Defining old growth and recovering old growth on the coast: discussion of options

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This background document was completed using a relatively small number of days, and is not intended to provide a complete literature review. Instead, it relies on the literature collections and knowledge of the authors.

Issue

Managing old growth is a primary goal of ecosystem-based management. In coastal BC, under natural conditions, the vast majority of forests are old, and most of these are much older than 250 years (Daniels and Gray 2006, Price and Daust 2003). This is why the original CIT guidance focussed on representation of old growth ecosystems rather than on representation of ecosystems *per se*. Legal objectives for the coast require that target amounts of each ecosystem type be maintained as old forest and that second-growth forests be recruited where old growth representation targets cannot be met. The legal objectives define old growth forests by a simple and somewhat arbitrary age criterion: 250 years or older for the North and mid-coast and 180 years or older for the South Central Coast. This approach is acknowledged by all to fail in terms of using ecologically appropriate definitions.

This background paper addresses the following questions which were presented at a workshop in Vancouver (July 08); the paper has been revised based on the authors' and attendees' discussions.

1. How should old growth be defined for the purpose of old growth representation?
2. Should we, and if so when and how, count younger stands towards old growth representation targets?
3. Where old growth targets cannot be met, what criteria should be used to guide recruitment of old growth in order to maximise ecological benefit?
4. Where restoration is required, what attributes (other than age), can be altered to expedite the creation of old growth-like stands?

Qn 1. How Should Old Growth be Defined for the Purpose of Representation?

The Purpose of Representation

In order to make rational decisions about old growth definitions and the potential contribution of younger forests, it is important to be specific about the intention of coarse filter old growth retention. The objectives of maintaining old growth are various:

- maintaining the functions associated with ecosystems over time (hydrologic cycles / nutrient cycles etc)
- maintaining habitat for all associated species, some of which only start to appear in older forests (e.g. epiphytic lichens)
- maintaining the ecosystems that define coastal temperate rainforests in good condition.

It is possible to maintain some of these attributes by managing for structural elements, and others by managing for old trees. However, because we know little about the vast majority of species, and because we do not understand how most processes operate, ecosystem representation is used as a coarse filter. This coarse filter is intended to maintain an adequate amount of the landscape in an unmanaged old seral condition so that the unknown species and processes/ functions will be maintained without direct management. Not only is this pragmatic, but it is borne of necessity, since managing for the vast number of single species is impossible (Haufler 1996; Hunter 1991; Noss and Cooperrider 1994; Franklin 1993; Coast Information Team 2004).

In general, ecosystems vary with site-specific characteristics (e.g. temperature, moisture, nutrients), time since disturbance and structural legacies of disturbances. Successful representation, then, must include the variability among ecosystems, and the natural age distribution and natural legacies typical of each ecosystem type.

Defining Old Growth

Attempting to define 'old growth forests' has created a great deal of literature over the last 20 years (e.g. Franklin et al. 1981, Wells et al. 1998, Pojar et al. 1992, Carey 2003). Aside from definitions based on economic gain or aesthetic experience, three main approaches have been used (Pojar et al. 1992):

- mensurational definitions using simple thresholds based on forest age estimates;
- ecological definitions based on structural or biological attributes within stands,
- ecological definitions based on stand dynamic theories (e.g. Oliver and Larson 1990).

We discuss these three approaches, and provide recommendations about how they can potentially be used in this context.

Using Age-Class Data

In British Columbia, the old growth definition used by forest planners is mensurational, based on estimated stand age classes determined from forest cover inventory. Stand age is estimated based on the interpreted or measured ages of trees in the canopy layers (dominant/co-dominant). This definition was originally designed to manage timber rather than to capture ecological elements and processes. Subsequently, ecologists used the existing age classes to define old growth in different ecosystems. These were outlined originally in the Biodiversity Guidebook (Province of B.C. 1995), and varied according to Natural Disturbance Type (based on biogeoclimatic units with similar disturbance return intervals). The upper age class, 250 years and above, is also a practical limit: it is a standard age class used on forest cover maps, and it is often difficult to measure the actual age of trees much older than 250 years accurately. Implementation of EBM on the coast therefore employed *status quo* approach of defining old growth as 250 years plus, except that in some cases the age of old was lowered from 250 years to 180 years (South Coast Ministerial Order[1]).

Age-based definitions are useful because they allow identification of old forests based on existing data without the expense of field sampling. Forest cover maps are one of the few inventory layers for which coverage exists for almost all of BC's Central and North Coasts. However, this simple working definition has a number of known limitations, particularly in application to the ecology of old forests:

- Forest cover age class data are often incorrect, and may systematically misclassify age for certain forest types. For example, the North Coast and Central Coast forest cover data are known to misclassify ages in low productivity forests (A. Banner and J. Pojar pers. comm. 2002; Holt and Rumsey 2008). In these ecosystems, a significant proportion of forest is typed as age-class 8 (141 – 250 years) or even age-class 7, when most is significantly older than the 250 years[2]. However, some other ecosystems (based on site series surrogates[3]) also appear to have some typing issues (see Holt and Rumsey 2008), and some of these are more difficult to correct[4].

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[1] http://ilmbwww.gov.bc.ca/lup/lrmp/coast/cencoast/objectives/index.html

[2] This issue has been typically dealt with by bumping up the ageclass of low productivity forests when analysing FC data (A. Fall pers. comm., Holt and Rumsey 2008). This creates a false 'hole' in the age class distribution which may influence EBM implementation by inaccurately representing the level of real 'old' forest on the landscape.

[3] The intent of EBM is eventually to move to management by site series. Currently, site series mapping is missing for large portions of the Central Coast and North Coast, and so management is by site series surrogates. Though both

- Forest cover age class data are imprecise; in particular, the oldest age class cannot discriminate between old and ancient forests. Particularly in coastal BC, this category includes an extremely wide range of both ages (251 years to many thousands of years) and structural attributes. It is also important to note the distinction between individual tree ages and "forest" age. The average or even maximum tree age in a stand may not reflect the total forest age, as measured by the time since a stand-replacing disturbance. Forest cover age classes are based on a few individual tree ages, or estimates. As long as all age-class 9 forests are as yet unharvested, not knowing the ages of all the stands is not an issue (since the natural distribution exists in the natural stands). However, in managed forests, 251-year-old previously harvested sites will likely differ from 1,000 year-old plus stands initiated by natural disturbance (we will have to wait considerable lengths of time to test this assumption). Within natural stands, various studies suggest that forests continue to develop as they age – from 250 years onto 1000 year old stands (Spies et al. 1988, Wells 1996, Kuiper 1994, Halpern and Spies 1995). Plus species composition differences have been measured through time (e.g. Goward 1994; Rose 1976).
- The age-based definition does not consider attributes present within the stand. Structural or biological attributes provide many of the unique habitat values and ecosystem functions that confer special importance to old growth, and vary considerably among stands in the same age class due to structural legacies and chance events. Defining old growth without an assessment of structure, particularly in managed forests, may fail to identify the most biologically important areas of forest[5]. On the other hand, defining 'old growth' simply in terms of structure may fail to adequately take into consideration the element of time. For organisms that disperse rarely or poorly, time (years) may be the most important factor (Goward and Arsenault [unpublished manuscript]).

Conclusion: A single age threshold fails to define the ecologically important elements of old growth in coastal ecosystems. In addition, the source of the age data (forest cover) is inaccurate. Forest Cover age data should be updated to reflect our understanding of the age class distributions within these forests, however it will remain inadequate for identifying real 'age' or 'time since disturbance' for many old-growth stands.

Attribute-Based Definitions

Ecologically-based definitions try to capture functional attributes of stands. People have developed definitions of "old-growthness" based on structural and biological attributes (Spies and Franklin 1988; Franklin and Spies 1991; Holt et al. 2002a,b; MacKillop and Holt 2004). This approach is often endorsed by ecologists because structures represent some of the functional aspects of old growth (Marcot *et al.* 1991; Kneeshaw and Burton 1998; Wells et al. 1998). Attributes used in this kind of ecological old growth definition include: large old trees, a multi-layered canopy, numerous large snags and logs, diverse tree community, old age of some trees, canopy gaps, horizontal patchiness, hummocky micro-topography, complex structure, wider tree spacing, and increased understory production (Pojar et al. 1992, Carey 2003, Kneeshaw and Burton 1998; see also Franklin and Spies 1991; Holt and Steeger 1998; Franklin and Van Pelt 2004). Quantitative approaches to defining old growth tend to focus on these structural elements since they are easily measured, are often linked to biodiversity and have the potential for manipulation through forest management (Wells et al. 1998).

Ecological definitions of old growth can take the form of minimum criteria or indices. Spies and Franklin (1988; Franklin and Spies 1991) use this assumption as the basis for their 'index of old-growthness' where the successional status of a stand is ranked on the basis of a number and size of attributes.

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terms are used in this document, and application at present is by site series surrogate, recommendations should be interpreted to apply to site series.

[4] For some areas of the coast, timber supply modeling has arbitrarily increased the age of stands from AC 8 to AC9 (e.g. Cortex 2006?) for areas that are higher productivity. This does create a problematic hole in the age class distribution and should not occur without clear rationale. Alternative approaches can be used that more realistically deal with this issue and that do not create a conflict with ecological values.

[5] This is less of an issue however, when representation is applied at a sufficiently fine scale (i.e. at site series).

Because all successional phase edges overlap, stands are not dismissed because they fail to meet a single old-growth threshold, but are instead given a relative ranking based on the abundance of a number of attributes. This approach has received support because it may avoid potential short-sighted errors in old-growth designation (Hunter and White 1997; Wells *et al.* 1998).

Conclusion: Indices of old-growthness provide a useful approach to defining some of the ecological values present in different aged stands. However, we recommend caution in applying this approach ubiquitously because it does not acknowledge uncertainty (e.g. unidentified attributes and their functional relationships) and does not consider landscape level function (e.g. landscape connectivity). We also recognize that detailed indices using multiple attributes have not yet been defined for many (if any?) coastal ecosystems, and data may be unavailable to implement such an approach across all the entire landbase. Where data are available however, use of stand structural indices may provide a useful approach to managing for older forests and their attributes.

Recommendation 1. A report should be prepared summarizing the available stand structure data available for site series in central coast and north coast BC (see Foonote [10]).

Stand Dynamics Definitions

Theories of stand dynamics have also been used to define old growth (Oliver and Larson 1990, Franklin et al. 2002). They can also discriminate between “old” forests and “ancient” forests where the age of the stand is older than the age of any remaining trees within the stand (Goward and Arsenault 2000, Kneeshaw & Burton 1998). In basic form, the theory shows how stands move through stages of development from disturbance and cohort establishment through stem exclusion, understory reinitiation and then into a dynamic, complex, old growth phase with repeated gap disturbance; legacies remain throughout all stages. Although there has been significant academic debate about the applicability of the general model in different forested ecosystems, it is possible to use local information and detailed sampling to develop ecosystem-specific models that identify movement between phases. In essence, this approach integrates structural and biological attributes and is analogous to defining indices of “old-growthness” as described above.

Conclusion: Stand dynamic theory cannot provide a useful way of defining old growth without collecting detailed data on structural attributes (as described above). However, it does provide insight into why keeping track of different stages of old-growth may be important (i.e. old and ancient forest stands are different – see **Recommendations 3 and 4**). It also provides insight into potential minimum development criteria when considering how to quantify and count values associated with younger stands (see **Recommendation 12**).

The Management Paradigm: maintaining the full age-class distribution

The CIT recommendations focus on maintaining ‘old growth’ because that is the age-class of forest that makes up the majority of the coastal landbase under unmanaged conditons, because it is most directly impacted by harvesting, and thus because old-growth associated elements of biological diversity are under particular threat from forest development. However, following the assumption that we are managing within a natural disturbance paradigm, we propose that maintaining ecological integrity in fact requires management (within a certain range) of the full age-class structure, since altering the distribution for any segment of the age-class affects all the others now and into the future. This assumption results in a number of conclusions:

- That simply managing for forests older than 250 years in age, may fail to adequately represent the full age range of older forests (i.e. those of 400 years+, 1000+, 2000+ etc);
- That forests younger than 250 should also be distributed (within bounds, eg. at +/-70%) of their natural age-class distribution.

We note here that we assume that EBM **should** require management of the entire natural forest age-class distribution i.e. a minimum target for old forests, and a maximum threshold for younger age classes. This paper is intended to focus on old growth recommendations, so we do not address this younger forest issue. However, we also make this recommendation:

Recommendation 2: if a low risk target for old forest is not implemented for all site series (or interim surrogates), additional effort should be put into examining potential maximum thresholds for each of the younger age-classes (e.g. age-class 1-3; 4-6 etc).

What is an appropriate natural distribution for age-class?

Disturbance frequency estimates for the coast already exist. These were derived from remote data and air photo interpretation of natural disturbances from the past 120 years (Price and Daust 2003, Pearson unpublished). The resulting disturbance frequencies (expressed as mean area disturbed/year) can be used to estimate the amount of forest expected in any age class. Extrapolation beyond the 120 years included in the original data requires application of a stand survivorship model such as the negative exponential to the estimates of disturbance frequency.

The negative exponential model was used as the basis for the Biodiversity Guidebook (Province of BC 1995) and has been used extensively elsewhere to predict how much forest is expected in each age-class. However, the model has limitations: it assumes a Poisson process as the underlying statistical model, and is very sensitive to lack of knowledge about the 'tail' of the distribution (i.e. the ages, or area of older forests; Lertzman et al. 2002). Detailed field research into fire history of the coastal temperate rainforest in BC and Alaska (Gavin et al. 2003, Lertzman et al. 2002), shows that the actual pattern of disturbance in many areas of these forests suggests a considerably longer 'tail' on the distribution curve than predicted by the negative exponential model (Lertzman et al. 2002). The errors are particularly large when areas with different disturbance regimes are combined.

Coastal analyses were successful in separating coarse-scale climatic and physiographic influences. They also included some finer-scaled factors including ecosytem type (based on ssPEM as well as timber Analysis Units/site series surrogates), riparian influence and colluvial soils (Price and Daust 2003). They were not, however, able to tease out all of the local site effects (e.g. aspect and slope) that can result in high variability in local disturbance regimes (Lertzman and Fall 1998; Heyerdahl et al. 2007). Hence, current values for the amount of very old forest are likely underestimates and represent a **minimum**.

The implication for EBM is that the actual amount of very old forest is likely higher in many ecosystems than is being used as the basis for targets[6]. To be effective in managing within a natural disturbance paradigm, fine-scale ecological variability should also be factored into the conservation planning and implementation process. All analyses confirm the existence of large proportions of very old forest and pose the challenge of how to maintain the function of these forests when so little is known of the changes as stands age from 250 years to 2,500+ years.

Within this discussion paper, we do not have time to develop new information on disturbance rates for finer scale effects. In the discussion below, we assume that the negative exponential model gives a reasonable—if low—estimate of old forest. Therefore, using the negative exponential distribution, it is possible to model the different proportions of the forest which would be expected in specific age classes under different disturbance frequencies (Figure 1). Thus for example, for a return interval of 500 years, about 60% of that ecosystem is expected to be older than 250 years, and about 15% is expected to be older than 1,000 years. Similarly, for a return interval of 4,000 years, 95% is expected to be older than 250 years, and about 30% is expected to be older than 5,000 years.

Given this approach, low risk representation targets (i.e. 70% of natural) should address multiple age classes (e.g. for 500 years return interval, with 70% expected over 250 years, target over 250 years = 70% x 60% = 42%, and target over 1,000 years = 70% x 15% =10.5%). Using the disturbance return

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[6] This paper is not focused on fine-tuning appropriate the range of natural variability (RONV) for different ecosystems. Compiling and further investigating how disturbances play out at smaller scales in different ecosystems may be an important component of an adaptive management program for EBM implementation.

interval to determine how much old forest to reserve forms the basis for current EBM targets that retain a percentage of the predicted natural amount of forest over 250 years. The only change is that targets can be applied to all age classes.

Recommendation 3: Maintain the low risk percentage of each age range of older age classes (e.g. 250 – 400; 400 – 1000; 1000 – 2000; 2000 – 4000 years etc). Meeting this distribution may be assumed under some conditions (see below), or may require additional work to assess stand age or structure (see Recommendation 1

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Note that the decision to change the age of old in some areas to 180 years was not matched by an appropriate change to the target, and as such fails to use the appropriate basis for representation target setting. Decreasing the age considered "old" leads to an increase in the amount expected to be above that age. For example, for a return interval of 500 years, a 70% target for forest over 250 years is 42%, whereas a 70% target based on 180 years is 48%.

Recommendation 4: ensure all targets are calculated correctly, based on predicted return interval and age of old appropriate for the site series (or interim surrogate).

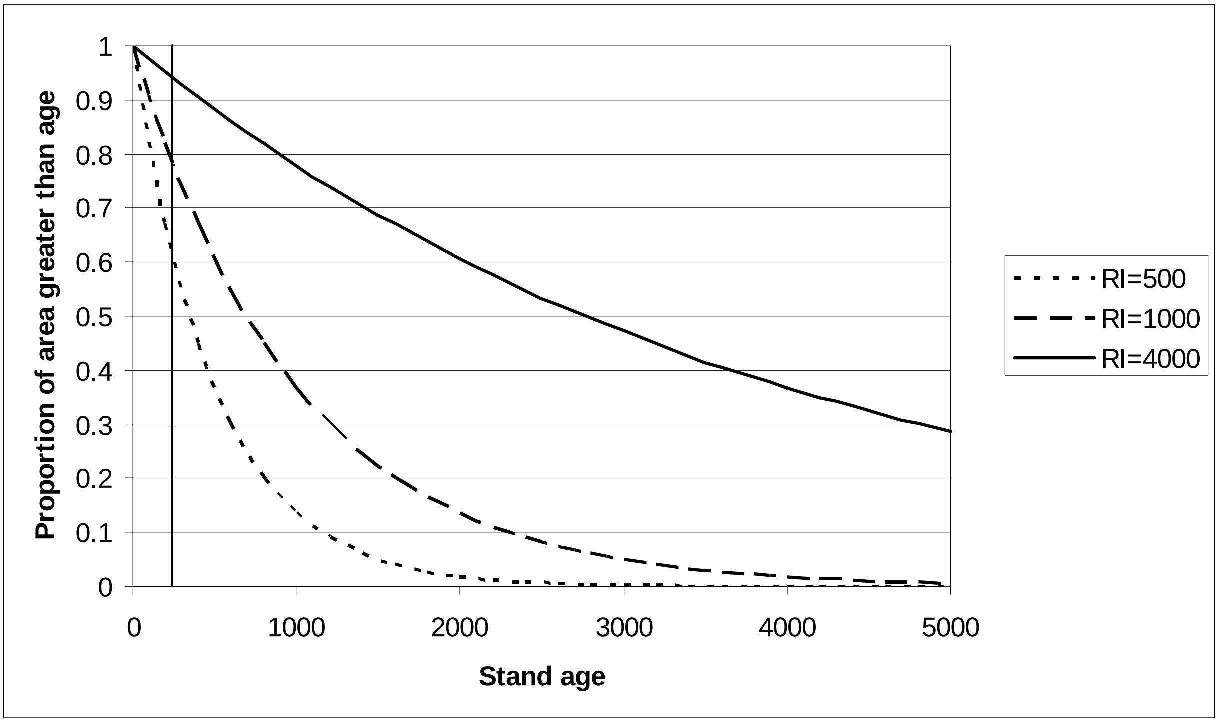

Figure 1. For ecosystems dominated by different disturbance frequencies (RI = disturbance return interval in years), a specific proportion of forest is expected in each age class. Where return internvals are very long (which has been experimentally demonstrated for example areas of the coast), the proportion of natural very very old forest is very high.

Considering very old forest is important because for some site series (or interim surrogates) there is a significant area of younger (age-class 7 and 8) forest in the database. It is possible that as this forest 'ages' to 251 years, significantly older forest may be 'freed' up from constraints under the current rules. Under the current rules, it is possible for very old forest to be harvested and replaced with forests 251 years old.

Application of Recommendation X with complete certainty would require additional data collection because there is no accurate age information for the oldest ageclass within the forest cover database. Even if there was a desire to do so, aging of these very old stands is extremely difficult and inaccurate. Therefore, we suggest it is reasonable to <u>assume</u> that the natural age-class distribution is being met within large areas of unmanaged forest, which (by definition) reflects the natural age class distribution. The probability that this assumption holds decreases as the area of a particular ecosystem decreases, because of the influence of chance events, and where harvesting affects a large percent of an ecosystem, because harvesting is not random with respect to age.

We therefore suggest that for ecosystems where the current approach is low risk (i.e. maintain 70% of the natural amount of old forest within each), following the current strategy will maintain a more natural age-class distribution of old forest types than historical practices provided that:

- sufficient area is set aside as representation (i.e. 70% of natural),
- significant harvesting has not occurred within that site series (or surrogate),
- the distribution of retention is random with respect to site series

We conversely suggest that concern should be raised about meeting this goal if:

- there is a low target for landscape retention (e.g. less than 30% total old forest),
- if there is a moderate target (e.g. 30 – 70% of natural old growth) especially if that is combined with an ecosystem with relatively small area,
- or where the timber harvesting landbase is a large percentage of an ecosystem, resulting in non-random patterns of retention with respect to age.

Recommendation 5. Managing specifically for the oldest age classes is not needed:

- **where large areas of unmanaged forest remain within each ecosystem, since it is reasonable to assume that the forest will reflect the natural age-class distribution for ages past 250 years.**

However, for site series (or surrogates) where a significant percent has been, or is to be, harvested (i.e. where the target is less than 70% of natural, and/ or operability is relatively high, and / or the total area of the site series is small),

- **Find, and maintain the oldest forests on the landscape,**
- **Measure and track at least two categories of old forest (e.g. create new age classes 9a and 9b - "Original old" (i.e. unharvested old today), and "Known Age" stands (i.e. with a known harvested/ disturbed date) that have reached 250 years (or 180). This tracking should be used to ensure that real younger stands are not exchanged for original 'old' stands. This can be implemented within all strategic planning immediately, even though it may be practically useful only in timber supply modelling immediately.**

The intention of this recommendation is to ensure that the oldest of the 'old' forests are maintained through time.

In addition, there are many instances where forests are typed as non-old (i.e. AC 7 or 8), but are known to have a significant proportion that is older (e.g. Holt 2004). These age issues are often 'fixed' in a short-term sense for individual projects (e.g. A. Fall pers. comm.), with differing levels of rationale.

Recommendation 6. Known issues with forest cover data should be corrected in the baseline Forest Cover database, while avoiding creation of 'holes' in the age-class distribution (see Holt and Rumsey 2008 for detailed discussion / recommendations).

Qn 2: Should we, and if so when and how, count attributes present in younger stands towards old growth representation targets.

Old forests are valuable **in part** because of the structure they provide. Clearly, as forests age, structural attributes of old forests develop. Under the current approach, only forests greater than the old growth threshold (>180, or >250) count towards the old forest targets. However, it is clear that these categories are somewhat fuzzy and that younger forests, e.g. 160 years, provide more old-growth value than newly harvested 20-year-old stands. So, the focus of this question is to ask whether we have sufficient information today to allow younger forests to contribute to old growth targets, and if so, how and when.

Following the suggestion above—that EBM should require meeting old growth targets for the full age-class distribution—would avoid this issue by allowing forests of all ages count towards their specific targets.

If the EBMWG does not wish to take this approach at this time, however, we need to ask: should a forest that is partially recovered contribute to old growth targets?

Many studies have looked at individual organisms or individual structures (e.g. snags > 50cm dbh) and compared their presence or abundance in forests of different ages and different histories (e.g. Price et al. 1998, Price and Hochachka 2001, Carey 2003). Structural development takes longer in managed than naturally-disturbed stands (e.g. Carey 1998, Carey et al. 1999), likely because natural stands contain more legacies (Price et al. 1998, Carey 2003). One strategy for improving structural legacies in managed stands is through variable retention approaches to silviculture (CSSP 1995; Lindenmayer and Franklin 2002).

Although useful information has been produced, the approach taken tends to be very reductionist, providing a different answer depending on the species in question: it really fails to address the broader objective of maintaining ecosystems and their associated communities. In addition, since the objective of ecosystem representation is to maintain unknown species and processes / functions then using studies based on single species is of questionable relevance.

Some work exists showing how stand structure develops over 400 years in coastal forests (Wells 1996). Further work is underway in coastal BC to look at how a broad range of attributes develop over time (A. Banner / A. MacKinnon pers. comm.). However, these data are not yet available. Meanwhile, hypothetical recovery curves developed for ecosystems of the North Coast (based on expert opinion; A. Banner and J. Pojar unpublished; example in Figure 2) provide a glimpse of what may be possible[7].

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[7] These curves were intended to be rolled into the North Coast coarse filter ERA work (Holt and Sutherland 2003), but that part of the process ended before they could be incorporated.

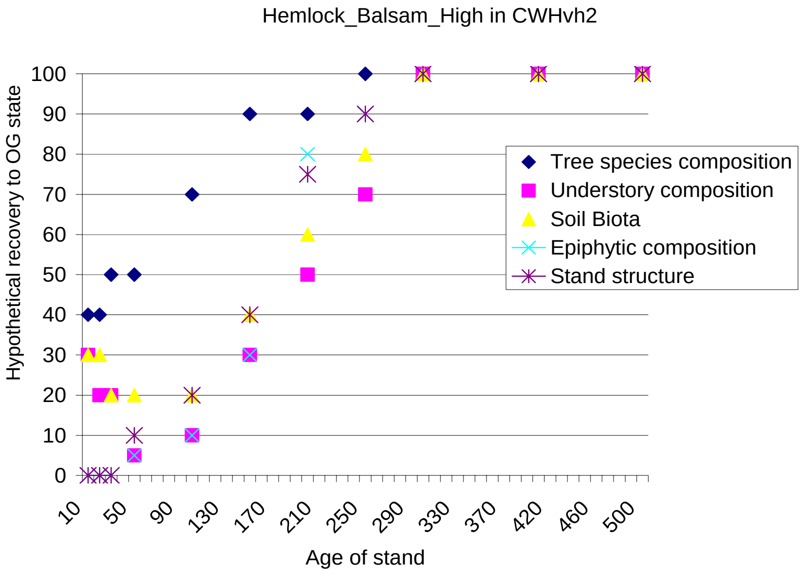

Figure 2. Theoretical recovery curve for attributes in a hemlock/ balsam (AU4) high productivity stand in the CWHvh2 (expert opinion curves by A. Banner and J. Pojar).

The example in Figure 2 shows the hypothesised recovery for a suite of structural and biological elements over time for a high productivity ecosystem. Tree species composition (as a percent of its old growth state) slowly increases over time, reaching 100% recovery after about 200 years. Understory composition and soil biota decline initially (during the 'stem exclusion' phase where there is little light within the stand), increase after around 100 years, and reach 50% recovery around 250 years. Stand structure is hypothesised to recover to 50% of the old growth state between 170 and 210 years. For this particular ecosystem, full recovery is hypothesised at 300 years; for less productive ecosystems, full recovery is estimated to take longer. This example demonstrates how important it is to consider both structure and biological elements of the stand. It also begs the question of how to interpret multiple elements—whether to use the average or to use the most limiting feature.

Figure 2 also shows that different stages of development have different biodiversity / function values. Young stands (stand initiation) are good for specific elements of biodiversity but change factors such as the hydrologic processes from old natural forest. Mid successional (stem exclusion) has very low values for many elements of biodiversity (**see Recommendation 10**). The understory reinitiation phase is when biodiversity values begin to increase again, increasing into the gap dynamic dominated/ complex or old-growth phase. For the ecosystem in Figure 2, the biodiversity values associated with soil biota and understory composition increase above clearcut values at about 170 – 210 years[8].

Various 'indices of old-growthness' using combinations of attributes have been developed for a range of stand ages (e.g. in Douglas-fir dominated coastal ecosystems and in a variety of interior ecosystems; Spies et al. 1988; Franklin and Spies 1991; Trofymow et al. 2003). Developing such an index for coastal ecosystems would allow a wide range of stand ages to be classified based on structure.

Counting younger forests towards old forest targets, where attributes are partly developed poses additional challenges. First, 2 ha of a 50% recovered stand (e.g. 210 years for understory composition in Figure 2) is not equivalent to 1 ha of an old growth stand because the same sensitive species and/or processes may be missing from both hectares of the partially recovered stand. In essence, including partially recovered stands combines apples with oranges—the ecosystems are both valuable, but they are not equivalent. As with other areas of uncertainty within EBM, allowing younger forests to count towards

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[8] This is the type of hypothesis that could be tested within an adaptive management framework.

old forest representation targets involves risk and therefore should require a precautionary approach be taken, in particular:

- The coarse filter is the key part of ensuring that forest management is low risk. Within the context of a regional 70% of natural target for all ecosystems, it may be precautionary to allow a small portion of the target to be met using younger stands, even though their full contribution is largely unknown at this stage (noting the proviso below that true very old stands should not be systematically swapped for younger stands).
- Since 30% of total habitat is considered to be the threshold for moving into high risk (see Price et al. 2007)[9], if the total existing remaining old forest is below 30% of total habitat, counting younger forest towards the total would not be precautionary and therefore should not be allowed.
- For younger coastal forests to count towards representation of old growth, it would be important that the stand had moved completely into the understory reinitiation phase (i.e. is fully out of the stem exclusion phase) when the biodiversity/ functional values are very low. Theoretically this age is likely within the 150 – 200 years, depending on the productivity and disturbance within the stand.[10].
- Additionally, since the intention is to meet the full age / ecosystem distribution, maintain the oldest forests and younger forest should count only towards the next lowest age-class group (to avoid exchanging young for very old forest).

We therefore make the following recommendations for counting younger stands towards old-growth targets:

Recommendation 7. If all ecosystems are represented with low risk (i.e. at 70% of natural), then it may be appropriate to include a small proportion of younger stands towards the old growth target.

Recommendation 8. Because 30% of total area represented in any ecosystem type is the high risk limit, do not allow younger forests to contribute to this first 30%.

Recommendation 9. Between 30 – 70% old forest, do not allow younger forests to count towards old growth targets, unless a stand structural index of old-growthness is developed, and it is demonstrated that the younger forest contains significant old-growth attributes.

Recommendation 10. Under Recommendation X (previous), do not count any younger forest towards old forest targets until it has reached at least structural stage 6 (Mature Forest)[11].

Recommendation 11. Maintain old forests first, and count younger forests only towards the lowest age-class of forest[12].

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[9] The original CIT guidance used 30% of **RONV** as the high risk threshold. However, this review of literature suggested that below 30% of **total habitat** could be high risk for many species and should be incorporated into EBM as the high risk minimum.

[10] As part of recommendation 1 X, examine this question by overlaying TEM (with structural stages) and forest cover (VRI) data. This should allow correlation of structural stage with age by site series or site series surrogate.

[11] Structural stage 6 is characterized by: “Trees established after the last disturbance have matured; a second cycle of shade-tolerant trees may have become established; understories become well developed as the canopy opens up; time since disturbance generally 80–250 years” (BC Ministry of Environment Lands and Parks and BC Ministry of Forests. 1998).

[12] This recommendation is intended to allow younger forest to count towards old forest targets, but to prevent older forest being logged while maintaining only younger forests.

Qn 3: What Criteria Should be Used to Guide Recruitment to Maximise Ecological Benefit?

When there is insufficient old growth to meet the landscape target, (i.e. the site series or surrogate is in deficit), legal objectives require that forest is recruited from younger age classes and allowed to reach the old growth stage. How can stands be selected for recruitment to maximise ecological benefit?

Criteria to consider include stand age, productivity, and location. First, the oldest stands within an ecosystem type should be considered. If all else is equal, these stands will be closest to the target ecosystem in terms of structure and processes, and hence provide the lowest risk to biodiversity. Second, if ecosystems are defined by site series surrogates rather than site series, recruitment should be selected from the most productive stands within the surrogate as these stands will have (theoretically) developed structural elements more quickly, and as these ecosystems are most at risk from previous targeted harvesting. Similarly, individual attributes that have been reduced across the landscape could also provide a focus – e.g. elements such as redcedar or yellow cedar that have been targeted during harvesting. Third, landscape context is important (see watershed or landscape plans). It may make more ecological sense to recruit a fairly old stand adjacent to an already reserved patch of old growth rather than a slightly older, but isolated, stand.

Recommendation 12. Use the following criteria to guide recruitment:

1. **Reserve/ recruit older and more structurally developed forest**
2. **Reserve/ recruit the most productive sites first since it is assumed these will recover attributes, on average, at a faster rate.**
3. **Use conservation planning principles to maximise the values gained at the landscape level (e.g. patch size / location / connectivity etc).**

Qn 4. Where restoration is required, what attributes (other than age), can be altered to expedite the creation of old growth-like stands?

Creating structural and compositional elements of old growth in managed second growth stands has been suggested as a possible means to restore ecological value and speed up development to the old growth phase, particularly in areas where most old growth has been harvested (e.g. Pacific North West; Carey 2003a, b). Ecological definitions, descriptions of old-growth forests and texts describing retention practices provide lists of structural attributes of forests that provide habitat for late-seral species, such as (adapted from Lindenmayer and Franklin 2002; Franklin et al. 1997):

- Large-diameter trees with large-diameter branches and complex bark;
- Trees with decaying features (e.g. stem cavities, dead tops);
- Standing dead trees;
- Large logs, coarse woody debris, and thick forest floor layers;
- Canopy gaps, multi-layered canopies, variable stand density, species diversity.
- For all elements, focus on maintaining spatial and vertical heterogeneity

Many of these attributes could be enhanced through stand treatments; some simply require time to develop (e.g., tree size, forest floor thickness).

Recently, studies have begun to examine the effectiveness of managing harvested stands to restore biodiversity. In a recent example, Carey (2003a) reports on the responses of soil organisms, fungi, plants, birds and mammals five years after a series of restoration treatments, including thinning to create heterogeneity, underplanting to restore tree species diversity, and killing trees and innoculating them with fungi to create snags. Results were equivocal. Of about 20 measurements, two were closer to old growth conditions (increased fungal and plant species diversity), one was less similar to old growth (creeping vole), and the remainder showed no difference (or were not clearly compared).

Although restoration activities make sense theoretically we have seen little evidence yet that they work in the short-term. In essence, representing sufficient old forest to ensure low risk is more effective than reducing levels and then working to restore the managed forests. Nevertheless, restoration may be the only option where insufficient old forest remains to meet management targets.

Recommendation 13. Reserve old forest rather than restore old structures in young stands. If there is no old growth to reserve, management-intensive options are possible, but are expensive and of unknown effectiveness.

Recommendation 14. The adaptive management program should conduct a study of the age and structural characteristics of stands in the >250 year forest cover age class.

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