khutzeymateen		60	512	572	509	72	581	383	1,153	2,660		45		6,859		180	12,433
Gribbell	155	262	64	481	58	976	1,034	96	582	10,059	8			1,370		73	13,703
Quottoon	141	136	203	480	335	587	922	281	1,435	10,595				3,183		230	17,126
Stagoo	6	311	157	474	118	297	415	258	1,790	6,254		55		10,659		124	20,029
Kaien	140	154	117	411	203	1,056	1,259	759	1,630	28,880	1,453			4,954	108	662	40,116
Triumph	65	216	50	331	137	1,325	1,462	9	1,663	5,769	10			1,965		59	11,268
Khtada	10	113	177	300	161	209	370	231	2,062	1,977	19	18		4,262		119	9,358
Sparkling	1	216	60	277	589	166	755	419	570	5,488				4,634		185	12,328
Khyex	12	128	107	247	465	286	751	445	1,441	7,302		25		6,087		239	16,537
Porcher	49	154	5	208	432	543	975	451	1,189	49,586	2,807		3	1,790	953	147	58,109
Brown	62	110	36	208	147	240	387	82	628	9,719				2,766		6	13,796
Chambers	46	90	59	195	252	128	380	179	841	10,574				10,285		11	22,465
Hawkes South	12	73	92	177	91	78	169	166	779	7,106	17			3,519			11,933
Johnston	36	59	72	167	285	208	493	618	419	7,596				7,718		391	17,402
Marmot	21	118	16	155	37	628	665	19	1,361	4,544				11,031		38	17,813
Hartley	1	117	35	153	83	1,198	1,281	304	1,000	30,494	264			6,882		42	40,420
Red Bluff		139		139	134	799	933	97	830	21,434	518			4,517		79	28,547

LU	CedarHigh	HemBalHigh	SpruceHigh	SUM High	SpruceMed	CedarMed	Sum Medium S and C	SpruceLow	HemBalMed	CedarLow	Pine	Cottonwood	HemBalHighThinned	HemBalLow	HemBalMedThinned	OtherDecid	Grand Total
Hevenor	90	26		116	42	1.076	1.118	75	573	27.924	1.470			3.848		44	35.168
Skeena Islands		91	20	111	85	167	252	54	289	1,077		75		1,163		418	3,439
Union	1	23	59	83	255	425	680	222	705	13,380	195			2,630		75	17,970
Olh	14	56		70	28	275	303	19	581	4,318				4,889		309	10,489
Belle Bay	12	27	25	64	31	429	460	71	912	14,464	9			6,145		18	22,143
Pearse	16		22	38	20	396	416	209	300	25,435	919			2,153		9	29,479
Gil			33	33		1,257	1,257		377	16,762	3,502			1,281		88	23,300
Kshwan		17	15	32	152		152	86	393	191		302		4,632		22	5,810
Aristazabal			31	31		142	142		23	36,258	5,222			63			41,739
Captain			25	25		934	934	64	170	17,035	33			732		65	19,058
Tuck	19	4		23	397	1,132	1,529	638	2,882	31,192	4,633			3,567		213	44,677
Observatory Ea	12	9		21	18	172	190	56	120	5,507				3,883		3	9,780
Anyox		18		18		200	200	38	653	5,030	167	5		6,354		58	12,523
Dundas	3			3	18		18	162	32	11,391	6,925			379			18,910
Monckton	1			1	10	555	565	45	280	23,807	1,374			2,146		46	28,264
Banks				0		490	490	73	43	76,259	13,973			326		6	91,170
McCauley				0		312	312	6	4	31,484	2,004			103		3	33,916
Pa aat				0	37	209	246	18	284	12,740	3			1,625		45	14,961
Observatory W				0	17	206	223	30	179	7,924				3,657		140	12,153
Chapple				0		73	73			255	117						445
Campania				0		23	23	7	14	4,861	10,746			226			15,877
Kiltuish				0		7	7	4	55	411				83			560
Stephens				0		7	7	5		4,844	2,579			18			7,453
Iknouk				0			0			1							1
Trutch				0			0	46		10,890	1,162			77			12,175
Grand Total	1,508	7,642	3,534	12,684	7,246	22,120	29,366	8,358	46,541	685,380	60,836	908	141	221,294	1,441	4,938	1,071,88

Appendix 2. Risk Modification Detail.

This table shows the Base Risk at three times intervals (0, 50 and 250 years), both numerically, and categorically for each ecosystem. Risk Modifiers: Ecosystem Conservation Value, Protected Areas, and Patch Trends are shown categorically and numerically. The resulting Modified Risk is then shown for three time intervals. Modifiers are simply added to scores for Base Risk to produce Modified Risk. Note that under Risk Modifiers, the value (H, L, M,) is the value of the analysis for that modifier, NOT the risk level (this is in contract to Table 9 where resulting effect on risk is shown).

		Base Risk at time 0, 50, 250						Risk Modifiers (score and value)						Modified Risk at time 0, 50, 250					
AU	BEC	BR_0	BR_G_0	BR_50	BR_G_50	BR_250	BR_G_250	ECV	ECV mod	PA	PA mod	Patch	Patch Mod	MR_0	MR_G_0	MR_50	MR_G_50	MR_250	MR_G_250
CedarHigh	CWHvm	88.3	VH	88.4	VH	88.6	VH	H	6	L	5	H	7	106.3	VH	106.4	VH	106.6	VH
HemBalHigh	CWHvh2	87.9	VH	87.9	VH	88.7	VH	M	3	L	5	H	7	102.9	VH	102.9	VH	103.7	VH
CedarHigh	CWHvh2	83.9	VH	87.8	VH	87.4	VH	H	6	L	5	H	7	101.9	VH	105.8	VH	105.4	VH
SpruceMed	CWHwm	79.9	H	78.9	H	81.3	VH	VH	7	L	5	M	3.5	95.4	VH	94.4	VH	96.8	VH
HemBalHigh	CWHvm	78.2	H	80.9	VH	84.8	VH	M	3	L	5	M	3.5	89.7	VH	92.4	VH	96.3	VH
SpruceLow	CWHwm	69.2	H	66.5	H	82.1	VH	M	3	L	5	M	3.5	80.7	VH	78	H	93.6	VH
SpruceHigh	CWHvh2	62.5	H	71.1	H	72.6	H	VH	7	L	5	M	3.5	78	H	86.6	VH	88.1	VH
SpruceHigh	CWHwm	60.2	H	25.6	L	82	VH	VH	7	L	5	H	7	79.2	H	44.6	M	101	VH
SpruceMed	CWHvh2	48.8	M	68.9	H	76.1	H	H	6	L	5	M	3.5	63.3	H	83.4	VH	90.6	VH
SpruceLow	MHmm1	45.6	M	47	M	46.7	M	L	0	H	-5	L	0	40.6	M	42	M	41.7	M
SpruceHigh	CWHvm	45.3	M	51.7	M	57.4	M	VH	7	H	-5	M	3.5	50.8	M	57.2	M	62.9	H
HemBalMed	CWHvh2	42.2	M	51.6	M	66.6	H	M	3	L	5	M	3.5	53.7	M	63.1	H	78.1	H
HemBalHigh	CWHws2	38.9	L	50.2	M	64.9	H	H	6	L	5	M	3.5	53.4	M	64.7	H	79.4	H
HemBalLow	CWHws1	38.1	L	51.2	M	58.9	M	L	0	L	5	M	3.5	46.6	M	59.7	M	67.4	H
HemBalLow	CWHwm	34.9	L	34.9	L	38.9	L	L	0	L	5	L	0	39.9	L	39.9	L	43.9	M
CedarLow	CWHwm	34.8	L	34.8	L	34.8	L	M	3	L	5	L	0	42.8	M	42.8	M	42.8	M
SpruceMed	CWHvm	31.4	L	41.9	M	66.2	H	H	6	H	-5	H	7	39.4	L	49.9	M	74.2	H
HemBalMed	CWHwm	31.1	L	45.6	M	63.3	H	M	3	L	5	M	3.5	42.6	M	57.1	M	74.8	H
HemBalMed	CWHvm	30.6	L	53.3	M	67.1	H	M	3	M	0	H	7	40.6	M	63.3	H	77.1	H
CedarMed	CWHwm	30.1	L	47.6	M	69.6	H	M	3	L	5	M	3.5	41.6	M	59.1	M	81.1	VH
HemBalMed	CWHws1	29.4	L	68.4	H	81.4	VH	M	3	L	5	H	7	44.4	M	83.4	H	96.4	VH
SpruceLow	MHwh1	26.9	L	22.3	L	27.4	L	L	0	L	5	L	0	31.9	L	27.3	L	32.4	L
HemBalMed	MHmm1	26.8	L	24.6	L	46.3	M	M	3	L	5	M	3.5	38.3	L	36.1	L	57.8	M

		Base Risk at time 0, 50, 250						Risk Modifiers (score and value)						Modified Risk at time 0, 50, 250					
AU	BEC	BR_0	BR_G_0	BR_50	BR_G_50	BR_250	BR_G_250	ECV	ECV mod	PA	PA mod	Patch	Patch Mod	MR_0	MR_G_0	MR_50	MR_G_50	MR_250	MR_G_250
HemBalHigh	CWHwm	26.6	L	41.1	M	70	H	M	3	L	5	M	3.5	38.1	L	52.6	M	81.5	VH
SpruceLow	CWHvm	23.8	L	28.9	L	42.7	M	H	6	H	-5	M	3.5	28.3	L	33.4	L	47.2	M
CedarMed	MHwh1	23.7	L	26.8	L	40.9	M	M	3	L	5	M	3.5	35.2	L	38.3	L	52.4	M
CedarMed	CWHvm	21.6	L	50.1	M	66.1	H	M	3	L	5	H	7	36.6	L	65.1	H	81.1	VH
CedarMed	MHmm1	19	VL	29.5	L	37.1	L	M	3	L	5	M	3.5	30.5	L	41	M	48.6	M
SpruceLow	CWHvh2	18.5	VL	24.1	L	28.2	L	H	6	L	5	L	0	29.5	L	35.1	L	39.2	L
HemBalMed	MHmm2	15	VL	47.2	M	49.7	M	M	3	L	5	M	3.5	26.5	L	58.7	M	61.2	H
CedarMed	CWHvh2	14.9	VL	31.7	L	53.4	M	M	3	L	5	M	3.5	26.4	L	43.2	M	64.9	H
HemBalMed	CWHws2	14.2	VL	43.4	M	67.9	H	M	3	L	5	H	7	29.2	L	58.4	M	82.9	VH
HemBalLow	MHmm1	13.7	VL	13.7	VL	14.5	VL	L	0	M	0	L	0	13.7	VL	13.7	VL	14.5	VL
HemBalHigh	CWHws1	13.4	VL	37.1	L	51.6	M	M	3	L	5	H	7	28.4	L	52.1	M	66.6	H
CedarLow	MHmm1	11.5	VL	11.5	VL	11.5	VL	M	3	L	5	L	0	19.5	VL	19.5	VL	19.5	VL
HemBalLow	CWHws2	10.6	VL	10.7	VL	31	L	L	0	L	5	M	3.5	19.1	VL	19.2	VL	39.5	L
CedarLow	MHwh1	10.6	VL	10.6	VL	10.6	VL	M	3	L	5	L	0	18.6	VL	18.6	VL	18.6	VL
Pine	CWHvh2	10.6	VL	10.6	VL	10.6	VL	M	3	L	5	L	0	18.6	VL	18.6	VL	18.6	VL
Pine	MHwh1	10.6	VL	10.6	VL	10.6	VL	M	3	L	5	L	0	18.6	VL	18.6	VL	18.6	VL
HemBalLow	CWHvm	10.5	VL	10.6	VL	18.5	VL	L	0	M	0	M	3.5	14	VL	14.1	VL	22	L
HemBalLow	CWHvh2	10.5	VL	10.6	VL	15.6	VL	L	0	L	5	L	0	15.5	VL	15.6	VL	20.6	VL
CedarMed	CWHws2	10.5	VL	10.5	VL	52.4	M	M	3	L	5	H	7	25.5	L	25.5	L	67.4	H
HemBalLow	MHwh1	10.5	VL	10.5	VL	11.6	VL	L	0	L	5	L	0	15.5	VL	15.5	VL	16.6	VL
CedarLow	CWHvm	10.5	VL	10.5	VL	11.1	VL	M	3	L	5	L	0	18.5	VL	18.5	VL	19.1	VL
CedarLow	CWHws2	10.5	VL	10.5	VL	10.6	VL	M	3	L	5	L	0	18.5	VL	18.5	VL	18.6	VL
HemBalLow	MHmm2	10.5	VL	10.5	VL	10.5	VL	L	0	L	5	L	0	15.5	VL	15.5	VL	15.5	VL
CedarLow	CWHvh2	10.5	VL	10.5	VL	10.5	VL	M	3	L	5	L	0	18.5	VL	18.5	VL	18.5	VL

BR = Base Risk; BR_G_0 = Base Risk Group (at time zero); MR_G_0 = Modified Risk Group (at time zero). ECV = Ecosystem Conservation Value category (very hig, high, medium, low). ECV_Mod = Applied modification factor. PA = Protected Areas Category (Low, Medium, High). PA Mod = Protected Areas Modification Factor. Patch = trends in patch size category (High, Medium, Low).