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March 30, 2004

The Coast Information Team is pleased to deliver the final version of the *CIT Central Coast Coarse Filter Ecosystem Trends Risk Assessment – Base Case (March 2004)*.

The Coast Information Team (CIT) was established to provide independent information for the central and north coasts of British Columbia and Haida Gwaii/Queen Charlotte Islands using the best available scientific, technical, traditional and local knowledge. The CIT was established by the Provincial Government of British Columbia, First Nations, environmental groups, the forest industry, and communities. It is led by a management committee consisting of representatives of these bodies; and is funded by the Provincial Government, the environmental groups and forest products companies, and the Federal Government of Canada. The technical team comprises nine project teams consisting of scientists, practitioners, and traditional and local experts. CIT information and analyses, which include this *CIT Central Coast Coarse Filter Ecosystem Trends Risk Assessment – Base Case*, are intended to assist First Nations and the three sub-regional planning processes to make decisions that will achieve ecosystem-based management (as per the April 4th 2001 Coastal First Nations—Government Protocol and the CCLRMP Interim Agreement).

In keeping with the CIT's commitment to transparency and highly credible independent analysis, the *CIT Central Coast Coarse Filter Ecosystem Trends Risk Assessment – Base Case* underwent an internal peer review and the CIT's independent peer review process chaired by University of Victoria Professor Rod Dobell. Peer reviews of the draft document and the authors' response are found at http://www.citbc.org/abostru-comm.html. The final document reflects changes made by the authors to address peer review comments.

We encourage all stakeholders involved in land and resource management decision-making in the CIT area to use the information and recommendations/conclusions of the *CIT Central Coast Coarse Filter Ecosystem Trends Risk Assessment – Base Case* in conjunction with other CIT products as they seek to implement EBM and develop EBM Land Use Plans. We are confident that the suite of CIT products provides valuable information and guidance on the key tenets of EBM: maintaining ecosystem integrity and improving human wellbeing.

Sincerely,

Robert Prescott-Allen, Executive Director
on behalf of the CIT Management Committee:
Ken Baker, Art Sterritt, Dallas Smith, Jody Holmes, Corby Lamb
Graem Wells, Gary Reay, Hans Granander, Tom Green, Bill Beldessi

Coast Information Team

Central Coast Coarse Filter Ecosystem Trends Risk Assessment – Base Case

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Executive Summary

An Environmental Risk Assessment (ERA) was performed for the Central Coast CIT region, to assess the implications of the current forest management scenario[1] (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
- summarizing 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. This is obviously a surrogate measure to represent a suite of general ecological functions for a diverse set of forested ecosystems. However, our goal is to focus on an ecosystem rather than species or single element approach and representation of age classes of forest (particularly old forest) provides an appropriate (and available) indicator for this scale of analysis. It is particularly applicable for coastal ecosystems because natural disturbance patterns and frequencies are such that old forest dominates the distributions of age classes in the unmanaged landscape.

To identify an ecological benchmark, we use estimates of the *lowest* and *highest most likely mean* values for stand-replacing natural disturbance rates to predict highest and lowest likely mean values for the predicted percentage of old forest in each ecosystem (A. Banner, pers. comm.). We considered ecosystems to be at increasing potential risk of having degraded ecosystem function as their projected percentage of old forest declines from this benchmark value. As a sensitivity analysis we used additional information on disturbance rates provided to the CIT but still under review (Price and Daust 2003). The estimated disturbance rates from Price and Daust result in higher predicted percent old forest, and therefore higher risk for all ecosystems (on average 5 points higher). However, the general pattern of the number of ecosystems in each risk category remained similar using either approach.

Output from the *Economic Gain Spatial Analysis – Timber* (Williams and Buell 2003) provided data on the projected abundance and distribution of old forest within different ecosystems (defined by analysis units within biogeoclimatic variants), through time from 0 to 200 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. The validity of our results is highly dependent on the extent to which "current management" assumptions in the harvest model do reflect the future reality of harvest on the ground. In particular, it is assumed that the size of the timber harvesting landbase remains the same over time. This assumption is key to our results, and if areas currently "inoperable" become operable through time, risks to some ecosystems could increase over those reported here.

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[1] Based on a composite of the Timber Supply Review (TSR) base case scenarios of the constituent management units (Williams and Buell 2003).

We present results in two different formats: 1) as direct graphical outputs of percent old forest directly from the timber model, and 2) as risk levels and risk categories as output from a Bayesian Belief Network (Netica™ [Norsys Software Corp; see www.norsys.com]). These two types of outputs are complementary. We provide the reader with first an overview of the raw data, and then with an interpretation in terms of risk.

Providing a reasoned interpretation of data is a key aspect of the scientific method, and identifying risk thresholds is a key element of any risk analysis. As a base set of thresholds, we interpreted percent deviation from natural old forest (0–100%) as corresponding 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). Often in ecological literature, risk is defined as the probability of an event occurring, combined with the magnitude of severity (or “loss”) in some value if that event occurs. In our analysis, we assume that the loss is a constant (ecological functioning is not adequate to maintain process and pattern), and simply define risk in terms of the probability of this loss occurring.

The “risk” then is the probability that coarse filter functions will not be maintained, and that species/processes/ecosystems will eventually be lost or degraded. This categorization is provided as a hypothesis and should be tested and refined as more information becomes available. The designation of “high risk” means a high probability that ecological integrity (as indicated by representation of old forest ecosystems) will not be maintained. It is not a commentary on whether choosing a high risk approach is or is not an “acceptable” management choice.

We perform sensitivity analysis using two alternative risk categorizations a “more precautionary” and a “less precautionary” alternative. The results based on the sensitivity analysis showed that the risk outputs were generally insensitive to the boundaries of risk categories used, within what we classified as a “reasonable range.” Although counter-intuitive, this result occurs because ecosystems in this landscape tend to be either already heavily modified by harvest, or almost completely unmodified—pushing ecosystems into the very high, or very low risk categories irrespective of the risk category thresholds. This gives us increased confidence in the relative risk rankings estimated from this model.

Key Findings

We found the abundance and distribution of old forest among ecosystems through time for the Central Coast Region was highly variable (see Table 3. In general, the abundance of old forest in high productivity ecosystems within all biogeoclimatic ecological classification (BEC) variants is currently much lower than that expected to occur under natural disturbance processes. Given our assumption that deviation for expected amounts of old forest area indicator of loss of ecological functioning, we interpret this 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 tends to be moderate compared with predicted natural abundance, suggesting a generally low or moderate current risk to those systems. Predicted harvesting pressure does increase the risk to high in most variants over the short term (i.e., the next 50 years). The abundance of old forest in low productivity ecosystems tends to be very similar to that expected under natural conditions. We interpret this as meaning these ecosystems are generally at very low or low risk through time—though this interpretation is difficult to make for some low productivity ecosystems due to some known inventory inaccuracies with respect to forest cover age typing for some low productivity ecosystems in this region.

Reporting on base risk, 60 and 14 of 146 ecosystems (>200 ha) are at very high or high risk, respectively, at time 0, in contrast with 63 and 3 ecosystems at very low or low risk, respectively, at the same time period. Straight interpretation of the risk results shows the number of ecosystems in the high risk groups decreasing through time (to 48 ecosystems at high or very high risk) and to 88 at low or very low risk. It is difficult to interpret all the results at face value, however, because of the combination of 1) likely underestimates of forest cover age for some low productivity units, and 2) a lack of natural disturbances projected in the inoperable landbase within the timber model—resulting in dramatically increasing percentage of old forest through time. These two factors tend to cancel one another out, making assessment of actual likely abundance of old forest, and therefore risk over the long term, difficult to make for lower productivity and some medium productivity ecosystems. However, we remain confident in the patterns demonstrated for all high productivity and most medium productivity ecosystems.

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Acknowledgements

This work was initially inspired by Greg Utzig, who used a similar approach to assess the potential implications of the Kootenay-Boundary Land Use Plan. Doug Williams and Mike Buell of Cortex Consultants Inc. provided the outputs from the economic gain spatial analysis (EGSA), and willingly answered our many questions. Karen Price, Dave Daust, and Allen Banner all provided data for and helpful commentary on disturbance intervals. This methodology used here was developed during a North Coast process, which saw input from many individuals who are additionally recognized here: Allen Banner, Jim Pojar, Don Reid, Hubert Burger, Don Morgan, Doug Steventon, and Marvin Eng.

Judith Anderson, SFU, provided a thorough and thoughtful review, which helped clarify an earlier draft.

We thank all for their input.

Report Audience

This report, produced under very short timelines, is a summary document that provides input to the Central Coastal LRMP Table. The level of technical detail and the background information are minimized here, but additional relevant details can be found in Holt and Sutherland (2003a), or from the authors.

1.0 Introduction

A primary component of broad-scale ecological monitoring of management practices is the examination of how well ecologically distinct habitat types are represented across the landbase. This assessment of 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; Margules and Pressey 2000; Nally et al. 2002).

Among the uses of such coarse-filter evaluations are: 1) contributing to the assessment of the present and projected ecological condition of selected portions of or the entire landbase; 2) identifying priority areas for biodiversity conservation; and 3) providing ecological baselines against which to assess impacts of forest practices (see Gonzales et al. 2003; Wells et al. 2003 for recent examples of coarse-scale representation analyses applied to the Central Coast). Within a set of conservation goals and management options, coarse-filter analysis can also help identify options for changing management policy (i.e., rates and/or methods of harvest on vulnerable lands) and for potential reclassification of harvestable lands (e.g., where to apply protection measures).

In this Environmental Risk Assessment (ERA), we use the abundance and extent of representation of old forest ecosystems as our basic indicator of the probability of maintaining coarse filter biological diversity, function, and ultimately ecological integrity in the Central Coast region.

To standardize and interpret our results in terms of a "risk," 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 interpret the current and projected trends in old forest through time in terms of the risk levels, presented as very low to very high.

This "Base Case" ERA identifies the risks to coarse filter biodiversity associated with the current management scenario planned for the Central Coast Region (as modeled by the Economic Gains Spatial Analysis – Timber[1] by Williams et al. 2003), from current time (time 0) through to 200 years into the future. The validity of our results is highly dependent on the extent to which current management assumptions in the harvest model do in fact reflect the future reality of harvest on the ground.

The analysis is regional: it looks at the risks to particular ecosystems over the entire region, summing and area weighting outputs accordingly. Useful application of this methodology requires an appropriate scale to be used (Morgan et al. 1994; Holt 2001). As a result, results are provided at the regional scale, and the location of regionally high-risk ecosystems both now and in the future should be used to put the analysis into a geographic context.

A number of different sets of information regarding natural disturbance regimes are available for this region (Price and Daust 2003; A. Banner, pers. comm.). To make the results generally comparable with a previous similar study for the North Coast (Holt and Sutherland 2003a), we used expert opinion for disturbance rates (A. Banner, pers. comm.; based on work for the North Coast LRMP). We compared these rates with newly available disturbance information (Price and Daust 2003) by conducting a sensitivity analysis.

The approach used in this analysis has been embraced within the general field of environmental assessment and planning (Landres et al. 1999; Swetnam et al. 1999; U.S. Department of Agriculture Forest Service 2001; Wright 2001) and has been endorsed by the Province of British Columbia as the basic rationale behind the *Biodiversity Guidebook* (B.C. Ministry of Forests and BC Environment 1995) and *Landscape Unit Planning Guide* of the Forest Practices Code (B.C. Ministry of Forests and BC Environment 1999). Determination of appropriate risk classes however is more controversial, and we provide both graphical outputs, raw risk levels, plus risk classes and risk class sensitivity analysis, to allow the reader to draw their own conclusions using alternative hypotheses about risk classes as they choose. The results are most appropriately used in a comparative sense, and not as absolute statements.

1.1. Report Organization

This report is organized with the objective of making the methods and results of the study accessible to the Central Coast LRMP Table. Following this Introduction is a summary of the methodology. Next, the regional scale results of the assessment of the Base Case is presented, with details on the spatial distribution of the results (by landscape unit) deferred to Appendices. The body of the report concludes with a discussion of the types and effects of the uncertainties in this study. A glossary is provided at the end for details on some concepts and terms used in the body of the report.

1.2. The Landbase

The geographic area included in this report is the Central Coast CIT area, comprising approximately 1.9 million hectares of productive forest land.[2] For this analysis, the area of productive forest within the study area has been classed into analysis units (defined by leading species and productivity, D. Williams, pers. comm.; Appendix 1), and biogeoclimatic variants. These surrogates for site series group represent “ecosystems” in this analysis. Although not ideal in terms of representing ecological function, this approach allows us to interpret the EGSA model outputs.

Therefore, for our analysis we define ecosystems as analysis units (AU) within biogeoclimatic ecological classification (BEC) variants, and we only report out on those with an area of >200 ha.[3] We also do not include any deciduous units in our analysis as these tend to be poorly defined in the forest cover database.

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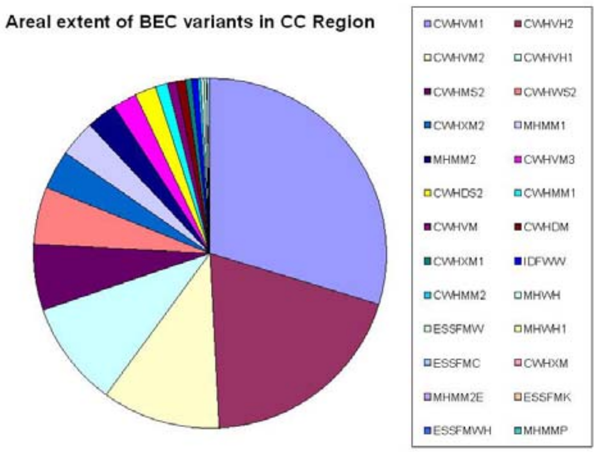
[2] NB. Only productive forest land is included in this analysis.

[3] This reduces the potential that GIS “slivers” are reported on.

Areal extent of AU's in CC Region



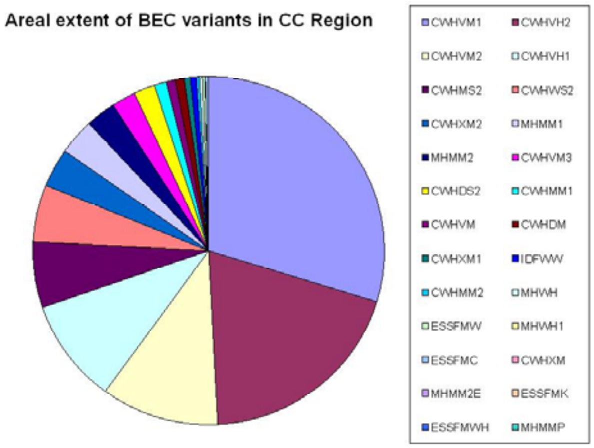


Figure 1. Relative area of BEC variants and analysis units within the Central Coast region.

There are a total of 146 AU x BEC ecosystems >200 ha in this area, with 11 AUs and 22 BEC variants. The areal distribution of these across the region is shown in Figure 1, which demonstrates the diversity of ecosystems accounted for using the AU by BEC descriptor. There are a large number of both AUs and BEC variants—but a large percentage of the CC area is comprised of a small number of units such as cedar/hemlock low, hemlock/balsam medium, and hemlock/balsam low AUs, and the CWHvm1 and CWHvh2 BEC variants.

In contrast, most of the ecological diversity of the area is represented within a relatively small area. Note that the AU designations provided (Williams and Buell 2003) are limited in terms of representing ecological diversity, and the use of site series groups within BEC variants would likely result in a considerably higher diversity of ecosystems than can actually be represented here. Therefore this analysis is likely of insufficient resolution to pick up all of the important ecological v variability in the region. In particular, rare ecosystems cannot be directly identified using this mapping base.

We assume in this analysis that the major factor affecting coarse filter function within this terrestrial region is industrial forestry activities. However, there could be additional factors that are not included in this model that affect the functioning of the ecosystem. Variables not in the assessment of risk, which may modify the outcome, include roads, mineral/fuel exploration, tourism, hunting, recreation, etc.

2.0 Methodology

2.1 Outline

Following the approach outlined by others (B.C. Ministry of Environment 2000; Utzig and Holt 2002), the ERA for coarse filter biodiversity involves the following specific steps:

- Identifying appropriate indicators and project their abundance and distribution through time.
- Identifying the natural benchmark for the comparison for each ecosystem (based on "range of natural variability" – RONV).
- Identifying hypothetical risk classes for interpreting the deviations between expected "natural" conditions and projected future trends.
- Examining 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.
- Summarizing results.

2.2 Identifying Indicators and Projecting Them through Time

For this analysis, we defined the abundance and extent of old forest (>250 years), stratified by ecosystem type, as our basic unit of measure (or indicator) to estimate the probability of maintaining coarse filter biological diversity, ecosystem function, and ultimately ecological integrity in the planning area over time. This is a surrogate measure intended to represent a suite of general ecological functions in forest ecosystems. This measure is particularly applicable for coastal ecosystems because natural disturbance patterns and frequencies are such that old forest dominates the distributions of age classes in the unmanaged landscape.

Projections of forest age class distributions for the operable and inoperable landbase were made by the Landscape projection model developed by Williams and Buell (2003) projected forest age-class distributions for the operable and inoperable landbase. This model is based on a series of objectives that the management of the landbase attempts to meet, and emulates the timber supply analyses that inform Timber Supply Reviews (TSR) and management planning processes for TFLS within the study area. For more details on the assumptions and data sources used by the model, see Appendix A in Williams and Buell (2003). The reader should keep in mind that the projections become increasingly uncertain as the projections extend further out through time.

Our analysis used the forest age-class outputs from the LP model, stratified by ecosystem type and landscape unit for the Central Coast. We examined the Base Case (current management) scenario.

Forest cover data and timber supply assumptions

In previous analyses on coastal forest ecosystems (North Coast LRMP: Holt and Sutherland 2003a, 2003b), based on forest cover information, two main issues of risk interpretation associated with the forest cover data were identified:

1 The projected age of some forest cover types appears to be incorrect in some of the source GIS data. The background methodology for assigning forest cover ages is to use photo-interpretation associated with field checks. In the past, this work has focused on accurate interpretation of productive stands in the timber harvesting landbase, and has been less concerned with non-commercial stands outside the timber harvesting landbase. Exploratory assessment 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. These forest stands are more 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 data problem, rectification has not been a priority because these forests are often outside the timber harvesting landbase. However, in our analysis, it is key to correctly interpret the age class of all forest types, otherwise risks may be over- or underestimated. The solution in the North Coast analysis was to reassign age classes to some ecosystems (e.g., age class 7 was reclassified as 9 in some cases; Holt and Sutherland 2003a). In this analysis, this upfront approach was not possible because the timber supply analyses were performed ahead of this work. The implication for the risk analysis is that higher risks will result in some ecosystems because the apparent amount of old forest is lower than is actually present.

Solution: we identify those ecosystems where this appears to be a problem (spruce/hemlock/fir low productivity types), and suggest where risks are likely lower than a straightforward interpretation of the data would suggest. The main results table () notes where this problem appears to be relevant.

2 The basic method of growing old forest in the inoperable (done by the timber supply model). The assumption in the timber supply model on which this analysis is based is to allow the inoperable forest to continually "grow" so that over time it all becomes old forest. This result follows from the simplifying assumption that no natural disturbances are modeled in the inoperable landbase. This assumption does not reflect reality in the study area: the composite of many small and infrequent larger disturbances does influence seral stage distribution in all areas of the coast (Dorner and Wong 2003).

The implication for the coarse filter risk assessment is that because the amount of old forest in the model increases without incorporating natural disturbances, risk may be underestimated (i.e., harvesting in the timber harvesting landbase is compensated for by the concomitant apparent growth of old forest in the inoperable). This effect can be very large, especially in ecosystems with a large area of inoperable forest (see Graphs Page C for examples).

Solution: Two different strategies were required to address this issue. First, unlike the model used in the North Coast, we did not allow an increase in old forest above the mean natural level to result in increased risk. This prevents overestimates of risk in these truly low risk systems. Second, although the best alternatives would be to 1) disturb the inoperable landbase, or 2) cap growth at some reasonable level (as in the North Coast SELES model), this was not done within the EGSA-Timber. As an alternative, we examine the data to identify cases where real risk is likely being offset by growing old forest in the inoperable ().

Note that these two issues identified above can act independently of each other—they can either cancel each other out, or exacerbate one another, resulting in both over and underestimates of risk. In the final results table () we identify those units for which we have high confidence in the risk results, and those for which we have lower confidence because of these difficulties of interpretation.

2.3 Defining the Natural Benchmark

To assess the effectiveness of any management strategy for environmental values, it is necessary to define the benchmark against which scenarios will be assessed (B.C. Ministry of Environment 2000; Beasley and Wright 2001). Over the last 10 years, scientists have developed approaches to characterize environmental risks in managed landscapes based on the concept of approximating natural disturbances. The theory is that the closer selected attributes of managed landscapes resemble those resulting from natural disturbances, the lower are the risks to environmental values.

This approach requires a description of what the landscape would look like under a natural disturbance regime (e.g., without harvesting but including events such as natural windthrow, fires, and avalanches). This is termed specifying the "range of natural variability – RONV." The concept of RONV refers to the effects of natural disturbances, and acknowledges that the scale and extent of disturbances will change annually and will therefore be "variable" through time (Figure 2). Describing RONV allows us to estimate how much forest of different ages is expected to be present on the landscape if it were not managed.

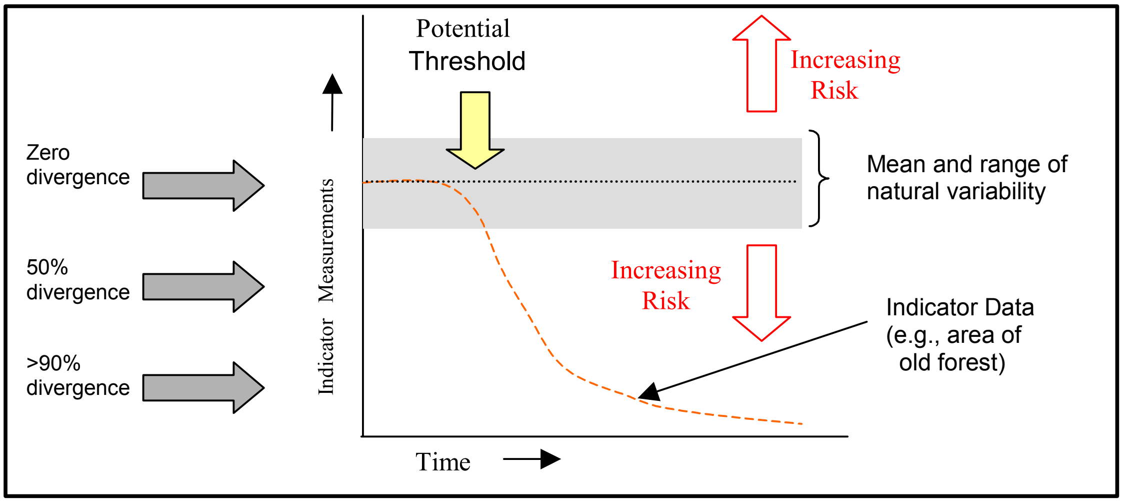
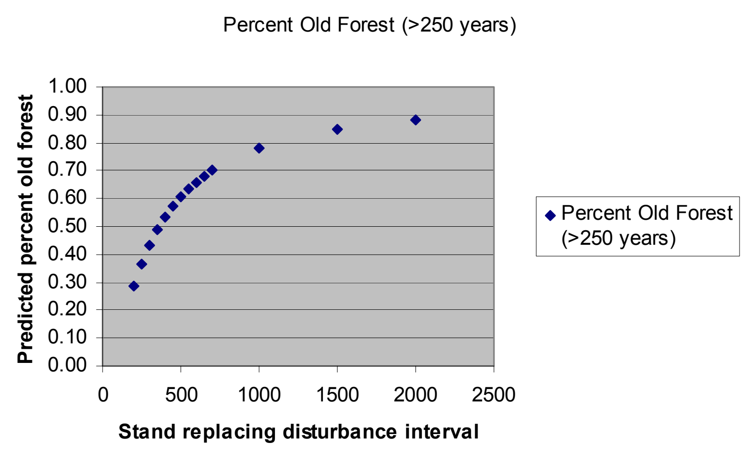


Figure 2. Using range of natural variability as a benchmark to assess ecological risks.

(Adapted from Holt and Utzig 2002). Arrows on the left show how “divergence from natural” is assessed.



Application of the “negative exponential” equation (B.C. Ministry of Forests and BC Environment 1995) to the natural disturbance data (Table 2) allows prediction of the mean and range percentage of old forest for each BEC variant. Note that the predicted amount of old forest is very insensitive to changes in disturbance frequency between 600 and 3000 years. If the estimates of stand-replacing disturbance interval are incorrect within this range, prediction of mean old forest varies by only a few percent and so will not radically influence the prediction of the natural benchmark of the model (see adjacent figure).

Disturbance parameters for the Central Coast Region

We obtained information on disturbance parameters for these ecosystems from two main sources. A separate report produced for the Central Coast used a number of techniques for estimating natural disturbance regimes for ecosystems (defined in a number of ways) for the coastal region including Haida Gwaii (Price and Daust 2003). In that report, estimates of disturbance frequency were not produced for ecosystems as defined by analysis units and BEC variants (as in this report), but the authors did provide us with estimates based on analysis units, for use in this analysis.

Alternatively, we used the background work provided for a similar analysis on the North Coast which used a number of non-analytical steps to define disturbance frequencies to ecosystems, which involved a background report (Dorner and Wong 2003), augmented by field experience (A. Banner and J. Pojar, pers. comm.). Using this information as a base, disturbance frequencies were provided for the Central Coast Analysis Units (A. Banner, pers. comm.). A summary of data from both methods is shown in Table 1.

Table 1. Estimates for disturbance rates based on Price and Daust (2003), and highest and lowest likely mean disturbance interval (A. Banner, pers. comm.) plus associated predicted percent old forest

Analysis units	BEC variants	Analytical estimate return interval/ years (Price)	Predicted percent forest >250 years (Price)	Lowest likely mean disturbance interval (Banner)	Highest likely mean disturbance interval (Banner)	Lowest likely mean percent old forest (Banner)**
Spruce Low	CWHds, ws, ESSFmw, IDFww, MSdc	16283	0.98	1000	1500	0.78
Hemlock Medium/Low Cedar medium/Low Spruce low	CWHvh, MHwh	8578	0.97	1500	5000	0.85
Cedar medium/Low Spruce low	CWHvm, MHmm	3347	0.93	1500	5000	0.85

Analysis units	BEC variants	Analytical estimate return interval/ years (Price)	Predicted percent forest >250 years (Price)	Lowest likely mean disturbance interval (Banner)	Highest likely mean disturbance interval (Banner)	Lowest likely mean percent old forest (Banner)**
Cedar High	CWHvh, MHwh	2308	0.90	1500	5000	0.85
Cedar low Spruce high/medium	CWHmm, dm, xm, ms	1726	0.87	600	800	0.66
Hemlock high/medium/low Cedar low Spruce medium	CWHds, ws, ESSFmw, IDFww, MSdc	1655	0.86	600	800	0.66
Hemlock High, medium/low Cedar high Spruce high/medium	CWHvm, MHmm	1443	0.84	600	800	0.66
Hemlock high Spruce high/medium	CWHvh, MHwh	1430	0.84	600	800	0.66
Hemlock high/medium/low Cedar high/medium Fir high	CWHmm, dm, xm, ms	891	0.76	400	600	0.54
Cedar high/medium Fir low	CWHds, ws, ESSFmw, IDFww, MSdc	757	0.72	400	600	0.54
Fir high/medium/low	CWHvm, MHmm	692	0.70	400	600	0.54
Fir high/medium	CWHds, ws, ESSFmw, IDFww, MSdc	483	0.60	400	600	0.54
Fir medium/low	CWHmm, dm, xm, ms	459	0.58	400	600	0.54
Pine	CWHds, ws, ESSFmw, IDFww, MSdc	289	0.42	200	400	0.29
Pine	CWHmm, dm, xm, ms	279	0.41	200	400	0.29

** This figure is used in the analyses because it will result in lowest likely risk output.

The two sets of disturbance rates differ, with those from Price and Daust being consistently lower, and resulting in higher estimates of percent old forest in natural forest. In this analysis, we use the numbers produced from Allen Banner to determine base risk so that these base risk results mirror those already produced for the North Coast (Holt and Sutherland 2003a). Although the ecosystems are not exactly the same, many of them are similar in their overall temporal dynamics and the general methodology and rationale for both sets of disturbance frequencies is similar. We use the disturbance frequencies produced by Price and Daust as a comparison through sensitivity analysis to help provide a simple assessment of the effects of uncertainties in natural disturbance rates on results.

2.4 Identify Risk Classes and Thresholds

The output of this ERA can be interpreted in two ways:

Ecosystems can be compared with each other to assess ***relative risks*** *to each ecosystem*

Ecosystems can be compared with the predicted "natural" range to gauge ***absolute risks***

The first comparison is useful in focusing on components of the landscape that are at most risk. The second comparison uses the assumption that the more different a managed landscape is from a natural landscape, the higher the risk to the coarse filter, and is useful for gauging whether a particular risk is actually "high" or just "higher" than another. Using this premise, we assume that a large deviation from natural results in a high risk to the coarse filter. There are clearly numerous ecosystem- or species-specific variables, plus stochastic (chance) environmental variation that influence how individual ecosystems could respond to changes in the amount of "habitat" available. Literature regarding ecological thresholds has been summarized elsewhere (CIT 2004; Dykstra, in prep.). Although these point to potential ecological thresholds at various degrees of divergence from a natural state, most result does not provide unambiguous thresholds from which to assess risks.

Based on the findings of the literature review, but acknowledging the likelihood of high variability, we used five equal risk categories based on a linear function of 0–100% deviation from natural with a change from low to moderate risk at 40% deviation, and a change to high risk at 60% deviation from natural (Table 2). For example, in the base risk class, if the deviation in old forest from natural is 0–20% the "risk" label given would be "very low."

Table 2. Risk categories - base categories, plus sensitivity categories

Sensitivity	Very low	Low	Moderate	High	Very high
Base risk class	0–20	21–40	41–60	61–80	81–100
"Lower risk"	0–34	35–57	58–74	75–88	89–100
"Higher risk"	0–12	13–26	27–43	44–66	67–100

In addition, we ran sensitivity analysis using two options: 1) a categorization where it is "easier" to become high risk, and 2) a categorization where it is "less easy" to become high risk (Table 2; Figure 7). Note that in applying these risk categories within the Bayesian Belief Network the outcome is actually the "most probable" risk category, which is defined as the conclusion (hypothesis) with the greatest belief weighting, given the belief weights on other hypotheses in the network. In other words, the most likely individual conclusion that can be drawn from the evidence as embodied in the network.

Note that readers can determine their own risk scale, and reassign risks on that. The key part of this type of analysis is to explicitly state assumptions and to allow the reader to reassess assumptions.

3.0 Results

3.1 Trends in Old Forest: A Graphical Overview

Trends of projected old forest abundance through time for a selection of ecosystems are presented graphically (Graphs Pages A–D following). 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 50, 100, 200 years) percentage of old forest in that ecosystem. Old forest is further separated into two strata: (1) percent in the timber harvesting landbase (THLB) and (2) percent in the non-contributing (NC) landbase.[4] Because much of the landscape is physically inoperable, this separation gives an indication of physical distribution of old forest on the landbase through time (see example for cedar/low on Graph Page A). If the percentage of old forest in an ecosystem at time 0 (current year) is very low, we interpret this as a reflection of harvesting pressures to date. This is particularly apparent for the high productivity AUs where historical harvesting has tended to focus, and is confirmed by graphs showing that very little old forest currently remains in these ecosystems.

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

Note that some AU x BEC combinations represent very small physical areas,[5] and as a result, a small amount of harvesting can change the "percent old forest" substantially. However, these small, relatively rare ecosystems are likely a very important component of the diversity of the Central Coast region and loss of small areas may have very high ecological significance. Because of the large number of ecosystems, graphs are shown generally only for the three largest ecosystems within each analysis unit.

An overview of how to interpret the graphs is shown on Page A. This first graph (Cedar/Low analysis units) is a typical unit for which there has been, and is projected to be, very little harvest. The second example shows the Fir/Low analysis unit in which the projected amount of old forest in the inoperable landbase increases dramatically over the 200 year forecast. This behaviour, which is an artifact of the timber supply model because it does not include modeling of natural disturbances in this landbase, creates an interpretation issue for risk values for some ecosystems. In this case, the risk category for these ecosystems will decrease through time, but most likely, the amount of old forest in the inoperable landbase will naturally stabilize through natural disturbance rates and will not continue to increase as shown. Likely, the risk categories for these units will not decrease to the extent shown – and ecosystems where this is occurring are highlighted in the result tables.

Risk values, and associated most probable risk category (from Netica) are shown for all ecosystems in , and summarized in Figure 3.

Interpretation of graphs is shown in regular font, *interpretation of risk classes (from Netica) is shown in italics.*

Ecosystem old forest trends and risk outputs

The number of ecosystems in each risk class over time (using base risk categories, and Banner disturbance frequencies) is summarized in Figure 3. Currently, most ecosystems are at either very high, or very low risk, and few are rated in the middle risk categories. This general pattern remains throughout the planning horizon, though the number of ecosystems at very high risk declines slightly through time, and the number at very low risk increases through time. See commentary on individual ecosystem summaries: some of this reduction is a result of growing old forest in the inoperable landbase.

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[5] No ecosystems less than 200 ha are shown anywhere in the results.

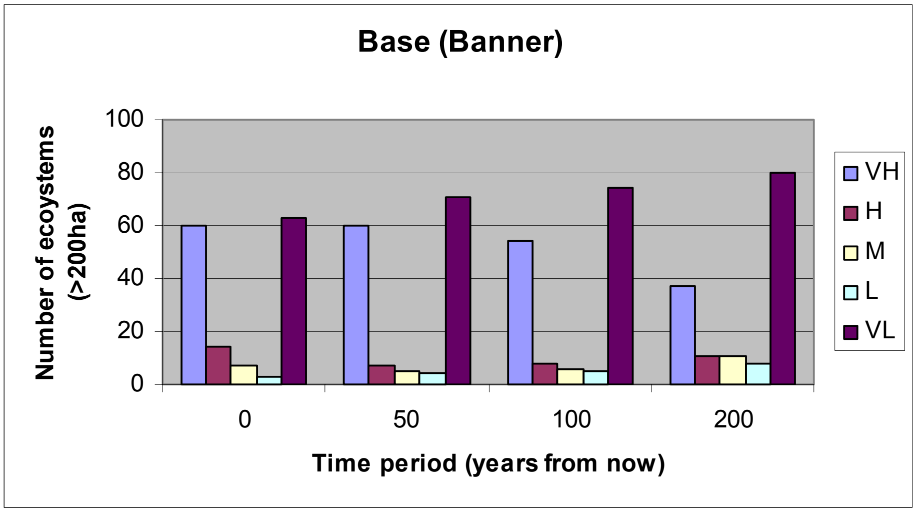


Figure 3. Summary of number of ecosystems (>200 ha) in each risk class, over time using Banner highest likely mean disturbance frequency, and base risk categories.

General patterns for ecosystems are summarized below. Ecosystems for which Forest Cover typing inaccuracies may create a risk interpretation problem are highlighted below and in :

Cedar/High, Fir/High, and Fir/Medium. Represents 0.9, 1.8, and 2.3% of landbase, respectively. There is very high deviation from mean predicted percent of old forest at time 0 for all cedar high ecosystems and all fir/high and fir/medium ecosystems (Graphs Page B). Any remaining old forest is harvested in these units in the short-term (within 50 years), and remaining old forest is found in the non-contributing landbase (which tends to be a low percentage of the total landbase). Within the drier ecosystems, there are only small portions of the landbase as cedar/high types, and within the CWHxm2 there already is no old forest remaining in the THLB (only 320 ha total land area; not shown).

All cedar/high, fir/high, and fir medium ecosystems are in the high or very high risk category at t=0, and remain there through time, with the exception of a) cedar/high in the CWHxm2 where the final risk category is reduced to high (because of forest growing old in the inoperable landbase) and b) fir/medium in the CWHvm and IDFww.

Cedar/Low. Represents 31.7% of the landbase (Graphs Page A). At time 0 the percentage of old forest in the total landbase is very similar to the predicted amount of old forest, and in general remains similar through time. The proportion of the Cedar/Low that is THLB is low, so as this is harvested the deviation from mean RONV is not large. The effect of growing old in the inoperable is seen as the amount of old forest increases, however the percentage change is relatively small for these units – though this equates to a large area of old forest. For example, in the CWHvh2, the percent old forest in the inoperable increases from 61 to 87%, which represents an areal extent difference of 73,451 ha of old forest. In some of the drier BEC variants (e.g., CWHdm, CWHxm) the total area of cedar/low is small, and for these ecosystems the percent old forest does decrease through time.

Cedar/Low risks for all ecosystems commence at very low risk, and remain at very low risk throughout the time period. With the exception of the Cedar/Low in the CWHvm–where risk initially is "very high" and becomes very low after 50 years – however, examination of the forest cover suggests this is a result of a typing error (the area of mature forest is very large at time 0).

Cedar/Medium, Hemlock/High, Hemlock/Medium, Spruce/High, and Spruce/Medium. Represents 8.9, 10.8, 23.6, 0.6, and 0.6% landbase, respectively. (Graphs Page D). The distribution and trends for old forest varies across these ecosystems. For some of these ecosystems, current percent old forest is quite low, and remains so over time. However, many of these ecosystems have a significant percent of old forest (usually around 50%), with a significant portion of the old forest remaining in the THLB at current time.

Over the mid-term (100 years) most of this is harvested and the remaining amount of old forest is dependent on the proportion of inoperable forest. For some ecosystems there is a relatively small proportion of inoperable (e.g., Cedar/Medium in the CWHvm1–41%) compared with others, which have a large percent of inoperable (Cedar/Medium in MHmm1 which has only 75% THLB). In most cases the percentage of old forest in the inoperable portion of these ecosystems increases through time, but for most of these units the increase is not so dramatic as to suggest either a forest cover typing problem, or a problem with interpretation of risk classes based on total old forest.

The patterns of risk within this group vary by type:

For Cedar/Medium units: Most ecosystems are at very low or low risk at time 0, and most remain very low after 50 years, but about one-third of the ecosystems become moderate, high, or very high over the remainder of the time period.

For Hemlock/High: Most (12 of 16) ecosystems are at very high risk at time 0, and three ecosystems (HH in the CWHvh2, vm, and vm2) are classed as very low risk at time 0. These ecosystems tend to remain in the same risk class over the whole time period through to 200 years.

Hemlock/Medium: risks are quite variable for this group, with a reasonable distribution of very low through to very high risk at time 0, and similarly at 50 years, though there is a move towards an increasing number of ecosystems in the higher risk categories after 50 years. The drier ecosystems tend to be high or very high risk, while wetter ecosystems are moderate or low. Overall, these ecosystems tend to remain in their original risk categories over time.

For Spruce/high: 3 of 5 ecosystems are at very low risk at time 0, while one ecosystem (in the CWHvh1) starts at very high risk. After 50 years 3 ecosystems are at very high risk and only remains in the very low risk group, and after 200 years the very low risk unit becomes low.

For Spruce/Medium: again, this group is diverse, with 4 of 6 ecosystems at very high or high-risk at time0, and 2/6 at very low risk. At 50 years, 4 are at very high risk, decreasing back to 3 at very high risk as inoperable forest becomes old through time at 200 years. Interpretation of risk over the long-term in this group is difficult as a result of this modeling artifact.

Hemlock/Low, Spruce/Low, Fir/Low. Represents 13.2%, 1.4%, and 1.7% of landbase, respectively. The output for these units is difficult to interpret given the data sources and certainty around forest cover data. In general in this group, the initial total percent old forest is considerably lower than that predicted. Examination of the seral stage distribution for these units (see Figure 4 for examples) suggests this is not a result of harvesting (there is a low proportion of early seral at time 0), though harvesting does affect some units through time, but likely results from Forest Cover age mistyping where a significant area is typed as mature forest at time 0, and which is all allowed to grow into old forest through time. We cannot determine from the available data whether the forest cover inventory is correct and this forest is in fact younger now than predicted (i.e., that the mean RONV estimates for these types are too low), or whether this is a forest cover typing issue – and that most of the forest is typed as age class 7 or 8 but in fact is age class 9 currently. It is interesting that in general this phenomenon was not seen within the Cedar/Low data.

Hemlock/Low: Most ecosystems begin at very low risk, and remain there through time. However, in the CWHds2 and in the vm risk is initially high though decreases through time as large percentages of the inoperable become "old" (97% and 70%, respectively, for these two variants). Examination of seral stage data (Figure 4) suggests that most of these units should be very low, or low risk at time 0, and remain there.

Spruce/Low most of these ecosystems are initially at very high risk, but over the duration, they mostly become low risk as again a large percentage of the inoperable forest grows old (e.g., the percent old forest in the inoperable in the CWHdh2 is initially 2%, and increases to 97% over the 200 years; most increase from around 20% to high 90% over the duration). Examination of the seral stage distributions suggest that this effect is mostly a result of misclassification of age class in these types, and that most of these units should be very low, or low risk and remain there throughout the forecast period (the percentage of early seral is very low for all ecosystems, averaging less than 5%).

Fir/Low: At time 0, most ecosystems are at very high risk, but over the 200 years, most become low or very low risk. This reflects the growing of the inoperable forest into high percentages of old forest. For most of these ecosystems the percent old forest in the inoperable landbase is approximately 20%, but over the duration of the model it increases usually into the higher 90% number. This likely reduces risk unrealistically (see table).

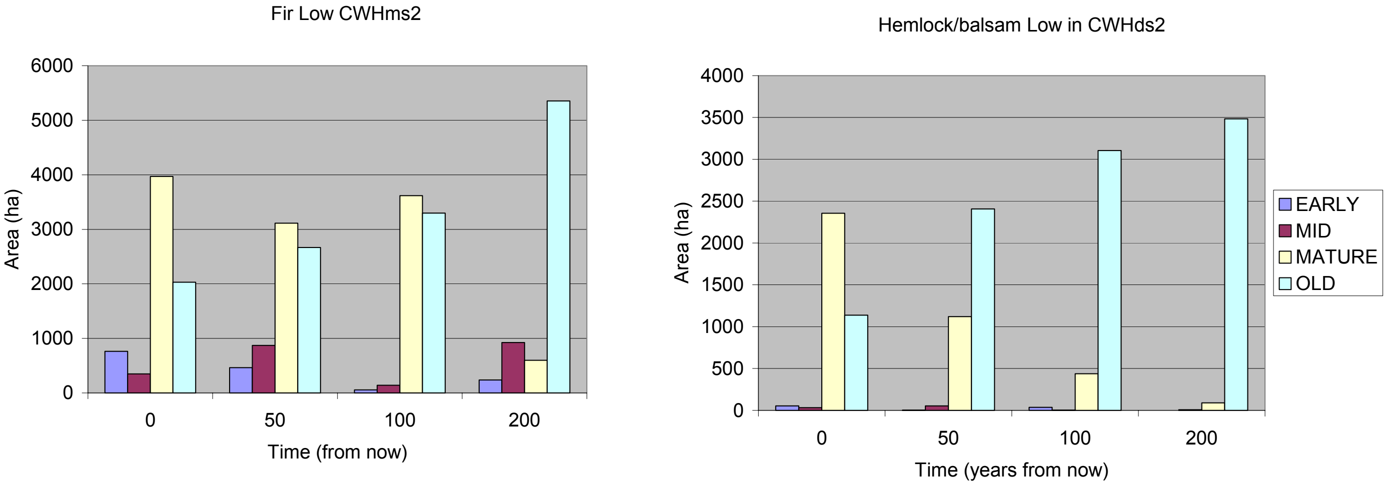
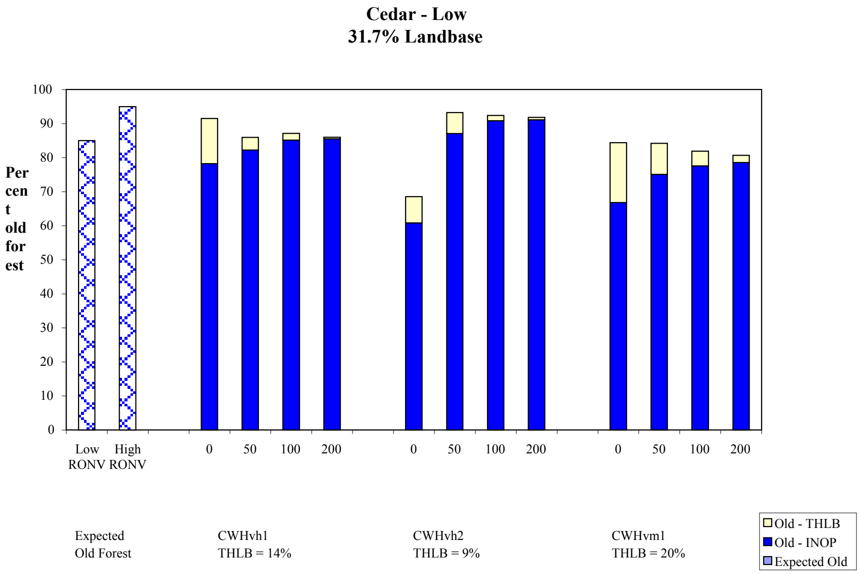
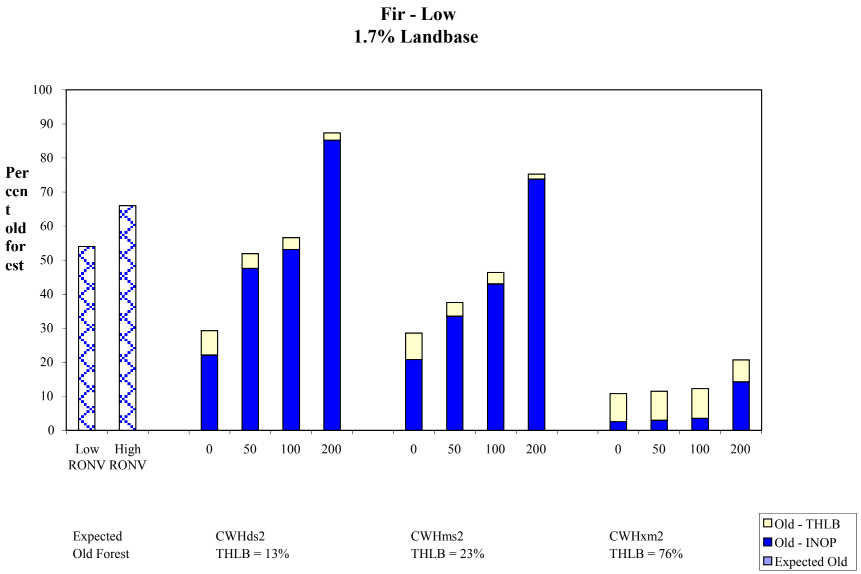


Figure 4. Seral stage distribution for hemlock/balsam low in the CWHds2 and Fir low in CWHms2.

Note the area of mature forest that becomes old after the first 50 years.

Graphs Page A

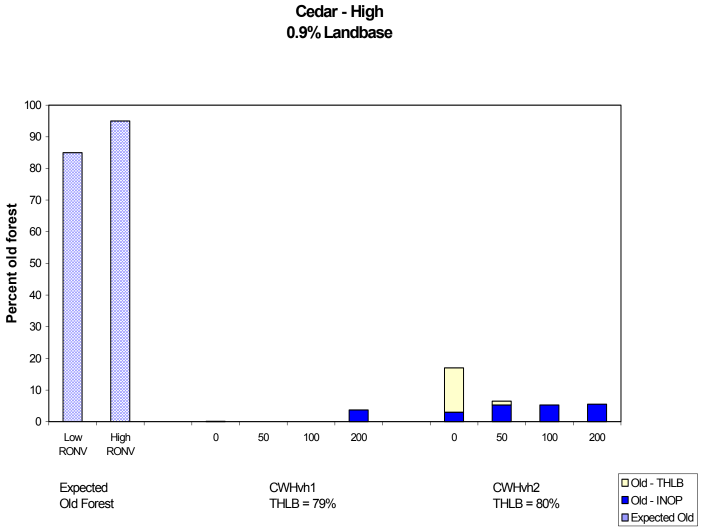


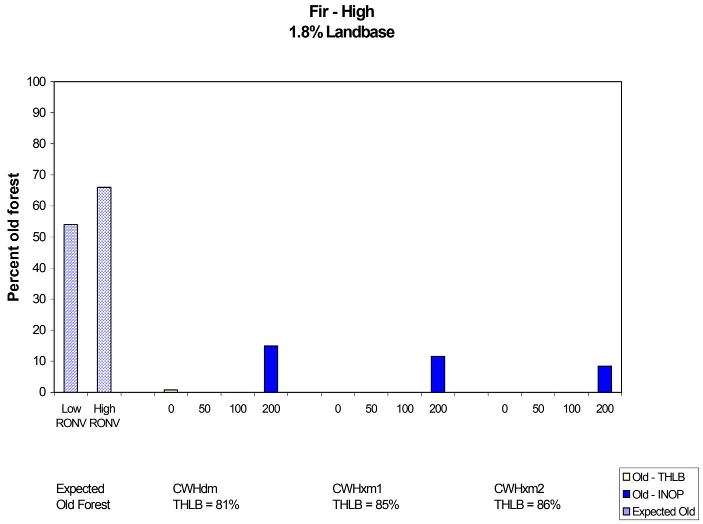


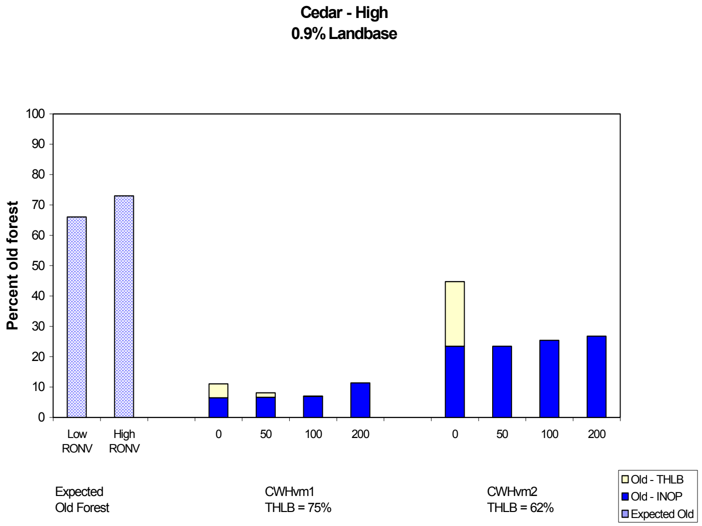
For example, this 1st figure shows the Cedar/ Hemlock Low productivity analysis unit, in the CWHvh1, CWHvh2 and CWHvm1 BEC variants. The predicted percent old forest (based on highest and lowest likely disturbance intervals) is shown on the left in hatched blue (around 90%). For each ecosystem, the actual percent old forest (at time 0) and forecast amounts from the harvest model (at time 50, 100 and 200 years from now) is shown for the timber harvesting landbase and the inoperable landbase. For Cedar/ Hemlock – Low in the CWHvh1 there is good agreement now between actual and predicted old forest, and it remains that way throughout the time period. For Cedar/ Hemlock Low in the CWHvh2 the initial percent old forest is lower than predicted (approx. 65%), but increases through time as forest in the inoperable grows into old forest. The old forest within the relatively small proportion of THLB for this unit is harvested throughout the period, but there remains a high percent of old forest overall because most of the landbase is inoperable.

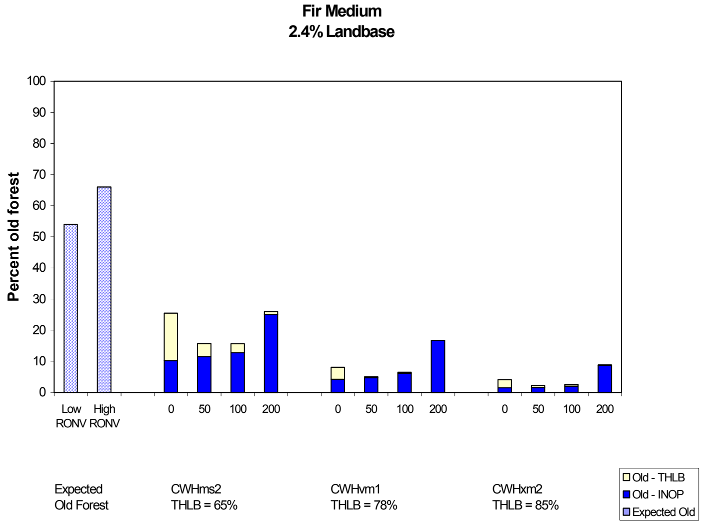
The 2nd figure shows the Fir low productivity analysis unit, within the CWHd2s, CWHms2 and CWHxm2 variants. In this figure the mean predicted natural range for Fir low AU is between 54 – 65%. The actual percent of old within the CWHds2 is currently (Time 0) at 30%, with about a 1/4th of it in the THLB. This example shows two of the difficulties in interpretation of some of the forest cover data in this region. Note the low initial level (compared with predicted mean RONV) and the increase in the percent of old forest in the inoperable landbase through time. We cannot determine whether the RONV numbers are incorrect, or whether the forest age-class typing is incorrect, or whether risk does reduce over time. Unfortunately, risk interpretations are complicated by both this and the lack of disturbance in the inoperable as discussed previously.

Graphs Page B



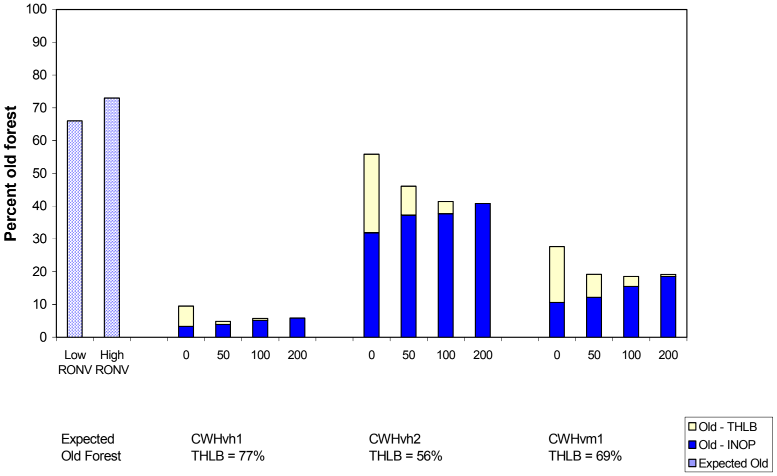




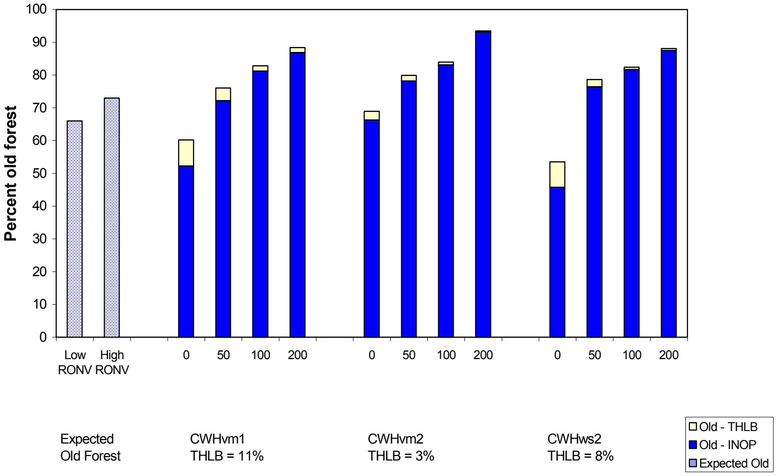


Graphs Page C

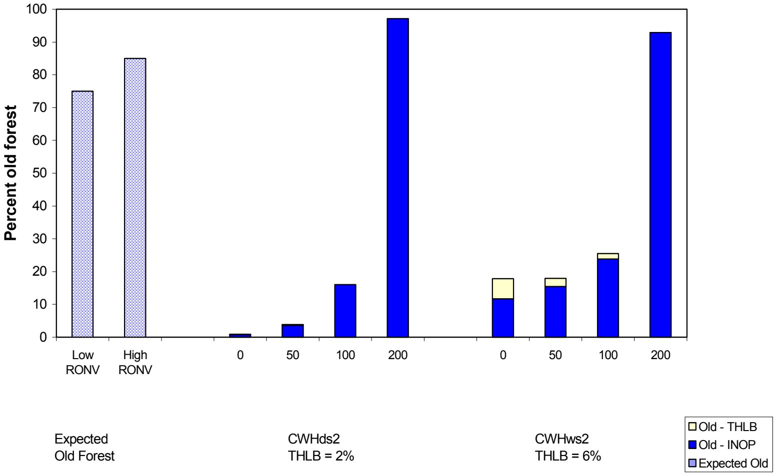
Spruce - Medium
0.6% Landbase



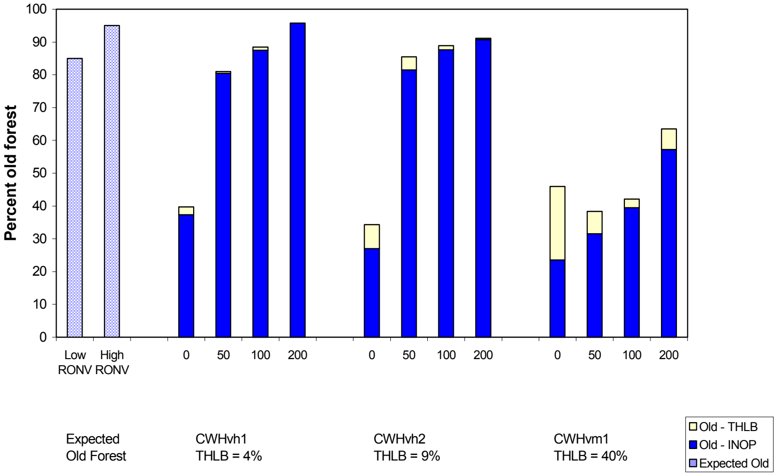
Hemlock/Balsam - Low
13.2% Landbase



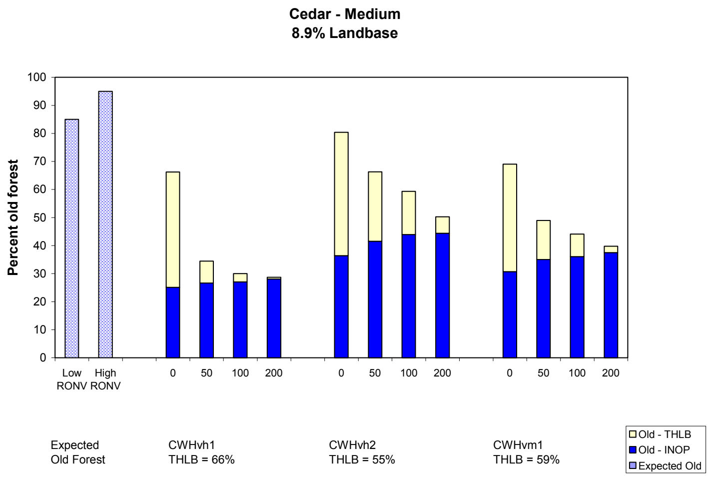
Spruce/Pine - Low
1.4% Landbase

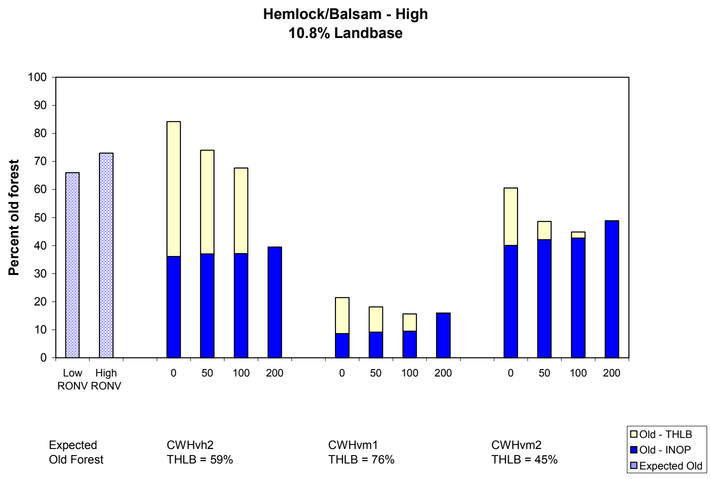


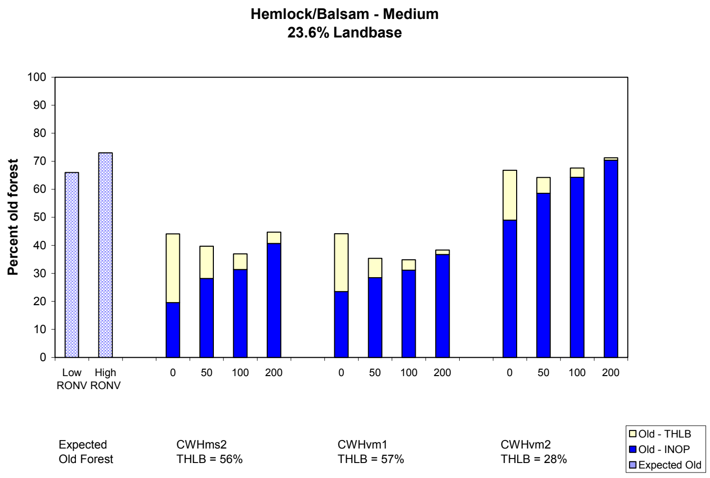
Spruce/Pine - Low
1.4% Landbase



Graphs Page D







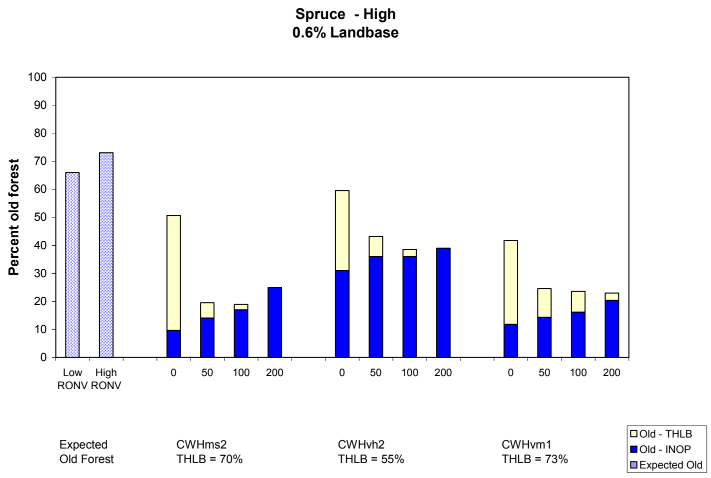


Table 3. Total summary of outputs, for ecosystems >200ha. **Base risk ratings (Banner) plus associated most probable risk rating. Sensitivity using Price disturbance regimes at time 0, and difference in risk score. The confidence scores summarise whether closer inspection of the data suggests forest cover ages, or growing the inoperable affected the risk outcome. Y = confident in result. N = not confident in result. U suggests an upward pressure, and D suggests a downward pressure.**

Analysis unit	**BEC Variant**	**Base risk values over time**				**Most probable risk categories over time**				**Sensitivity (Price) at time 0**	**Base minus sensitivity**	**Confidence in outcome**	
		0	**50**	**100**	**200**	**0**	**50**	**100**	**200**			**Time 0**	**Time 200**
CedarHigh	CWHdm	61	84	84	84	VH	VH	VH	VH	70	9	Y	Y
CedarHigh	CWHms2	67	69	71	68	VH	VH	VH	VH	78	11	Y	Y
CedarHigh	CWHvh1	90	90	90	88	VH	VH	VH	VH	90	0	Y	Y
CedarHigh	CWHvh2	76	85	86	86	VH	VH	VH	VH	77	0	Y	Y
CedarHigh	CWHvm1	81	81	81	78	VH	VH	VH	VH	83	3	Y	Y
CedarHigh	CWHvm2	52	61	60	58	VH	VH	VH	VH	54	2	Y	Y
CedarHigh	CWHxm2	83	83	83	73	VH	VH	VH	H	89	5	Y	Y
CedarLow	CWHdm	18	18	12	12	VL	VL	VL	VL	36	18	Y	Y
CedarLow	CWHds2	46	24	24	15	VL	VL	VL	VL	52	6	Y	Y
CedarLow	CWHmm1	15	32	32	41	VL	VL	VL	VL	23	8	Y	Y
CedarLow	CWHmm2	11	17	17	13	VL	VL	VL	VL	14	4	Y	Y
CedarLow	CWHms2	32	14	14	14	VL	VL	VL	VL	44	12	Y	Y
CedarLow	CWHvh1	11	11	12	12	VL	VL	VL	VL	13	2	Y	Y
CedarLow	CWHvh2	27	11	11	11	VL	VL	VL	VL	33	6	Y	Y
CedarLow	CWHvm	73	12	11	11	VH	VL	VL	VL	75	2	Y	Y
CedarLow	CWHvm1	15	13	14	15	VL	VL	VL	VL	17	2	Y	Y
CedarLow	CWHvm2	13	11	11	11	VL	VL	VL	VL	14	1	Y	Y
CedarLow	CWHvm3	27	13	11	11	VL	VL	VL	VL	31	4	Y	Y
CedarLow	CWHws2	20	13	16	16	VL	VL	VL	VL	26	6	Y	Y
CedarLow	CWHxm2	21	21	15	21	VL	VL	VL	VL	28	7	Y	Y
CedarLow	MHmm1	22	12	11	11	VL	VL	VL	VL	23	1	Y	Y
CedarLow	MHmm2	15	11	11	11	VL	VL	VL	VL	16	1	Y	Y
CedarLow	MHwh	55	11	11	11	M	VL	VL	VL	60	5	N (D)	Y
CedarLow	MHwh1	16	11	11	11	VL	VL	VL	VL	17	2	Y	Y
CedarMedium	CWHdm	20	51	51	36	VL	M	M	L	41	21	Y	N (U)
CedarMedium	CWHds2	50	46	50	46	M	VL	VL	VL	63	14	Y	N (U)
CedarMedium	CWHmm1	13	56	56	60	VL	VH	VH	M	29	16	Y	N (U)
CedarMedium	CWHms2	33	32	32	31	VL	VL	VL	VL	44	11	Y	N (U)
CedarMedium	CWHvh1	24	58	67	67	VL	H	H	H	34	10	Y	Y
CedarMedium	CWHvh2	17	24	31	40	VL	VL	L	L	20	3	Y	N (U?)
CedarMedium	CWHvm	30	16	22	33	L	VL	VL	L	32	3	Y	Y
CedarMedium	CWHvm1	23	44	49	53	VL	L	M	H	28	4	Y	Y
CedarMedium	CWHvm2	16	22	25	30	VL	VL	VL	VL	18	2	Y	N (U)
CedarMedium	CWHvm3	20	22	27	28	VL	VL	L	L	21	1	Y	Y
CedarMedium	CWHws2	33	26	23	31	VL	VL	VL	VL	37	4	Y	N (U)

Analysis unit	BEC Variant	Base risk values over time				Most probable risk categories over time				Sensitivity (Price) at time 0	Base minus sensitivity	Confidence in outcome	
CedarMedium	CWHxm2	27	28	23	59	VL	L	VL	M	42	16	Y	Y
CedarMedium	IDFww	11	11	11	11	VL	VL	VL	VL	11	0	Y	Y
CedarMedium	MHmm1	20	24	23	23	VL	VL	VL	VL	22	2	Y	Y
FirHigh	CWHdm	84	84	84	73	VH	VH	VH	VH	90	6	Y	Y
FirHigh	CWHds2	84	84	84	63	VH	VH	VH	VH	88	4	Y	Y
FirHigh	CWHmm1	84	84	84	84	VH	VH	VH	VH	90	6	Y	Y
FirHigh	CWHms2	70	71	73	62	VH	VH	VH	VH	77	6	Y	Y
FirHigh	CWHvm1	82	83	84	80	VH	VH	VH	VH	88	5	Y	Y
FirHigh	CWHxm1	84	84	84	78	VH	VH	VH	VH	90	6	Y	Y
FirHigh	CWHxm2	84	84	84	81	VH	VH	VH	VH	90	6	Y	Y
FirLow	CWHdm	70	81	81	39	VH	VH	VH	VL	75	5	N (D)	Y
FirLow	CWHds2	54	23	16	11	H	VL	VL	VL	60	7	N (D)	Y
FirLow	CWHmm1	50	66	66	50	H	H	H	M	58	8	N (D)	?
FirLow	CWHms2	49	37	19	12	M	VL	VL	VL	55	5	N (D)	? U
FirLow	CWHvm1	68	64	63	21	H	H	H	VL	77	9	N (D)	? U
FirLow	CWHvm2	56	61	61	35	VH	VH	VH	VL	64	8	N (D)	Y
FirLow	CWHvm3	61	53	35	11	H	M	VL	VL	69	7	N (D)	Y
FirLow	CWHws2	52	16	15	13	M	VL	VL	VL	63	11	N (D)	Y
FirLow	CWHxm1	82	81	81	52	VH	VH	VH	M	86	4	?	?
FirLow	CWHxm2	77	77	77	57	VH	VH	VH	H	81	5	N (D)	?
FirLow	IDFww	11	11	11	11	VL	VL	VL	VL	11	0	N (D)	Y
FirLow	MHmm2	58	43	30	15	VH	VL	VL	VL	63	4	N (D)	Y
FirMedium	CWHdm	80	84	77	59	VH	VH	H	VH	85	4	Y	Y
FirMedium	CWHds2	70	44	44	34	H	VL	VL	VL	76	6	Y	N (U?)
FirMedium	CWHmm1	80	82	82	80	VH	VH	VH	VH	85	4	Y	Y
FirMedium	CWHms2	54	67	67	55	VH	VH	H	VH	59	5	Y	Y
FirMedium	CWHvm1	81	81	79	65	VH	VH	VH	H	86	6	Y	Y
FirMedium	CWHvm2	68	67	59	53	VH	VH	VH	VL	75	7	Y	N (U)
FirMedium	CWHvm3	42	52	52	55	VL	VL	VL	M	45	3	?	?
FirMedium	CWHws2	63	42	44	30	H	VL	VL	VL	68	6	Y	N (U)
FirMedium	CWHxm1	83	83	83	61	VH	VH	VH	M	87	4	Y	N (U)
FirMedium	CWHxm2	84	84	84	81	VH	VH	VH	VH	88	4	Y	Y
FirMedium	IDFww	11	11	11	11	VL	VL	VL	VL	11	0	Y	Y
HemBalHigh	CWHdm	84	84	84	80	VH	VH	VH	VH	90	6	Y	Y
HemBalHigh	CWHds2	88	88	88	79	VH	VH	VH	VH	90	1	Y	Y
HemBalHigh	CWHmm1	84	84	84	84	VH	VH	VH	VH	90	6	Y	Y
HemBalHigh	CWHmm2	84	84	84	84	VH	VH	VH	VH	90	6	Y	Y
HemBalHigh	CWHms2	80	82	81	71	VH	VH	VH	VH	87	7	Y	Y
HemBalHigh	CWHvh1	87	88	88	88	VH	VH	VH	VH	90	2	Y	Y
HemBalHigh	CWHvh2	18	19	19	41	VL	VL	VL	L	19	1	Y	Y ?
HemBalHigh	CWHvm	44	47	47	65	VL	VL	VL	M	46	2	Y	Y
HemBalHigh	CWHvm1	70	72	72	74	VH	VH	VH	VH	72	2	Y	Y

Analysis unit	BEC Variant	Base risk values over time				Most probable risk categories over time				Sensitivity (Price) at time 0	Base minus sensitivity	Confidence in outcome	
HemBalHigh	CWHvm2	35	39	41	38	VL	VL	VL	VL	37	1	Y	N (U?)
HemBalHigh	CWHvm3	76	87	73	67	VH	VH	VH	VH	80	4	Y	Y
HemBalHigh	CWHws2	75	85	83	78	VH	VH	VH	VH	81	5	Y	Y
HemBalHigh	CWHxm	84	84	84	84	VH	VH	VH	VH	90	6	Y	Y
HemBalHigh	CWHxm1	84	84	84	70	VH	VH	VH	H	90	6	Y	N (U)
HemBalHigh	CWHxm2	84	84	84	84	VH	VH	VH	VH	90	6	Y	Y
HemBalHigh	MHmm1	41	55	56	53	VL	VH	VH	VH	42	1	Y	N (D)
HemBalLow	CWHds2	58	27	12	11	H	VL	VL	VL	63	5	N (D)	Y
HemBalLow	CWHmm1	25	26	18	12	L	L	VL	VL	30	5	Y	Y
HemBalLow	CWHmm2	11	11	11	11	VL	VL	VL	VL	13	2	Y	Y
HemBalLow	CWHms2	37	19	19	19	VL	VL	VL	VL	41	4	Y	Y
HemBalLow	CWHvh1	24	28	18	15	VL	VL	VL	VL	34	10	Y	Y
HemBalLow	CWHvh2	29	11	11	11	VL	VL	VL	VL	41	12	Y	Y
HemBalLow	CWHvm	71	14	13	11	H	VL	VL	VL	77	5	N (D)	Y
HemBalLow	CWHvm1	33	22	16	13	VL	VL	VL	VL	41	7	Y	Y
HemBalLow	CWHvm2	26	18	14	11	VL	VL	VL	VL	32	6	Y	Y
HemBalLow	CWHvm3	25	13	12	12	VL	VL	VL	VL	31	6	Y	Y
HemBalLow	CWHws2	34	12	12	12	VL	VL	VL	VL	42	8	Y	Y
HemBalLow	CWHxm2	14	11	11	11	VL	VL	VL	VL	32	18	Y	Y
HemBalLow	ESSFmw	62	12	12	11	VH	VL	VL	VL	66	3	N (D)	Y
HemBalLow	IDFww	15	15	15	11	VL	VL	VL	VL	15	0	Y	Y
HemBalLow	MHmm1	33	21	17	14	VL	VL	VL	VL	39	6	Y	Y
HemBalLow	MHmm2	32	14	14	14	VL	VL	VL	VL	38	7	Y	Y
HemBalLow	MHmm2e	25	11	11	11	VL	VL	VL	VL	33	8	Y	Y
HemBalLow	MHwh	69	11	11	11	H	VL	VL	VL	74	5	N (D)	Y
HemBalLow	MHwh1	28	11	11	11	VL	VL	VL	VL	34	6	Y	Y
HemBalMedium	CWHdm	61	77	77	63	H	VH	VH	M	74	13	Y	N (U)
HemBalMedium	CWHds2	82	58	46	26	VH	H	H	VL	85	4	Y	N (U)
HemBalMedium	CWHmm1	60	79	79	79	M	VH	VH	VH	72	13	Y	Y
HemBalMedium	CWHmm2	36	60	60	62	L	M	M	M	54	19	Y	Y
HemBalMedium	CWHms2	25	32	36	29	VL	VL	VL	VL	41	16	Y	N (U)
HemBalMedium	CWHvh1	44	62	57	55	VL	M	L	L	54	10	Y	?
HemBalMedium	CWHvh2	26	29	36	36	VL	VL	L	L	30	4	Y	N (U?)
HemBalMedium	CWHvm	47	46	56	65	M	M	M	H	56	8	Y	Y
HemBalMedium	CWHvm1	47	58	59	56	M	H	H	H	56	9	Y	Y
HemBalMedium	CWHvm2	26	27	24	24	VL	VL	VL	VL	33	7	Y	N (U)
HemBalMedium	CWHvm3	20	19	25	21	VL	VL	VL	VL	30	9	Y	N (U)
HemBalMedium	CWHws2	25	25	24	19	VL	VL	VL	VL	35	10	Y	?
HemBalMedium	CWHxm	69	84	84	52	H	VH	VH	M	80	11	Y	N (U)
HemBalMedium	CWHxm1	84	84	84	84	VH	VH	VH	VH	90	6	Y	Y
HemBalMedium	CWHxm2	75	75	75	80	VH	VH	VH	VH	82	8	Y	Y
HemBalMedium	ESSFmc	88	88	11	11	VH	VH	VL	VL	90	1	N (D)	?

Analysis unit	BEC Variant	Base risk values over time				Most probable risk categories over time				Sensitivity (Price) at time 0	Base minus sensitivity	Confidence in outcome	
HemBalMedium	ESSFmw	88	39	22	22	VH	L	VL	VL	90	1	N (D)	Y
HemBalMedium	IDFww	67	67	53	11	H	H	M	VL	74	7	?	?
HemBalMedium	MHmm1	26	19	15	14	VL	VL	VL	VL	33	7	Y	Y
HemBalMedium	MHmm2	44	16	12	11	VL	VL	VL	VL	52	7	Y	Y
HemBalMedium	MHwh	16	16	17	17	VL	VL	VL	VL	18	2	Y	Y
SpruceHigh	CWHms2	32	70	76	69	VL	VH	VH	VH	39	8	Y	Y
SpruceHigh	CWHvh1	70	77	76	73	VH	VH	VH	VH	71	1	Y	Y
SpruceHigh	CWHvh2	30	37	40	41	VL	VL	L	L	35	5	Y	N (U?)
SpruceHigh	CWHvm1	50	66	67	68	VL	VH	VH	H	53	4	Y	Y
SpruceHigh	CWHws2	61	55	55	55	H	H	H	H	68	7	Y	Y
SpruceLow	CWHds2	89	88	74	11	VH	VH	VH	VL	90	1	N (VL)	Y
SpruceLow	CWHms2	75	75	57	21	VH	VH	VH	VL	78	3	N (VL)	Y
SpruceLow	CWHvh1	52	21	18	13	VH	VL	VL	VL	58	7	N (VL)	Y
SpruceLow	CWHvh2	61	14	13	14	VH	VL	VL	VL	64	3	N (VL)	Y
SpruceLow	CWHvm1	50	55	55	37	VH	VH	VH	VL	52	2	N (VL)	Y
SpruceLow	CWHvm2	18	15	15	11	VL	VL	VL	VL	19	1	N (VL)	Y
SpruceLow	CWHws2	75	74	65	12	VH	VH	VH	VL	78	3	N (VL)	Y
SpruceLow	CWHxm2	89	89	89	17	VH	VH	VH	VL	91	1	N (VL)	Y
SpruceLow	ESSFmc	89	89	14	11	VH	VH	VL	VL	91	1	N (VL)	Y
SpruceLow	ESSFmw	89	89	72	11	VH	VH	VH	VL	91	1	N (VL)	Y
SpruceLow	IDFww	89	11	11	11	VH	VL	VL	VL	91	1	N (VL)	Y
SpruceLow	MHmm2	83	75	53	11	VH	VH	VL	VL	84	1	N (VL)	Y
SpruceMedium	CWHms2	48	51	49	51	VL	VH	VL	H	52	5	Y	Y
SpruceMedium	CWHvh1	80	86	86	85	VH	VH	VH	VH	83	3	Y	Y
SpruceMedium	CWHvh2	34	41	46	44	VL	VL	VL	VL	37	3	Y	N (U)
SpruceMedium	CWHvm1	63	68	70	70	VH	VH	VH	VH	67	4	Y	Y
SpruceMedium	CWHvm2	85	84	79	79	VH	VH	VH	VH	87	2	Y	Y
SpruceMedium	CWHws2	60	43	54	55	H	VL	M	M	64	4	Y	N (U)

3.2 Sensitivity Analysis

We ran sensitivity analysis on two types of information: 1) natural disturbance parameters, and 2) risk category thresholds.

Natural disturbance parameters

The base analysis used the Banner estimates of highest likely mean disturbance frequencies (), and the risk level obtained using the Price and Daust sensitivity risk associated for each ecosystem is higher using these alternate data for disturbance frequencies (which are lower, and therefore predict a higher level of old forest). The mean difference is 5 points difference (1/4 of a risk class), with a maximum difference of 21 (a full risk category) and a minimum difference of zero. The largest differences were seen in general for cedar/medium and low and hemlock-balsam/medium and low ecosystems.

Smallest differences between scenarios tended to be for Cedar/High, Hemlock/High, and Spruce/Low ecosystems (though with high variability;).

For summary, the number of ecosystems (>200 ha) in each risk category in the base run is compared with that from the mean disturbance frequencies predicted analytically by Price and Daust (2003; Figure 5).

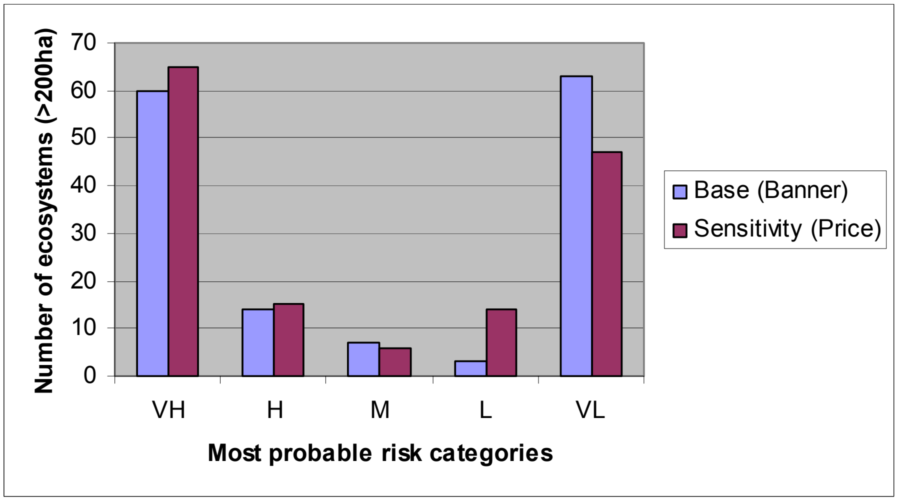


Figure 5. Sensitivity analysis on natural disturbance regime.

Although there are differences in the number of ecosystems in each risk category, the overall pattern remains very similar using either the Banner estimates, or the Price estimates of disturbance frequency.

Risk category thresholds

A sensitivity for risk class thresholds was performed using a range of risk category cutoffs (Figure 6). The results are summarized in terms of the number of ecosystems found in each risk class.

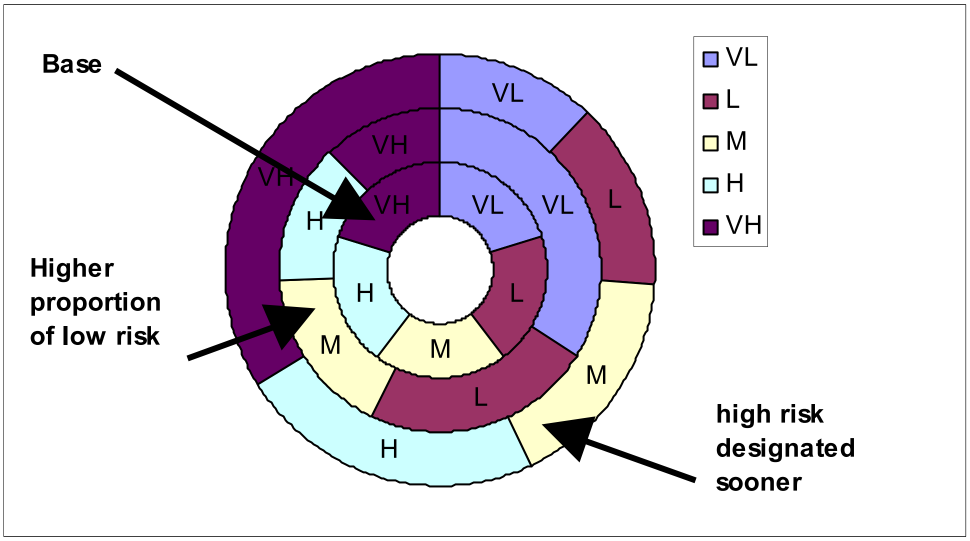


Figure 6. Risk categories for base and for sensitivity analyses.

In summary, although the actual number of ecosystems in each risk class does change using difference risk cutoffs, due to the nature of the landbase (most ecosystems are either very impacted, or very slightly impacted) the general pattern remains very similar. Although counterintuitive, this results from the fact that ecosystems here tend to be either highly modified, or largely unmodified—pushing ecosystems towards the high/very high category, or the very low category, largely irrespective of risk category thresholds. The risk class results are therefore relatively insensitive to the risk categories used, within the range considered reasonable here.

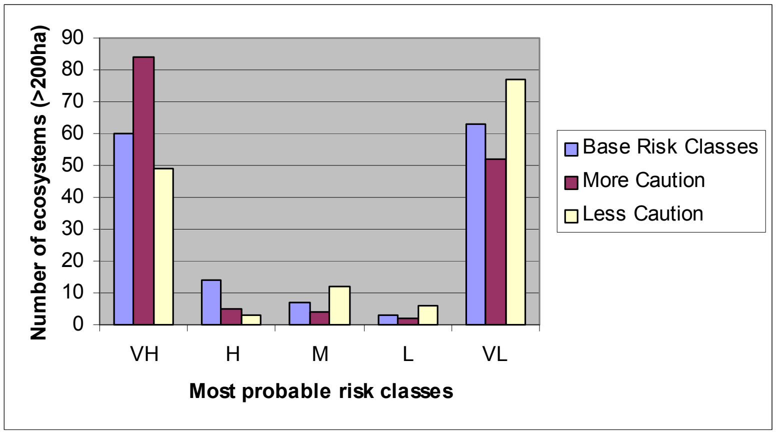


Figure 7. Sensitivity analysis on risk categories.

3.3 Geographic Location of Risks

This is a regional analysis. It sums the results of actions at individual watershed scales, and provides the reader with an overview of how different ecosystems are affected, and over what timeframes. However, it does not directly provide an assessment of risks to individual ecosystems within individual watersheds through time.

To interpret these results within a local context requires an overview of where ecosystems in different risk categories are located. For example, what area of high risk ecosystems is located in a particular watershed or landscape unit? Given the number of ecosystems (146 greater than 200 ha), and the often small areas involved, it is difficult to map and tabulate this information in an accessible way. To give the reader a general overview of locations, analysis units (without BEC variant) are tabulated with respect to landscape units (Appendix 2; Tables 1 and 2). Table 1 provides the percentage of the total area of each analysis unit (all seral stages). Table 2 provides the percentage of the existing old+mature forest in each landscape unit. For summary value, an "index" (simply a summation of the percentages for the top five highest risk ecosystems) is provided, and can be used to key into landscape units which have either a very high percentage of an individual high risk ecosystem, or a lower percentage of multiple high risk ecosystems.

Using this methodology, a number of landscape units stand out for having a high percentage of a particular analysis unit, or a number of different high risk units. For example

4.0 Discussion

The abundance and distribution of old forests through time for the Central Coast Region is highly variable with respect to different ecosystems (). 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 low or moderate risk to those systems currently, but predicted harvesting pressure increases the risk to high in most variants over the short term (the next 50 years). Low productivity ecosystems have generally high abundance of old forest compared with natural abundance, which we interpret as meaning they are generally at very low or low risk through time. However, this interpretation is difficult to make due to some known issues with respect to forest cover age typing for some low productivity ecosystems in this region.

Reporting on base risk, 60 and 14 of 146 ecosystems (>200 ha) are at very high or high risk, respectively, at time 0, in contrast with 63 and 3 ecosystems at very low or low risk, respectively, at the same time period. Straight interpretation of the risk results shows the number of ecosystems in the high risk groups decreasing through time (to 48 ecosystems at high or very high risk) and to 88 at low or very low risk. It is difficult to interpret all the results at face value however because of the combination of 1) likely underestimates of forest cover age for some low productivity units, and 2) a lack of natural disturbance projected in the inoperable landbase within the timber model, resulting in dramatically increasing percent old forest through time. These two factors tend to cancel one another out, making assessment of long-term risk difficult for lower productivity and some medium productivity ecosystems. We are confident, however, in our assessment of all high productivity and most medium productivity ecosystems.

Quantitative ecological thresholds for ecosystem-based analyses such as this are not well known. However, in this case, the number of ecosystems in each risk class was insensitive to changing the risk probability functions, which increased our confidence that they represent a reasonable picture of the ecological risks to the Central Coast area in relation to the Base Case management regime.

Several substantive practical and theoretical challenges are involved in coarse-filter representation analyses such as this. First, these analyses are inherently scale- and context-dependent: the criteria for evaluating ecosystems vary both with the type of ecosystem, its local and regional rarity, and (although not considered here) its spatial relationship with similar ecosystems across the landbase. Second, data requirements of ecosystem representation are relatively poorly defined (either theoretically or in practice), and few data standards are in place for this type of analysis. Most such studies define "ecosystem surrogates" that are intended to capture the primary characteristics of ecosystem function (i.e., distribution and abundance of habitats and where known, species, biotic and abiotic flows; and the historical range of productivity, natural disturbance types, and rates of ecosystem recovery) (Nally et al. 2002). Yet these ecosystem surrogates vary widely from place to place, as does the reliability of the empirical data on which they are constructed.

Key uncertainties in our analysis include:

Representation of ecosystems: Using analysis units within BEC variants to represent ecosystems is reasonable for this coarse, regional scale analysis. However, it has two key failings: 1) it does not allow representation of rare/listed ecosystems (as would a site series analysis), and 2) it may inherently under-represent the impact to ecosystems that have already been highly modified and had a change in leading species compared with the natural condition.

Modeling: Any trends analysis model is only as representative as the forecasting model. The model is an estimate of how the land will be managed into the future, based on current management assumptions. However, any failure to represent reality will result in inaccurate ecosystem trends. If these assumptions do not hold over the time period (200 years) then the abundance of old forest, and therefore risks will differ with those presented here. A number of assumptions are likely to change during this period: First, the timber harvesting landbase is likely to increase. Even at this current time, timber harvesting occurs inside the zone designated as "inoperable," but these effects are not included in the timber model. As a result the abundance of old forest in the currently lower productivity/inoperable stands will likely decrease and risks will increase over those shown here. Second, the model assumes only clearcut harvesting is occurring, when some variable retention harvesting is likely already occurring and may increase through time. This may have a number of outcomes depending on the specific changes, but increased variable retention may result in lower local risks (due to maintenance of stand structure) but higher risks over the landscape as more areas are harvested at a faster rate (Holt and Sutherland 2003b).

Inventory: As highlighted throughout the text forest cover inventory issues limit the interpretation of risk for **a selection of the ecosystems** included here. However, we do not believe that the higher productivity (and usually higher risk) ecosystems are impacted by these forest cover typing issues primarily because this area of the landbase is the primary area targeted for accurate mapping.

Predictions of natural disturbance parameters and percent old forest: This analysis is dependent on reasonable predictions of natural disturbance parameters. In this analysis we used the most conservative (highest frequency) numbers available for *highest likely mean* disturbance intervals (A. Banner, pers. comm.). A sensitivity analysis shows that using longer estimates (from an analytical study on this region) results in somewhat higher risk values, but in general does not change the ratings of most individual ecosystems.

Risk classes: In this analysis we present raw data trends in graphical format, risk ratings, and an interpretation of the risk ratings using a simple 5 class linear risk categorization. Using this system, most ecosystems are either very high/high risk, or very low/low risk. Sensitivity analysis on these category thresholds does not result in a highly modified pattern of the number of ecosystems in each risk class.

Scale of analysis: As described above, this is a regional scale analysis, and the methodology is not easily applied at the level of watersheds (or CIT Landscapes and Seascapes [aggregates of intermediate watersheds]) due to the small scale, and high diversity of ecosystems present. When applied at too small an area, errors can arise simply due to the stochasticity of harvesting individual blocks, etc., and the analysis may fail to clearly represent broad patterns. However, at the scale of the region, currently high risk, or future high risk ecosystems are identified. To apply this to the local/management direction level, the location of these higher risk systems can be used to identify current, or future high risk geographic areas. An example is presented using analysis units only, within landscape units.

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Appendix 1. Analysis unit definitions

Table A1.1. Analysis units used in this analysis (defined by Williams and Buell 2003 for EGSA-Timber)

AU	Description
FirHigh	AU 1: Fir, ITG=1-8, SI >27
FirMedium	AU 2: Fir, ITG=1-8, 21<= SI <=27
FirLow	AU 3: Fir, ITG=1-8, SI <=20
CedarHigh	AU 4: Cedar, ITG=9-11, SI >23
CedarMedium	AU 5: Cedar, ITG=9-11, 16<= SI <=23
CedarLow	AU 6: Cedar, ITG=9-11, SI <=15
HemBalHigh	AU 7: HemBal, ITG=12-20, SI >22
HemBalMedium	AU 8:HemBal, ITG=12-20, 12.6<= SI <=22
HemBalLow	AU 9: HemBal, ITG=12-20, SI <=12.5
SpruceHigh	AU 10: Spruce, ITG=21-34, SI >22
SpruceMedium	AU 11: Spruce Pine, ITG=21-34, 16<= SI <=22
SpruceLow	AU 12: Spruce, ITG=21-34, SI <15

Appendix 2. Broad summaries of geographic locations (by landscape unit) of analysis units

Table A2.1. Percentage possible of each analysis unit, located by landscape unit.
All seral stages included. Final "Index" column is total of top five at risk AUs present in each LU. Example: 12% of the total cedar/high is located in Allison LU – note it may already be harvested. The Index shows simply the summed percentages of the highest at risk AUs present in each LU (cedar/high, fir/high, fir/medium, hemlock-balsam/high, spruce/high). It is not a measure—just an index!

Landscape unit	Cedar - High	Fir - High	Fir - Medium	HemBal - High	Spruce - High	Cedar - Medium	Spruce - Medium	HemBal - Medium	Fir - Low	HemBal - Low	Spruce - Low	Cedar - Low	Total	*Summary Index – top 5 AUs*
Aaltanhash	0	0	0	1	1	0	0	0	0	0	0	0	0	*2*
Ahnuhati-kwalate	0	0	0	0	2	0	2	1	0	1	0	0	1	*3*
Ahta	1	0	0	0	0	1	1	0	0	1	0	1	1	*1*
Allison	12	0	0	0	0	2	2	0	0	0	3	6	2	*12*
Ape	0	0	1	0	0	0	0	0	0	0	1	0	0	*1*
Belize	4	0	0	1	0	2	0	1	0	2	4	6	3	*5*
Bella Coola	0	1	2	0	0	0	0	0	2	0	1	0	0	*3*
Bonanza	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
Braden	0	0	0	0	1	1	2	1	0	2	1	1	1	*1*
Brooks	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Broughton	7	0	0	4	0	4	3	1	0	0	0	1	1	*11*
Butedale	0	0	0	2	1	1	0	0	0	0	0	0	0	*4*
Calvert	0	0	0	0	0	0	0	0	0	0	1	2	1	*0*
Chapple	0	0	0	0	1	0	1	0	0	1	3	2	1	*1*
Charles	0	0	0	0	0	1	0	0	0	1	0	1	0	*1*
Clayton	0	0	1	0	0	0	0	1	5	1	1	0	1	*2*
Clyak	0	0	0	0	5	1	2	2	0	0	1	2	1	*6*
Cortes	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Crag	0	0	3	0	0	0	0	1	2	1	11	0	1	*3*
Dean	1	1	3	0	1	0	1	2	6	2	3	0	1	*6*
Denny	0	0	0	0	0	1	0	0	0	1	1	2	1	*0*
Don Peninsula	1	0	0	1	1	3	4	1	0	1	3	1	1	*2*
Doos/Dallery	0	0	0	0	3	1	2	2	0	1	0	1	1	*3*
Draney	1	0	0	0	0	3	0	1	0	0	0	4	2	*2*
Ellerslie	0	0	0	0	0	2	1	1	0	0	1	1	1	*0*
Estero	2	1	2	1	0	1	0	1	1	1	0	1	1	*6*
Evans	0	0	0	0	1	2	1	1	0	1	1	3	1	*1*
Fish Egg	0	0	0	0	0	2	0	0	0	0	0	5	2	*1*
Franklin	0	1	1	0	0	0	1	1	1	2	0	0	1	*3*
Fulmore	11	10	8	10	0	4	0	4	5	1	2	1	4	*39*
Gilford	11	1	2	10	2	3	6	2	1	1	0	1	3	*26*

Landscape unit	Cedar - High	Fir - High	Fir - Medium	HemBal - High	Spruce - High	Cedar - Medium	Spruce - Medium	HemBal - Medium	Fir - Low	HemBal - Low	Spruce - Low	Cedar - Low	Total	*Summary Index – top 5 AUs*
Gray	1	2	2	3	0	1	0	1	0	0	0	0	1	*9*
Green	0	0	0	3	4	1	0	0	0	0	0	0	1	*8*
Helmcken	0	0	0	0	0	0	0	0	0	0	0	3	1	*0*
Holberg	0	0	0	1	0	0	0	0	0	0	0	0	0	*1*
Huaskin	7	0	0	3	0	4	2	1	0	0	0	3	2	*10*
Hunter	0	0	0	0	0	0	1	0	0	0	1	1	0	*0*
Johnston	0	0	0	0	1	1	0	1	0	0	0	2	1	*1*
Jump Across	1	0	0	0	1	0	0	2	1	1	1	0	1	*2*
Kakweiken	0	0	0	1	2	1	0	1	0	2	0	1	1	*3*
Kashutl	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Keogh	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Khutze	0	0	0	2	1	0	0	0	0	0	0	0	0	*3*
Kilbella/Chuckwalla	0	0	0	0	11	1	4	2	0	1	0	1	1	*12*
Kilippi	0	0	0	0	1	0	0	1	0	2	0	0	0	*1*
King Island	0	0	0	0	1	1	1	2	0	2	0	1	1	*1*
Klaskish	1	0	0	0	0	0	2	2	0	1	0	0	1	*1*
Klekane	0	0	0	1	1	0	0	0	0	1	0	0	0	*2*
Klinaklini Glacier	0	0	0	0	0	0	0	0	0	1	0	0	0	*0*
Knight East	1	0	0	2	1	1	0	2	0	1	0	1	1	*4*
Kwatna/Quatlena	2	0	0	1	6	1	6	2	0	3	1	1	2	*9*
Kynoch	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Labouchere	0	0	0	0	0	1	2	2	0	1	1	0	1	*0*
Laredo	0	0	0	4	1	2	0	0	0	1	0	3	2	*5*
Lower Kimsquit	0	0	0	0	1	0	2	2	2	2	1	0	1	*2*
Lower Kingcome	0	0	1	1	1	1	2	1	0	1	0	0	1	*3*
Lower Klinaklini	0	2	5	0	2	0	1	2	5	4	1	0	1	*9*
Lower Nimpkish	0	0	0	0	0	0	0	0	0	0	0	0	0	*1*
Lull-Sallie	2	0	1	2	1	1	2	1	0	1	0	1	1	*5*
Machmell	1	1	1	0	3	0	1	2	0	2	0	0	1	*6*
Mahatta	1	0	0	1	2	0	9	1	0	1	0	0	1	*4*
Malcolm	1	0	0	1	1	1	0	0	0	0	1	0	0	*3*
Marble	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Middle Klinaklini	0	0	2	0	0	0	0	1	7	2	18	0	1	*3*
Miriam	1	0	0	1	0	2	0	0	0	0	0	2	1	*2*
Nahwitti	1	0	0	0	1	1	2	0	0	0	0	3	1	*2*
Nascall	0	0	0	0	0	1	0	1	0	1	0	0	0	*0*
Nasparti	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Neechanz	1	0	1	0	1	1	0	2	1	2	0	0	1	*3*
Nekite	0	0	0	0	6	3	2	2	0	1	0	2	2	*6*
Neroutsos	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Nigei	0	0	0	0	1	0	1	0	0	0	0	1	0	*1*
Nootum/Koeye	3	0	0	1	6	3	2	3	0	0	0	3	2	*9*
Nusatsum	0	0	1	0	1	0	1	2	0	1	1	0	1	*2*
Outer Coast Islands	0	0	0	0	0	0	0	0	0	0	0	1	0	*0*

Landscape unit	Cedar - High	Fir - High	Fir - Medium	HemBal - High	Spruce - High	Cedar - Medium	Spruce - Medium	HemBal - Medium	Fir - Low	HemBal - Low	Spruce - Low	Cedar - Low	Total	*Summary Index – top 5 AUs*
Owikeno	0	1	2	0	0	0	0	1	2	1	0	0	1	*4*
Phillips	6	0	2	2	2	1	0	1	0	0	0	0	1	*12*
Price	0	0	0	0	0	0	0	0	0	0	0	1	0	*0*
Quadra	0	3	0	0	0	0	0	0	0	0	1	0	0	*4*
Quinsam	0	4	1	0	0	0	0	0	0	0	0	0	0	*5*
Roderick	0	0	0	6	6	5	0	0	0	0	0	2	2	*12*
Roscoe	0	0	0	0	0	2	7	1	0	2	1	1	1	*0*
Salmon	0	3	2	1	0	0	0	1	1	1	0	0	1	*5*
Saloompt	0	0	1	0	0	0	0	2	2	2	0	0	1	*2*
San Josef	2	0	0	1	2	0	3	1	0	0	0	1	1	*5*
Sayward	1	52	28	4	1	0	0	3	19	1	2	0	3	*85*
Seymour	0	0	0	0	1	0	2	0	0	2	0	1	1	*1*
Sheemahant	1	1	2	0	4	0	1	1	3	2	0	0	1	*8*
Sheep Passage	0	0	0	0	0	0	2	0	0	0	0	1	0	*0*
Shushartie	0	0	0	0	0	0	0	0	0	0	1	2	1	*1*
Sigulat	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Sim	0	0	1	0	0	0	0	1	0	1	0	0	0	*1*
Simms	0	2	0	0	0	0	0	0	0	0	0	0	0	*2*
Smith Sound	0	0	0	0	0	1	0	0	0	0	3	2	1	*0*
Smitley/Noeick	0	1	1	0	0	0	0	2	1	1	1	0	1	*3*
Smokehouse	0	0	0	0	1	1	1	1	0	1	0	2	1	*1*
Snowdrift	3	0	0	1	0	4	2	1	0	1	0	2	1	*4*
South Bentinck	0	0	1	0	0	0	0	1	1	2	1	0	1	*1*
Stafford	5	1	0	3	1	3	0	0	0	1	0	0	1	*11*
Sumquolt	0	0	0	0	1	0	0	1	0	2	0	0	1	*1*
Surf	0	0	0	0	0	1	1	0	0	2	0	2	1	*0*
Sutslem/Skowquiltz	0	0	1	0	0	0	1	1	3	1	0	0	1	*1*
Swindle	0	0	0	0	0	1	0	0	0	1	0	2	1	*0*
Tahsish	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Talchako/Gyllenspetz	0	0	3	0	0	0	0	0	5	1	1	0	0	*4*
Taleomey/Asseek	0	0	2	0	0	0	1	1	3	1	0	0	1	*3*
Thurlow	2	10	8	8	0	0	0	1	7	0	1	0	2	*28*
Tolmie	0	0	0	2	0	1	0	0	0	0	0	1	1	*2*
Triumph	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Tsulquate	3	0	0	0	0	1	0	0	0	1	0	2	1	*3*
Twin	0	0	0	0	0	0	1	2	0	3	0	0	1	*0*
Unclassified	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Upper Campbell	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Upper Kimsquit	0	0	0	0	1	0	2	1	0	3	0	0	1	*2*
Upper Kingcome	0	0	0	0	0	0	1	2	0	1	0	0	1	*1*
Upper Klinaklini	0	0	3	0	0	0	1	0	10	1	14	0	1	*4*
Wakeman	1	0	0	1	1	2	1	3	0	1	0	0	1	*3*
Walker	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Washwash	0	0	1	0	1	0	0	1	0	2	0	0	1	*3*

Landscape unit	Cedar - High	Fir - High	Fir - Medium	HemBal - High	Spruce - High	Cedar - Medium	Spruce - Medium	HemBal - Medium	Fir - Low	HemBal - Low	Spruce - Low	Cedar - Low	Total	*Summary Index – top 5 AUs*
Water	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Water/Dean-Burk Channel	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Whalen	0	0	0	0	1	1	1	1	0	2	0	1	1	*1*
White	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Yeo	0	0	0	2	1	2	0	1	0	0	0	2	1	*3*
Young	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Area (al seral stages)	18,200	36,074	46,790	212,360	11,010	175,435	12,661	465,973	32,956	259,691	27,967	625,122	1,971,500	

Table A2.2. Percent of OLD + MATURE forest of each analysis unit, located by landscape unit.

Final "Index" column is total of top five at risk AUs present in each LU. Example: 6% of the remaining old+mature cedar/high is located in Belize LU. The Index shows simply the summed percentages of the older forest, present for the highest at risk AUs present in each LU (cedar/high, fir/high, fir/medium, hembal/high, spruce/high). It is not a measure of anything—just an index!

	Cedar - High	Fir - High	Fir - Medium	HemBal - High	Spruce - High	Cedar - Medium	Spruce - Medium	HemBal - Medium	Fir - Low	HemBal - Low	Spruce - Low	Cedar - Low	*Index – TOP 5 SUMARY*
Aaltanhash	0	0	0	4	2	0	0	0	0	0	0	0	*5*
Ahnuhati-kwalate	0	0	1	0	2	0	6	2	1	1	0	0	*4*
Ahta	0	0	0	0	0	1	0	1	0	1	0	1	*0*
Allison	0	0	0	0	0	2	0	0	0	0	4	6	*0*
Ape	0	0	2	0	0	0	0	0	0	0	1	0	*2*
Belize	6	0	0	0	0	1	0	1	0	2	5	6	*6*
Bella Coola	0	0	1	0	0	0	0	0	3	0	1	0	*1*
Bonanza	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Braden	0	0	0	0	1	1	2	1	0	2	1	1	*1*
Brooks	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Broughton	1	0	0	1	0	4	0	1	0	0	0	1	*2*
Butedale	0	0	0	7	2	1	0	0	0	0	0	0	*9*
Calvert	0	0	0	0	0	0	0	0	0	0	1	2	*0*
Chapple	0	0	0	0	0	0	0	0	0	2	4	2	*0*
Charles	1	0	0	0	0	1	0	0	0	1	0	1	*1*
Clayton	0	1	3	0	0	0	0	1	7	1	1	0	*4*
Clyak	0	0	0	0	5	1	2	1	0	1	1	1	*5*
Cortes	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Crag	0	1	9	0	0	0	0	2	3	1	13	0	*10*

	Cedar - High	Fir - High	Fir - Medium	HemBal - High	Spruce - High	Cedar - Medium	Spruce - Medium	HemBal - Medium	Fir - Low	HemBal - Low	Spruce - Low	Cedar - Low	*Index – TOP 5 SUMARY*
Dean	0	6	8	0	1	0	2	2	8	2	4	0	*15*
Denny	0	0	0	0	0	1	0	0	0	1	1	2	*0*
Don Peninsula	4	0	0	3	1	3	9	1	0	1	4	1	*7*
Doos/Dallery	0	0	0	0	4	1	1	2	0	1	0	1	*4*
Draney	0	0	0	0	0	3	0	0	0	0	0	4	*0*
Ellerslie	0	0	0	0	0	2	3	1	0	0	1	1	*0*
Estero	0	3	4	1	0	1	0	1	1	1	0	0	*8*
Evans	0	0	0	0	1	2	2	1	0	2	2	3	*1*
Fish Egg	1	0	0	0	1	3	0	0	0	0	0	5	*1*
Franklin	0	0	1	0	0	0	0	1	0	2	0	0	*2*
Fulmore	15	17	5	3	1	3	0	1	4	1	1	1	*41*
Gilford	1	1	0	2	0	2	0	1	0	1	0	1	*4*
Gray	1	0	0	1	0	1	0	0	0	0	0	0	*2*
Green	0	0	0	10	6	1	0	1	0	0	0	0	*16*
Helmcken	0	0	0	0	0	0	0	0	0	0	0	3	*0*
Holberg	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Huaskin	2	0	0	0	0	3	0	0	0	0	0	3	*2*
Hunter	0	0	0	0	0	0	0	0	0	0	2	1	*0*
Johnston	0	0	0	0	1	2	0	1	0	0	0	2	*2*
Jump Across	3	0	1	0	1	0	1	2	1	1	1	0	*5*
Kakweiken	0	0	0	0	3	1	0	1	0	1	0	1	*3*
Kashutl	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Keogh	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Khutze	0	0	0	5	2	0	0	0	0	0	0	0	*6*
Kilbella/Chuckwalla	0	0	0	0	5	1	1	2	0	1	0	1	*6*
Kilippi	0	0	0	0	1	0	1	1	0	2	0	0	*1*
King Island	0	0	0	0	0	1	0	2	0	2	0	1	*0*
Klaskish	0	0	0	0	0	0	1	2	0	2	0	0	*0*
Klekane	0	0	0	3	1	0	0	0	0	0	0	0	*4*
Klinaklini Glacier	0	0	0	0	0	0	0	0	0	1	0	0	*0*
Knight East	1	0	1	0	1	1	0	2	1	1	0	1	*4*
Kwatna/Quatlena	4	0	0	1	4	1	3	3	0	3	1	1	*9*
Kynoch	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Labouchere	0	1	0	0	0	1	4	2	0	1	2	0	*1*
Laredo	0	0	0	11	2	3	0	1	0	1	0	3	*13*
Lower Kimsquit	0	0	0	0	0	0	4	2	2	3	2	0	*1*
Lower Kingcome	0	2	0	0	1	1	2	1	0	1	1	0	*4*
Lower Klinaklini	0	0	2	0	1	0	2	2	5	4	2	0	*3*
Lower Nimpkish	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Lull-Sallie	0	1	1	0	0	1	0	1	0	1	0	1	*3*
Machmell	3	7	1	0	5	0	1	2	1	2	0	0	*16*
Mahatta	0	0	0	0	0	0	1	0	0	1	0	0	*0*
Malcolm	0	0	0	0	0	0	0	0	0	0	1	0	*0*
Marble	0	0	0	0	0	0	0	0	0	0	0	0	*0*

	Cedar - High	Fir - High	Fir - Medium	HemBal - High	Spruce - High	Cedar - Medium	Spruce - Medium	HemBal - Medium	Fir - Low	HemBal - Low	Spruce - Low	Cedar - Low	*Index – TOP 5 SUMARY*
Middle Klinaklini	0	1	7	0	0	0	0	1	10	2	20	0	*9*
Miriam	0	0	0	0	0	2	0	0	0	0	0	2	*0*
Nahwitti	0	0	0	0	1	1	1	0	0	0	0	3	*1*
Nascall	0	0	0	0	0	1	1	1	0	1	1	0	*0*
Nasparti	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Neechanz	3	0	1	1	1	1	0	2	0	2	0	0	*6*
Nekite	0	0	0	0	7	3	4	2	0	1	0	2	*8*
Neroutsos	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Nigei	0	0	0	0	0	0	1	0	0	0	0	1	*0*
Nootum/Koeye	0	0	0	1	6	4	5	3	0	0	0	3	*7*
Nusatsum	0	0	1	0	0	0	2	2	0	1	1	0	*1*
Outer Coast Islands	0	0	0	0	0	0	0	0	0	0	0	1	*0*
Owikeno	2	10	5	1	1	0	0	2	3	1	0	0	*18*
Phillips	9	0	0	1	1	1	0	2	0	0	0	0	*12*
Price	0	0	0	0	0	0	0	0	0	0	0	1	*0*
Quadra	0	7	0	0	0	0	0	0	0	0	0	0	*8*
Quinsam	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Roderick	0	0	0	16	8	5	0	0	0	0	0	2	*24*
Roscoe	2	0	0	0	0	2	5	1	0	2	1	1	*2*
Salmon	0	0	0	0	0	0	0	1	0	1	0	0	*1*
Saloompt	0	0	0	0	0	0	1	2	2	2	0	0	*0*
San Josef	0	0	0	0	1	0	3	1	0	0	0	1	*1*
Sayward	0	17	4	2	0	0	0	1	3	1	0	0	*23*
Seymour	0	0	0	0	0	0	0	0	0	2	0	1	*0*
Sheemahant	2	3	3	0	5	0	1	1	3	3	0	0	*13*
Sheep Passage	0	0	0	0	0	0	5	1	0	0	0	1	*0*
Shushartie	0	0	0	0	0	1	0	0	0	0	1	2	*0*
Sigulat	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Sim	0	0	1	0	0	0	0	1	1	1	0	0	*2*
Simms	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Smith Sound	0	0	0	0	0	1	0	0	0	0	4	2	*0*
Smitley/Noeick	0	0	2	0	0	0	0	2	2	1	1	0	*2*
Smokehouse	1	0	0	0	1	1	3	1	0	1	0	2	*3*
Snowdrift	0	0	0	0	0	4	0	1	0	1	0	2	*0*
South Bentinck	0	0	2	0	0	0	1	1	2	1	1	0	*2*
Stafford	31	6	0	6	1	4	0	0	0	1	0	0	*45*
Sumquolt	0	0	0	0	1	0	1	1	0	2	0	0	*1*
Surf	0	0	0	0	0	1	2	1	0	2	0	2	*0*
Sutslem/Skowquiltz	0	0	3	0	0	1	2	2	5	1	0	0	*3*
Swindle	0	0	0	0	0	1	0	0	0	1	0	2	*0*
Tahsish	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Talchako/Gyllenspetz	0	0	4	0	0	0	1	0	8	1	1	0	*4*
Taleomey/Asseek	1	0	5	0	0	0	1	2	4	2	0	0	*7*
Thurlow	1	11	6	3	0	0	0	1	4	0	1	0	*21*

	Cedar - High	Fir - High	Fir - Medium	HemBal - High	Spruce - High	Cedar - Medium	Spruce - Medium	HemBal - Medium	Fir - Low	HemBal - Low	Spruce - Low	Cedar - Low	*Index – TOP 5 SUMARY*
Tolmie	0	0	0	6	1	2	0	0	0	0	0	1	*6*
Triumph	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Tsulquate	0	0	0	0	0	0	0	0	0	1	0	2	*0*
Twin	0	0	0	0	0	0	0	2	0	2	0	0	*0*
Unclassified	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Upper Campbell	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Upper Kimsquit	0	0	0	0	2	0	3	2	0	3	0	0	*2*
Upper Kingcome	0	0	0	0	0	0	1	2	0	1	0	0	*0*
Upper Klinaklini	0	0	10	0	0	1	1	0	14	1	6	0	*10*
Wakeman	0	0	0	1	1	2	1	3	0	1	0	0	*2*
Walker	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Washwash	0	2	1	0	2	0	1	1	1	2	0	0	*6*
Water	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Water/Dean-Burk Channel	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Whalen	0	0	0	0	0	1	2	1	0	2	0	1	*0*
White	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Yeo	2	0	0	5	1	2	1	1	0	0	0	2	*8*
Young	0	0	0	0	0	0	0	0	0	0	0	0	*0*
Area mature + old only	2,899	2,726	16,162	70,957	7,004	147,959	5,414	349,838	21,732	237,774	22,118	617,097	

Appendix 3. Glossary

Analysis units (AU): These units are used as a surrogate for ecosystems, defined on the basis of leading species[6] in the stand and the productivity of the stand (high, medium, and low). AUs were defined for this analysis by the EGSA team (Williams and Buell 2003; Appendix 1). AUs were used in this analysis because they provide additional information on ecosystems at a finer scale than that given by biogeoclimatic variants, and "analysis units within each BEC variant" are used to define old forest ecosystems for this analysis. Analysis units do not provide as detailed a classification of ecosystems as site series and therefore may fail to identify patterns of risk for key ecosystems. Additionally, AUs can result in an individual site's classification changing through time as species composition changes.[7] This is a potentially significant problem with classification of any areas already harvested, because they will now have designations based on whatever species were planted or came in naturally rather than their original composition. As a result, the area of cedar is likely underestimated due to stand conversion and the area of spruce may be overestimated due to an increase in planted spruce in second-growth stands (A. Banner, pers. comm.). All AU names are shortened in the report for ease of reading (e.g., cedar/hemlock high productivity analysis unit is referred to as cedar/high).

Bayesian statistics: A statistical approach to data analysis that is appropriate for complex environmental assessment where 1) traditional statistical approaches may fail to identify a problem due to the lack of "statistical power," and 2) where quantitative data are lacking. Bayesian Belief Networks (BBN) are a method for application of Bayesian methods that allow expert opinion to be incorporated into a model.

Coarse filter: An approach to management of natural ecosystems that uses broad habitat types as the primary ecological unit to assess consequences of management activities. The objective of a coarse filter is to capture sufficient "habitat" to maintain the vast majority of ecosystems, populations of species, and genetic variation through time and space. For this assessment we focus at the regional level, and the coarse filter strategy is primarily associated with managing for old forest[8] throughout the landscape. This "coarse filter" risk assessment focuses on the risk/probability of failing to maintain an adequate coarse filter management regime, which we assume to be related to the probability of maintaining ecological integrity. Failure to maintain ecological integrity is hypothesized to result in species/ecosystem extirpations from areas of the coast. In addition, the complex and largely undocumented processes that maintain the ecosystem will be disturbed and ecosystems will not provide their natural services.

Environmental Risk Assessment: A procedure for determining the risks to environmental values based on the premise that divergence from natural patterns increases risks to environmental values (as per B.C. Ministry of Environment 2000). For this analysis we use the abundance and distribution of old forest ecosystems as the broad indicator to represent full ecosystem function, or ecological integrity.

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[6] Inventory Type Group.

[7] Note that under Base Case assumptions in the timber supply, existing AUs don't change their designation through time as stands are harvested. It is assumed in SELES that there is no species conversion in the landscape (H. Burger, pers. comm.).

[8] In other areas of the province, a coarse filter should also include managing for mature forest, but old forest is the dominant natural seral stage on the north coast, so old forest is the focus of this assessment.

Ecological integrity: The state of a natural unmanaged or managed ecosystem in which the natural ecological processes are sustained, with genetic, species and ecosystem diversity assured for the future.

Old forest: Described and mapped by the Ministry of Forests as those forests older than 250 years old for most of the ecosystems in the Coast region. In reality, many of the "old forests" on the coast are considerably older than 250 years old, and due to the types of natural disturbance in these ecosystems are likely much older than the age of individual trees. For example, gap dynamics produces a stand with trees of many ages (young to old) but the stand itself has existed longer than even the oldest tree.

Old forest ecosystems: Ecosystems can be defined at a range of scales. Implicit in the definition is that one ecosystem is tangibly "different" from another in terms of species composition, or ecological processes (Kimmins 1987). In this analysis, AUs within BEC variants are used to define ecosystems: this is adequate because AU x BEC[12] does describe significant differences between old forest ecosystems in this landscape (A. Banner, pers. comm.). Additionally, large structure (large tall trees) is an ecologically important component of temperate rainforest ecosystems. Although "high productivity" stands will fail to identify some large structure stands (e.g., slow growing, but old and very large cedar stands on poor sites), using productivity will generally identify the large structure ecosystems. Structure has been shown to be an important component in identifying useful coarse filter indicators (Nally et al. 2002).

Range of natural variability (RONV): Due to natural disturbances, ecosystems are dynamic and are never static. RONV is a term used to describe the natural amount of variability in natural disturbances in a given ecosystem. A full understanding of the dynamics of natural disturbances (rates, frequencies, and locations at multiple scales) remains unavailable. For this base analysis of risk levels we use the "***highest likely mean***" disturbance frequency as identified by expert opinion (A. Banner, pers. comm.). On graphical outputs we highlight both the highest likely mean and the lowest likely mean disturbance frequency to provide a "mean range."

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[9] In other areas of the province, a coarse filter should also include managing for mature forest, but old forest is the dominant natural seral stage on the north coast, so old forest is the focus of this assessment.

[10] Inventory Type Group.

[11] Note that under Base Case assumptions in the timber supply, existing AUs don't change their designation through time as stands are harvested. It is assumed in SELES that there is no species conversion in the landscape (H. Burger, pers. comm.).

[12] Read as "analysis unit within a particular biogeoclimatic variant."