Forest Practices Board

SPECIAL INVESTIGATION

High Retention Harvesting and Timber Sustainability on the British Columbia Coast

FPB/SIR/20

Revised January 2009

Letter From the Chair

January 2009

In January 2008, the Board published a report about the practice of high retention harvesting in coastal BC. The report was the result of an investigation that looked at timber sustainability in high retention stands. The Board undertook the project because it was aware of concerns among government agencies and professional foresters about this issue. In 2006, the joint government/industry FRPA implementation team for the coast had undertaken a study of 10 cutblocks and identified some issues. The Board undertook its own investigation to look further into the issue and see how widespread it was and what the extent of any problems might be.

Our final report was published in January 2008. In September, we were contacted by a forest company with some concerns about the report findings and the reactions it has generated in government and the professional community. Based on how some parties were interpreting the report conclusions, it was clear that we had not been completely successful in communicating what our findings were and what the Board believes the important conclusions and required corrective actions are. Also, we discovered some errors in how we rolled up and presented the data.

We have now issued a revised report on our website that clarifies and corrects the report. A brief summary of the changes is attached. Despite these errors and clarifications, our original conclusions and recommendations still stand. However, I would like to restate the Board's views about this issue, to ensure all parties have a clear and consistent understanding of what we are saying.

Our investigation found that high retention harvesting in over half of the stands we examined may not be sustainable forestry. Remaining harvest options in these stands were limited, and future growth will be impacted. However, it was meeting objectives for other social and environmental values, such as visuals, cultural resources, wildlife habitat, etc. In some cases, this type of harvesting might be appropriate in response to social pressures not to clearcut and to leave as little visible evidence of harvesting as possible.

The Board is not saying that this practice is necessarily bad. We are saying it needs to be transparent, with a full professional and public discussion of the options, the impacts and the trade-offs being made, and it needs to be done strategically. Accordingly, we recommended that government and the professional foresters' association provide strategic direction and guidance about the appropriate use of high retention harvesting, and that government develop policy on harvesting that is not likely to provide a future economic crop of trees – we referred to that as "opportunity cuts."

We recognize that the area subject to this practice in not extensive. Another issue that came up in our investigation was the inability to even determine with any precision how much high retention harvesting is taking place in BC. But regardless, what we do know is that there is potential for the practice to increase as we implement ecosystem-based management on the coast. Therefore, it is important to address the strategic and operational issues early, to ensure economic, social and environmental objectives and trade-offs are clearly identified and understood by stakeholders and the public, and that the resulting practices are monitored to ensure they are meeting the intended objectives.

Since we made our recommendations, we have received encouraging responses from government and the Association of BC Professional Foresters that they are working hard at addressing these issues and we are pleased with the progress that is being made. The Board recognizes that this is an evolving and complex matter and we hope that our report helps to generate frank and open discussion about the objectives, the trade-offs and the consequences of balancing economic, environmental and social objectives in these difficult operating areas.

We regret the data presentation errors made in the report and we are undertaking an improved quality assurance program for Board reports as a result.

Sincerely,

Bruce Fraser, Ph. D.
Board Chair

SUMMARY OF CHANGES

January 2009

- Sample size correction – 54 changed to 39 – 15 cutblocks were dropped from the evaluation because they did not qualify as high retention harvest. Accordingly, the percentage of sites with problems changes from 60 to 54 percent.
- References to the extent of high retention harvesting on the Coast revised to better reflect the uncertainty in estimating how much of this harvesting has taken place.
- Definition of high retention harvesting used to determine the sample for the study corrected.
- Methodology revised to better describe how the stands were selected and surveyed to gather the data.
- Description of the "Types" categories and the results clarified to better describe the range of conditions found in each category and to clarify that "Type 3 – Forest Health Issues" is actually a subset of the Type 2 stands, not an additional set of stands. Accordingly, the summary tables have been revised.
- Tables 2 and 5 deleted.
- Conclusions clarified to describe the concern about transparency and the need for public discussion of these issues.

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Executive Summary

One of the objectives of British Columbia's *Forest and Range Practices Act* (FRPA) is to maintain and enhance an economically valuable supply of commercial timber from B.C.'s forests, while ensuring sustainability. To this end, considerable work has been done on developing appropriate silvicultural systems for B.C.'s various coastal ecosystems in the last few decades. However, economic realities of the forest industry on B.C.'s north and central coast – such as remote locations and high harvesting costs – create pressure to selectively harvest only the most valuable trees, a potential risk to long-term timber sustainability.

The objective of this investigation was to examine the timber sustainability in stands on B.C.'s coast that have been partially harvested using a high retention system. There is no one definition of what constitutes 'high retention'; instead, retention can form a continuum from relatively intact forest to very open stands with sparse scattered retention. For the purposes of this report, a minimum of 20 square metres per hectare (m^2/ha) dispersed residual basal area was used.

The investigation examined conditions in 39 stands with high retention, and found that objectives set out in the planning stages for visual quality, slope stability, hydrological care, soil conservation, and wildlife habitat were largely met in these stands.

However, objectives for a sustainable timber supply were impacted in more than half of the stands (54 percent) due to the remaining structure. Primarily commercially valuable cedar and spruce were harvested, leaving behind areas with limited prospects for an economically viable future harvest, and limited effective means for reforesting with valuable tree species.

In coastal, old-growth stands, the most common silvicultural systems prescribed for partial cutting are the retention, irregular shelterwood and the single tree selection systems. These systems are meant to retain timber value for future harvests and also to provide sufficient space for forest regeneration.

A cornerstone of forest management is choosing and applying a silvicultural system to a harvest area that allows extraction of current timber value while providing for similar values in the future. This investigation found that the current approach of high-retention harvesting achieved the first objective (extraction of timber value in the present day), but typically does not promote timber values into the future.

Executive Summary

While the use of high retention harvest systems appears to be small in scale and limited in its area, it is a practice that could grow as we move forward, particularly with ecosystem-based management.

There are basically two challenges for sustainability here. First, the trees left behind may have insufficient timber value for a future harvest. Most of these trees are old and low-value, often hemlock, with significant decay. Second, these trees shade and occupy growing space, precluding the establishment and growth of a new crop of trees of a more desirable species. There are a number of issues that have been raised by this investigation:

- Due to the preference for harvesting cedar and spruce over hemlock, there will be a species shift towards hemlock in stands that have not been planted.[1] Depending upon the remaining value, there may be limited options for subsequent entries to promote additional space for growth.

- High retention was often prescribed in order to meet other objectives (for example visuals). In some cases, this made sense. In other cases, it was not always clear that high retention was necessary to achieve the objectives, or the objectives themselves were not readily apparent on the site. [2]

- Although some site plans projected future growth and harvest levels, none of the site plans examined by the Board projected a reduction in volume production or a species shift as a result of the partial harvest approach, when there clearly would be in some cases.

- In some cases, site plans and silvicultural prescriptions were very similar to one another despite site differences, and often did not describe site specific conditions. They also provided insufficient data on the relative vigour of existing and target trees for each site.

- Blocks were often not planted. Instead there was reliance on release of understory, or natural regeneration, which will almost certainly encourage hemlock and true fir growth, rather than regeneration of higher-value cedar. This is especially of concern on high-cost harvesting sites.

- Dwarf mistletoe is not always being managed appropriately, leaving abundant infected trees in residual stands, which will negatively impact strategies for natural regeneration of vulnerable hemlock. In some cases, however, blocks that were initially designed for partial harvest were heli-clearcut due to the presence of mistletoe.

- Slash levels in some sites are high, but planting spots are still available; however, distribution of stock will be irregular.

[1] This species shift is not confined to areas of high retention or partial harvesting, it can occur on clearcuts as well. The issue of species shift to hemlock is further exacerbated where overstory competition slows understory growth rates. Mistletoe may complicate this further.

[2] The other objectives were not investigated in detail, but were considered by the team and discussed with the licensees on-site in some cases.

Board Commentary

This special investigation illustrates that high-retention harvesting on the central and northern B.C. coast is impacting growth and timber sustainability. The impacts have not been clearly considered as a tradeoff for achieving other objectives. There are a number of issues that arise from this investigation.

One of the main issues is transparency. Kimmins[3] (1997) said that, "timber mining is not necessarily an inappropriate management goal; however, its danger for the forestry profession is not inherent in the practice itself, but only when it occurs consciously or unconsciously under the guise of sustained yield. To do so only further diminishes the credibility of foresters in the eyes of the public and the scientific community."

Some of the stands examined in this investigation are being "high-graded[4]" to meet today's economic needs, but at the expense of future harvesting opportunities. While high retention harvesting appears green – because the majority of trees are left behind – and meets some environmental and social objectives, it may not result in sustained yield forestry or eco-system based management (EBM), which seeks to balance timber, environmental and social objectives.

Often, high retention harvest is at best, a logging practice with provisions to leave an adequate amount of standing timber to protect other values. While it may be decided that this is an acceptable harvest practice in coastal B.C., professional foresters and government need to engage in public discussion on management objectives for these forests, with a full realization of the tradeoffs.

Sometimes high retention harvesting is done under EBM, which is meant to balance economic and ecological benefits over the long term. However, the EBM system does not necessarily require high levels of dispersed retention. Relatively "open group" retention systems or "clearcut-with-reserve systems" may be adequate. EBM and high retention harvesting can be complimentary, but balancing objectives and tradeoffs must be carefully considered. EBM is not an implicit license to highgrade. Strategies to ensure that the environmental, social and economic objectives of EBM are not compromised are required.

[3] Kimmins, J.P., *Forest Ecology, A Foundation for Sustainable Management*, 2nd Edition, Prentice Hall,(1997), p. 596.

[4] See definition on page six of this report.

Board Commentary

A silvicultural system is a planned program of treatments during the whole life of a stand, designed to achieve specific stand structural objectives. In many of the stands reviewed in this investigation, the "silvicultural system" appeared to be a rationale for harvesting a portion of the species profile that is presently desirable from an economic standpoint.

Professional foresters wrote silviculture prescriptions (now site plans and stocking standards) for harvesting in these marginally economic stands; however some of the prescriptions have little hope of ensuring future timber harvest within a reasonable period of time. Further, some professionals use boilerplate prescriptions that, in some cases, don't reflect the actual situation.

The Board found that there were instances where prescriptions made by professional foresters were not implemented on the ground. In some cases, the level of retention appeared higher than prescribed and measures described for treating mistletoe were not followed.

Even if the prescription was reasonable and had good chance at success, sometimes the lack of implementation jeopardized potential for re-establishing economically viable stands.

Since the Board began this investigation, the Coast Region Implementation Team (CRIT), a multi-agency / industry working group, has been tackling the issue of high retention harvesting.

As part of its efforts to address the issue, a workshop was held in Tofino in October 2007 to address options and direction for high retention harvesting. The approach the CRIT is taking to resolve these issues is consistent with the Board's conclusions and recommendations.

Recommendations

In accordance with section 131(2) of the *Forest and Range Practices Act*, the Board is making the following recommendations:

1. The current regulations and policies do not provide strategic direction to help determine when silvicultural systems and/or harvest approaches with high amounts of retention should be used. The Ministry of Forests and Range should provide strategic direction to guide licensees on appropriate approaches for high amounts of retention, based on clear strategic objectives for the full range of values over time, including timber species/values.

2. In addition, the Association of BC Forest Professionals (ABCFP) should provide guidance to members to ensure they are using appropriate professional diligence in the design of high retention silvicultural prescriptions on the coast.

3. The Ministry of Forests and Range should require clear, achievable and measurable up-front targets for post-harvest retention levels. Stocking standards should require the use of residual basal area ranges with compliance limits at both the lower and upper end. Some characterization of vigour and economic viability should be used to allow trees to contribute to stocking. Ultimately, retention stocking standards must be designed so they can be audited for compliance, and monitored for effectiveness.

4. The Ministry of Forests and Range should develop policy about 'opportunity cuts' with no expectations of future yield (and therefore no silvicultural system) which should be considered, for example, in areas constrained from harvest due to other objectives, such as slope stability concerns.

The Board requests that the Ministry of Forests and Range advise the Board of progress in implementing recommendations 1, 3, and 4 by July 31, 2008, and that the ABCFP advise the Board of progress in implementing recommendation 2 by July 31, 2008.

Introduction

BACKGROUND

Variable retention silviculture using partial cutting has become increasingly widespread in British Columbia forestry in recent years. There are biological, social, and administrative reasons for the interest in retention systems. One benefit is that structural elements of the existing stand are retained for the long term throughout a harvested area to achieve specific silvicultural, ecological, habitat, biodiversity and economic objectives. Other documented benefits include reducing the impacts to focal bird species such as marbled murrelet and goshawk, reducing slope instability, reducing the incidence of windthrow, reducing hydrological change, conserving fish habitat, enhancing protection of riparian areas, maintaining visual quality and protecting cultural features.

Retention is a silvicultural system that retains trees, or groups of trees, during a harvest as a way to maintain structural diversity over the whole area of the cutblock for at least one rotation. The retention system requires a reasonable distribution of retained timber across the whole cutblock, generally interspersed with open spaces for adequate regeneration. A range of stand volume can be left on the block, depending on required objectives. For the purpose of this investigation, a high-retention system is defined as a minimum average of 20 square metres per hectare (m^2/ha) residual basal area dispersed relatively uniformly over the harvest area. This is in contrast to group retention where unharvested groups or combinations of groups[5] and small clumps of dispersed trees are left post harvest. (See Figure 1).

With low volume removals and high levels of residual timber, the character and structure of a pre-harvest stand is kept relatively intact, which can result in stands that continue to fully occupy their growing spaces immediately after harvesting. Future harvesting for economic purposes may still be feasible if sufficient value (species and volume) remains. Conversely, with slightly higher volume removals and residual overstory timber closer to the minimum of 20 m^2/ha, most of the stand value may be extracted, leaving an overstory that may be uneconomic to remove, based in part on the low available volume. If not removed, this timber will reduce understory growth potential. While this form of harvesting fits with the small gap disturbance regimes historically found in these stands, assumptions for future timber supply need to be evaluated when the approach is used.

Along with the ecological objectives to provide for biodiversity and maintenance of visuals, economic pressures such as remote locations and high harvesting costs can induce what is commonly known as, "high-grading." This is particularly the case with helicopter yarding systems, where single, commercially valuable trees can be extracted one by one. Smith[6] (1986) defined high-grading as, "harvesting the best and leaving the poor," saying:

> ***"This kind of cutting can result from a single-minded concern about avoiding the high cost of small trees. Even more short-sighted is the policy of regarding the stand merely as a magic warehouse into which one ventures sporadically attempting to find trees that will meet the specifications for current orders, ultimately leaving stands of poor trees that cannot be harvested economically by the most ingenious logging or the most astute salesmanship."***

[5] Groups are usually a minimum of 0.25 ha.
[6] Smith, D.M., *The Practice of Silviculture*, 8th edition, John Wiley and Sons, 1986.

Figure 1: *High retention harvesting area – it is often difficult to see harvesting, even from above.*

Figure 2: *Typical group retention system with open areas for regeneration – this is NOT considered high retention.*

Figure 3: *Small gap created in high-retention block; limited space for new regeneration and limited future harvest options.*

OBJECTIVE

The objective of this special investigation was to examine the sustainability of timber in areas with high retention harvesting on the Queen Charlotte Islands and the central and northern B.C. coast, by assessing post-harvest stand structure and condition in recent cutblocks.

The investigation did not explicitly examine the maintenance of other forest values, such as soils, water quality or biodiversity, though it did consider these values for context, recognizing that they are often the reason for the high retention prescription in the first place. Non-sustainable harvesting for timber may be acceptable for non-timber values if the post-harvest forest condition represents the best that can be done while meeting the non-timber objectives. This "trade-off" was not evaluated explicitly in the investigation, as the focus was on post-harvest timber values.

This report is not about compliance with either the *Forest and Range Practices Act* (FRPA) or the *Forest Practices Code of British Columbia Act*. It is about effectiveness in achieving timber sustainability in the sample of stands. The purpose of this type of Forest Practices Board investigation is to assess the effectiveness of current forest practices and recommend improvement to practices, policies or legislation, where warranted. The assessment process was designed to identify the potential for future harvest options and timber trajectories on partially harvested stands; it was not meant assess the performance of individual licensees.

The investigation was carried out in the north coast, central coast and Queen Charlotte Island forest districts. All sites are within the coastal western hemlock biogeoclimatic zone, and tree species are dominated by western red cedar, yellow cedar, western hemlock, amabalis fir and Sitka spruce. Only cutblocks harvested after 2001 were assessed, all of which were yarded by helicopters. While cutblocks were used to identify sites where high retention harvesting occurred, the investigation did not assess the overall condition of the entire cutblock, but focused on representative high retention areas within the block to determine trends and verify ocular observations about the post-harvest condition.

APPROACH

For project context the following was considered: a well-designed silvicultural system is sustainable when: 1) desirable timber species are regenerated; 2) site productivity and quality is maintained over time; 3) a healthy gene pool of the desirable species is maintained; and, 4) a decline in stand health is avoided (Beese and Zielke[7] 1999).

In a high retention situation where lesser amounts of high-value trees are harvested, site growing space is largely captured by the remaining canopy trees. Seedlings and saplings cannot readily grow into the canopy, so value production must come mainly from residual canopy trees. Ultimately, removing the high value component thus reduces both current value and value production potential.

[7] W.J. Beese and Zielke, K., SPs for VR: *Guidelines for Designing Variable Retention—Layout and Silviculture Prescriptions*, 3rd Edition, Weyerhaeuser, BC Coastal Timberlands, August 1999, March 2004, Chapter 5: Partial-Cutting to Avoid High-grading.

In a high retention situation where heavier amounts of multi-value trees are harvested, seedlings and saplings are required to augment the retained trees to fully capture growing space. However, if too many of the retained trees are of poor quality, they reduce the growth of the seedling/sapling layer while not contributing value growth themselves.

The impact of high retention harvesting on the FRPA goal "to maintain or enhance an economically valuable supply of commercial timber," can therefore be assessed through its impact on unit-area-volume and value. Both the current post-harvest volume and the potential of the harvested area to "re-grow"need to be considered. The timber goal will be met when the post-harvest growing space is fully captured and value production potential is maintained or enhanced.

Conceptually, a sustainable silviculture prescription should allow for sufficient open space for new regeneration, or should provide sufficient volume and value of retained timber to allow for a subsequent entry. The Board used four indicators to reflect this model:

1. Basal area of commercially valuable overstory trees.
2. Percent of value removed to percent of basal area removed.
3. Basal area of trees of poor timber quality.
4. Degree of site occupancy by quality seedlings and saplings.

Retention forms a continuum from low to nil in a clearcut, to a fully occupied stand, when a few trees are windthrown or removed. For this report two main categories were used that encompass a range of overstory.

Type 1 - future economic harvest options are available.

Type 1 includes stands where the amount of residual timber was deemed to have sufficient volume and value for a subsequent entry, thus maintaining timber harvest options. It also includes stands where the amount of residual timber may not be high enough for a subsequent harvesting entry by itself. However, together with developing regeneration in gaps, these stands will provide for a valuable harvest in the future.

Some post-harvest stands are similar in structure and species profile to the pre-harvest stands, thus, if there was a high value component in the original overstory, as long as the retained trees remain healthy, it is maintained until the next harvest entry. Some stands managed in this way will have sufficient volume of economically valuable stems remaining for subsequent harvest, and this future harvest is not dependant on regeneration or understory release.

In this high retention scenario, the growing space is fully occupied by the remaining canopy, so no new regeneration is required. This scenario meets the FRPA timber objective in the short term. Tracking of this 'type' is still important, as there will be less overall volume for the next pass due to the harvest entry.

Some of these stands are more open in structure, but likely similar in species profile to the preharvest stands. A significant proportion of stand value and potential volume for the future will come from understory regeneration developing in gaps. While an intermediate entry may be possible in some situations to remove the residual overstory, in most cases it will be managed together with the developing understory. While some volume impacts may occur, these are expected to be compensated by future timber value.

Type 2 - Harvest options are limited, growth will be impacted.

Type 2 also has a range of stand conditions. In some of these stands, future options are limited due to high residual cover of low-value standing timber that fully occupies the site. These stands would be considered 'high-graded' in the traditional sense, as limited options remain for economic harvesting with insufficient space for regeneration. Other stands in this category are in the 'greyer' end of high retention. These stands have between 20 and 40 m2/ha average basal area, with a high proportion of those stems being of lower value, making a subsequent economic harvesting entry questionable for these stems alone. Competition from the remaining overstory limits understory growth, impacting site productivity.

Forest Health Issues

Some of the Type 2 stands had forest health issues as complicating factors. A forest health concern is the infection of new hemlock regeneration by mistletoe that can potentially spread from infected overstory hemlock. Western hemlock dwarf mistletoe (Arceuthobium tsugense) is a parasitic plant that reduces volume production and can reduce the value of hemlock sawlogs. If mistletoe infection occurs, as the young trees grow, they continue to be infected by the overstory mistletoe source, reducing growth and affecting form. While hemlock may be marginally economic on these sites, the lower quality that results from mistletoe infection further limits future options.

Field Team Members

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METHOD

The methodology was designed to efficiently provide a snapshot of post-harvest conditions in high retention stands. It was based on the project team's experience and knowledge gained over the past 20 years from similar assessments on partially cut stands throughout the province.

1. Identification of potential high retention blocks

The provincial database, RESULTS, had no query available for identifying high retention cutblocks or the level of retention found on a cutblock. As a surrogate, the project team queried RESULTS to identify stands with multi-layer stocking standards, which are often applied to partially harvested cutblocks. A total of 97 cutblocks logged since 2001 were identified in the target districts as having multi-layer stocking standards and a harvest volume with greater than 50 percent western red cedar or Sitka spruce. The project team selected 53[8] of those cutblocks for ground review, ensuring a distribution across licensees and geographic area, while also considering logistics.

2. Ground assessment of potential sample blocks

The project team surveyed the 54 cutblocks on the ground by measuring trees, stumps and regeneration. The team selected, from the air, a transect line that would pass through a representative portion of what appeared to be the most common stratum with high levels of dispersed retention. Transects avoided non-representative areas within the cutblock, such as unharvested patches, areas with unusual levels of retention, cleared helipads or similar openings. While the majority of blocks were fairly uniformly treated, there were some that were quite variable across the block. On each transect, plots were established 100 metres apart. Between 5 and 10 plots were established, depending on the variability of the stand.

For each plot, overstory retention and basal area harvested were tallied using a 5 or 8 basal area factor prism sweep. Data were sorted by species, size (diameter) and vigor category (Table 1). Stumps were also tallied by size and species. At each plot, well-spaced and total regeneration stems were tallied within a 3.99 metre fixed radius. The sampling design and approach was not intended as a "silviculture survey" or a "timber cruise," but rather to provide general information describing post-harvest conditions.

3. Sample confirmation

Cutblocks were included in the report analysis only if the ground assessment determined that residual basal area (RBA)[9] in the assessed stratum averaged more than 20 square metres per hectare—the cut-off considered to be high retention for the purposes of this project. Fifteen of the cutblocks were found to have lower retention or uneven distribution of retention, so did not qualify as high retention and were not considered further. This left 39 cutblocks in the sample for analysis.

[8] One block was later split into two strata, hence the total number evaluated is 54.

[9] Residual Basal Area (RBA) measures the cross sectional area of the retained tree's bole at a predefined measure above the ground (1.3 m). It is expressed as ratio of the bole area of all the remaining trees to the land area, e.g., m^2/ha. On Coastal BC stands, the preharvest Basal Area (BA) ranges from approximately 40 m2/ha to greater than 100 m^2/ha.

Table 1 - Criteria used to assess vigour of leave trees

GOOD/ ECON[10]	HIGH VIGOR – HIGH PROBABILITY OF PERSISTING THROUGH ROTATION • No heartrot suspected. • AND 40%+ live crown (H, Ba, C, Y) / 30%+ (Fd, P) / 25%+ (broadleaf). • AND foliage has normal, healthy color. • AND tree is highly windfirm – there is a high chance that the tree will remain standing until the end of the rotation.
FAIR / ECON	MODERATE VIGOR – MODERATE PROBABILITY OF PERSISTING THROUGH ROTATION • Heartrot unlikely or insignificant. • AND 20%+ live crown (all conifers) / variable - (broadleaf). • AND foliage has normal, healthy color. • AND tree is moderate to highly windfirm – there is a reasonable chance that the tree will remain standing until the end of the rotation.
POOR / UNECON	POOR VIGOR – LOW PROBABILITY OF PERSISTING THROUGH ROTATION • Heartrot is significant. • OR < 20%+ live crown (all conifers) / variable - (broadleaf). • OR foliage is patchy and sparse. • OR foliage has an abnormal, unhealthy color. • OR tree is NOT windfirm – there is a low chance that the tree will remain standing until the end of the rotation.

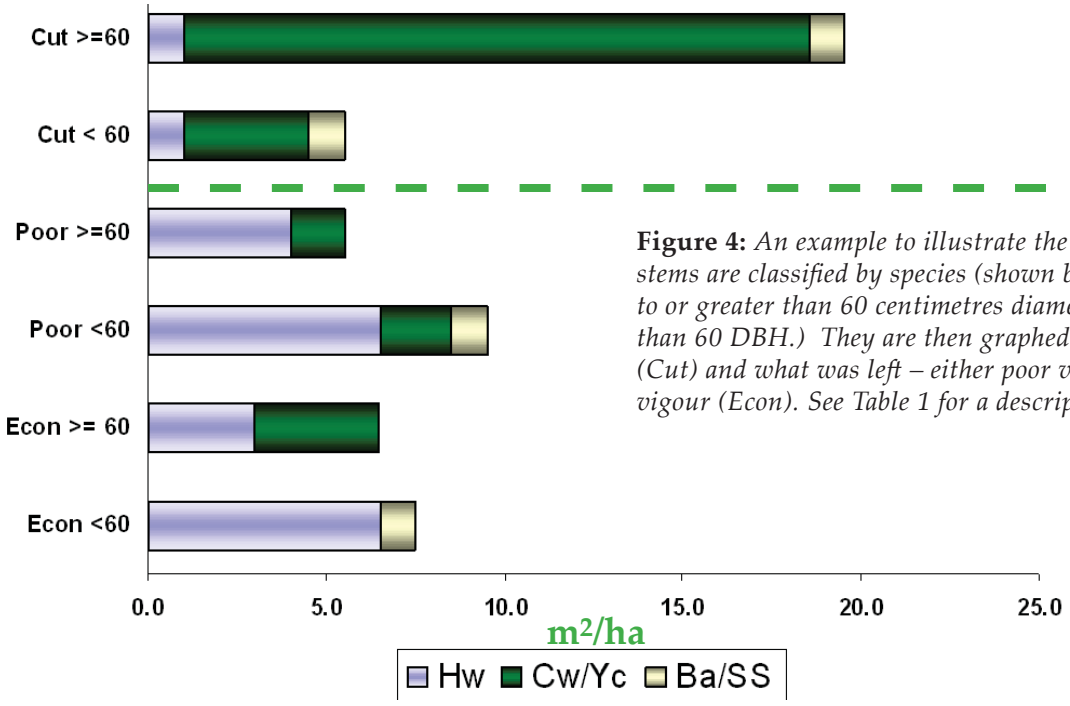

Figure 4: *An example to illustrate the method – for each block, stems are classified by species (shown by colour) and size (equal to or greater than 60 centimetres diameter – or DBH – and less than 60 DBH.) They are then graphed to show what was harvested (Cut) and what was left – either poor vigour (Poor) or fair to good vigour (Econ). See Table 1 for a description of vigour categories.*

[10]Economic strictly from a wood quality standpoint – not species and grade (size).

Results

Extent of High Retention Systems

It is extremely difficult to quantify the extent of this type of harvesting on the BC Coast, mainly because current tracking systems do not differentiate the amount of retention in partial cut stands. While the use of high retention harvest systems appears to be small in scale and limited in its area, it is a practice that could grow as we move forward, particularly with ecosystem-based management.

Background Conditions

Systems with high retention levels are often well suited to meet non-timber management objectives. In some cases, prescriptions to address multiple objectives are needed.

Non-timber management objectives[11] for:

i. **Visual landscape management, ranging from a visual quality objective (VQO) of "partial retention" to "retention."**

Seventeen of the 39 cutblocks (44 percent) had visual objectives specified in their management plans. High retention harvesting allowed all visual objectives to be met.

ii. **Cultural /archaeological values, such as retaining the presence of culturally modified trees.**

Ten of the cutblocks had goals to preserve culturally modified trees specified in their management plans. High retention allowed for maintaining no-harvest areas around all of them.

iii. **Equivalent Clearcut Area (ECA) limitations over the watershed.**

Three watersheds had rate-of–cut concerns specified in their management plans. High retention harvesting avoided increasing open areas.

iv. **Marbled murrelet strategy.**

Two cutblocks included potential marbled murrelet habitat management in their plans. High retention harvesting allowed for the leaving of potential nesting trees.

v. **Site sensitivities, such as unstable slopes with a moderate to high risk of failure if clearcut.**

Potentially unstable slopes were identified on eight of the cutblocks, and high retention harvesting minimized risk.

[11] Some sites had more than one of these objectives, so they add up to more than the total number of sites.

Types of Retention

Type 1 - Future economic harvest options are available.

Eighteen stands, or 46 percent of the sample fell into Type 1 – that is they had future harvest options remaining (Table 2). An average of 25 square metres per hectare of basal area with fair or good vigour was retained.

Table 2 - Description of Type 1 stands (all stands = 39 high retention stands sampled).

Type	Average Residual BA (m^2/ha)	Average RBA Fair and Good (m^2/ha)	Total # of stands	% of all stands
Higher retention	55	27	15	38%
More open	33	17	3	8%
ALL STANDS	51	25	18	46%

Prescribed retention levels are block-specific. For the most part, there are future options for these stands, and a second pass harvest could take place at any time. However, the majority of these stands are now too stocked to allow for regeneration. With only about 50 percent of fair to good quality stems remaining to add incremental value, there will be fewer stems available to add volume, compared with the uncut stand. In all cases, western hemlock is considered a preferred species, but the species actually harvested on most sites was mainly western red cedar and/or Sitka spruce.

In certain cases, the licensee used stand/stock tables; target basal area and maximum diameter to determine cutting rules, so as to ensure that the next cutting phase will achieve their objectives. It may take several cuts to convert a multi-aged forest into a 'selection' forest, and there are concerns with this approach because it is uncertain when the next planned cut will actually occur. It may also be prohibitively expensive to use a helicopter in periodic 'improvement cuts.'

Figure 5: *Example of light harvest level with future harvest options remaining.*

Example one of a Type 1 stand (Figures 6 & 7) showed a very light harvest of a low value stand. The species profile was retained by harvesting all three species. There was adequate stocking of overstory sized spruce (greater than 60 centimetres) to warrant a second cut. This block will continue to develop, as it was prior to harvest, although with fewer large trees. However, there is limited space for new regeneration, and the trees currently on site will continue to grow or rot depending upon their relative health.
To promote timely ingress, a system that creates gaps and is regenerated with cedar and spruce (group selection system) would be preferable.

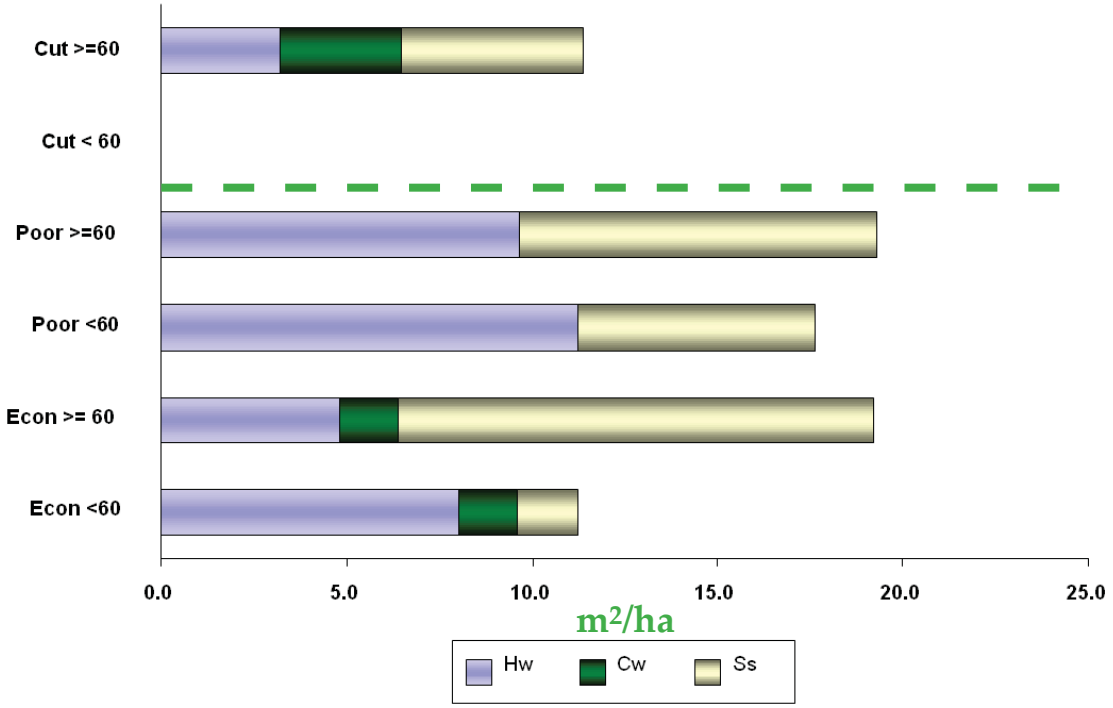

Figure 6: *Example 1, harvest and retention by species, diameter and condition.*

Figure 7: *Example 1, light removal, value remains.*

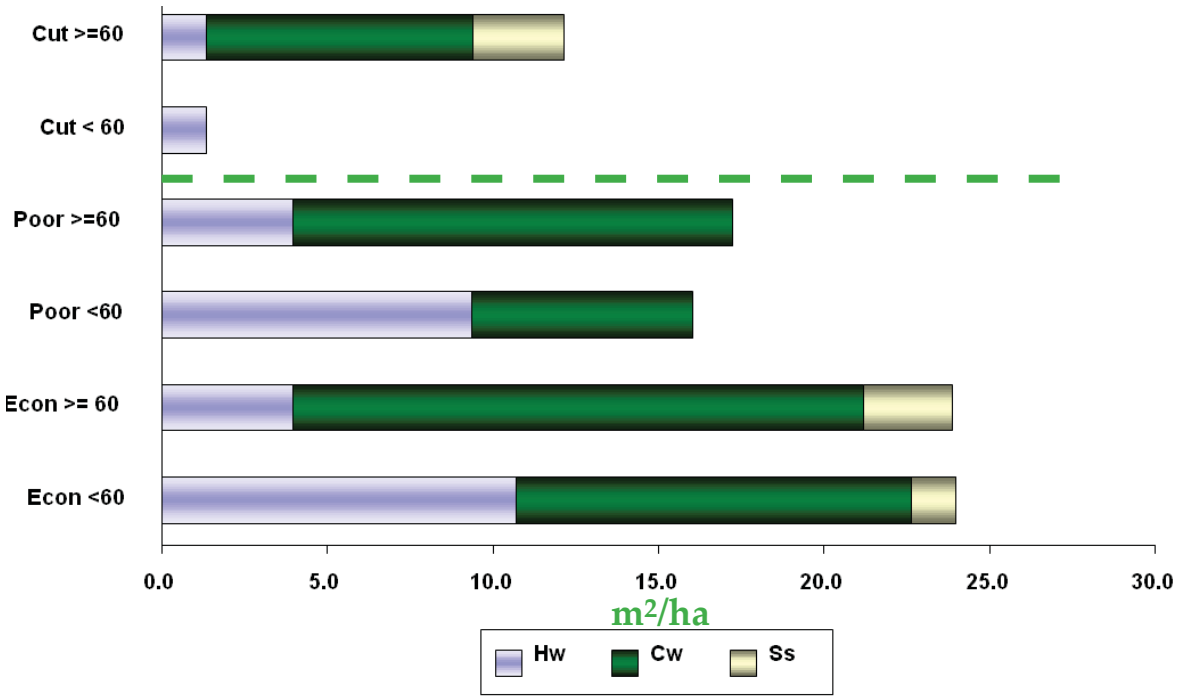

Figure 8: *Example 2, light dispersed harvest.*

Example two of a Type 1 stand had a light dispersed harvest (Figures 8 & 9). There was a potential for increasing volume in this stand, due to high numbers of healthy trees in both the economic size classes and due to the amount of healthy vigorous mid-sized stems, there was also an immediate opportunity for a two-pass system.

Figure 9: *Example 2, light removal, value remains.*

A third example of Type 1 (Figures 10 & 11) was a stand where the harvest had focused on large diameter cedar (greater than 60 centimetres), but left a sufficient level of economic grade large and small diameter cedar to allow another entry. The vigour and space available for growth of understory remained limited, so most of the future growth will be on larger trees. Recruitment from smaller sizes will be limited because their growth rates are relatively slow.

Figure 10: *Example 3, good quality cedar removed, but also remaining.*

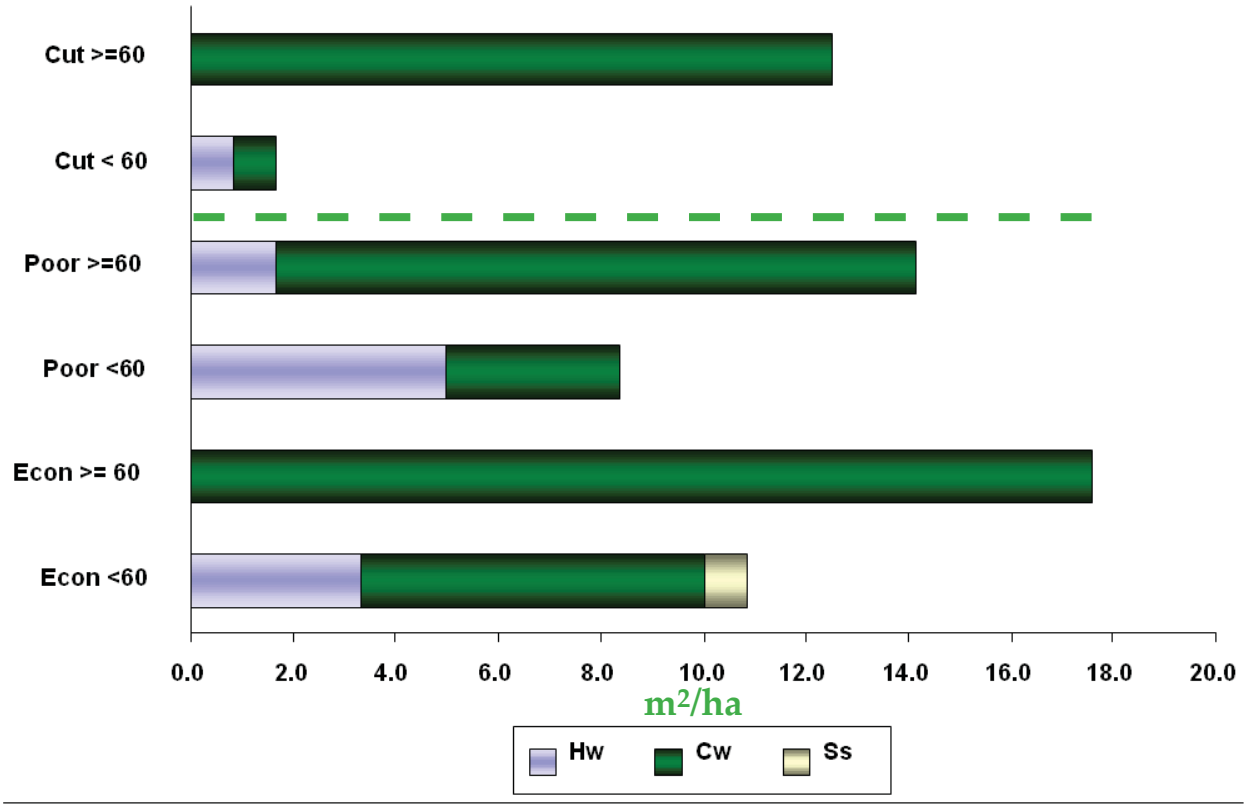

Figure 11: *Block summary graph for example 3.*

Type 2 - Harvest options are limited, growth will be impacted.

A total of 21 stands (54 percent of the survey sample) were Type 2.

Eight of these stands had limited future options with high levels of low value residual basal area occupying the site. Limited options remain for economic harvesting with insufficient space for regeneration.

Thirteen of these stands are in the 'greyer' end of high retention. These stands have between 20 and 40 m2/ha average basal area, with a high proportion of those stems of lower value, making an economic subsequent pass questionable. While these retention levels offer some opportunity for understory establishment and growth, they are limited, with estimates of 50 to 80 percent reduction in understory volume growth, compared with open growing conditions.

The 21 Type 2 stands with limited options had:

- a residual basal area between 21 and 56 square metres per hectare, averaging 36 square metres per hectare (Table 3).
- only 38 percent of the residual basal area was considered potentially economic (i.e., without symptoms of rot). This equated to approximately 13 square metres per hectare.

Table 3 - Description of Type 2 stands (all stands = 39 high retention stands sampled).

Type	Average Residual BA (m^2/ha)	Average RBA Fair and Good (m^2/ha)	Total # of stands	% of all stands
High Retention	48	**17**	8	21%
More Open	28	11	13	33%
ALL STANDS	36	13	21	54%

Example four (Figures 12 & 13) had 39 percent basal area removal. Virtually the entire harvest consisted of large diameter cedar, leaving poor quality overstory cedar and hemlock rife with dwarf mistletoe.

This example of a Type 2 stand will have static to declining volume for future harvest. Most of the stand currently has from 20 to 40 square metres per hectare RBA, which limits regeneration growth substantially. As well, this stand is unlikely to develop economic harvest options that would open up the understory for added light and potential growth. Without that, regeneration growth will be limited indefinitely by low light levels, and areas that are more open will require planting in order for desired species to propagate.

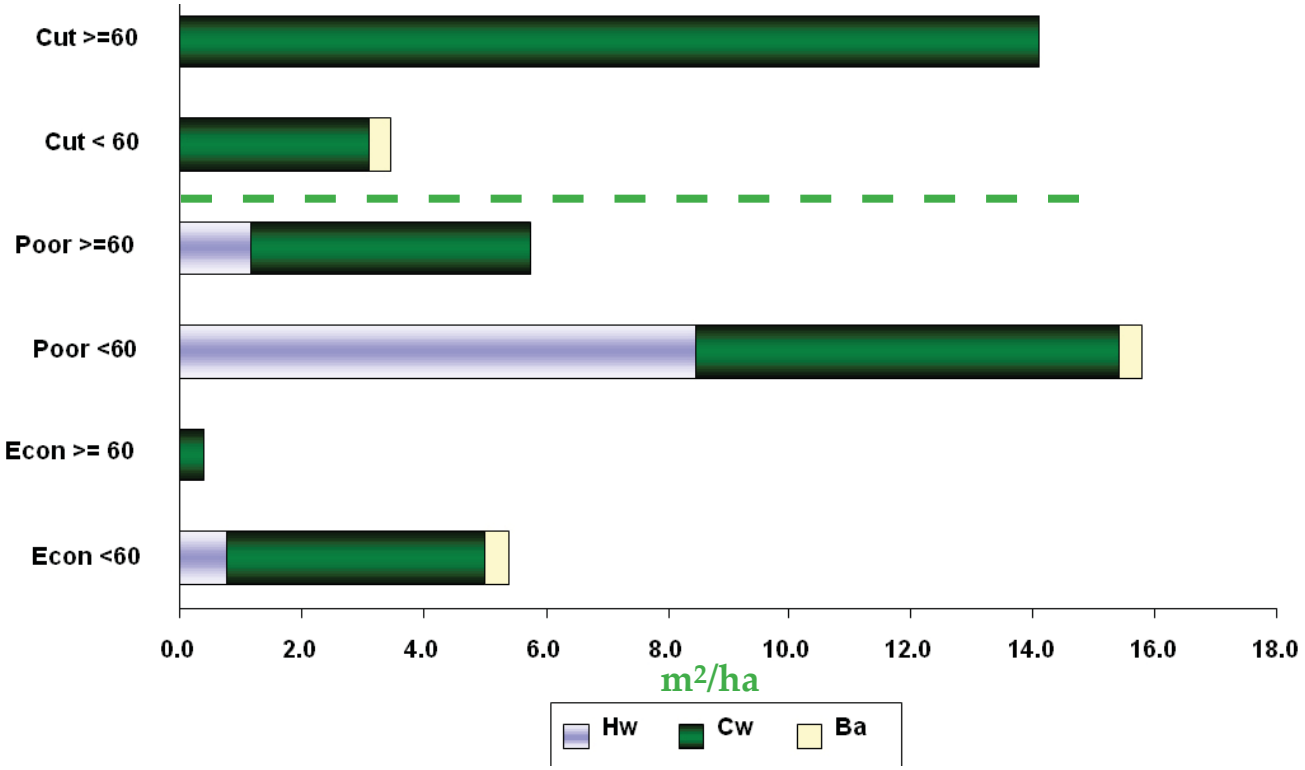

Figure 12: *Example 4, entire harvest was in large diameter cedar; residual forest in poor quality cedar and hemlock.*

Figure 13: *Example 4, Selected larger cedar removed.*

Forest Health Issues

Nine of the 21 Type 2 blocks had limited future options exacerbated by hemlock dwarf mistletoe.

These stands have the characteristics described above for the Type 2 stands, with the additional complication of high levels of hemlock dwarf mistletoe in the stand. In stands fully occupied by overstory trees, mistletoe reduces tree vigour and merchantability.

Infection of the understory is not, however, a major concern as there is little room for regeneration to contribute to site occupancy. However, understory infection is a concern in the more open retention stands where 7 of the 13 stands had high levels of mistletoe identified.

Species shifts in Type 2 stands

In many stands, there has been a shift in the species profile of the stand to that of being dominated by hemlock. Example 5 is a hemlock-spruce stand (Figure 14). About 30 percent of the stand was harvested (70 percent retention). All of the Sitka spruce and most of the economic quality hemlock were cut from the stand, leaving a pure hemlock stand of poor quality and declining volume.

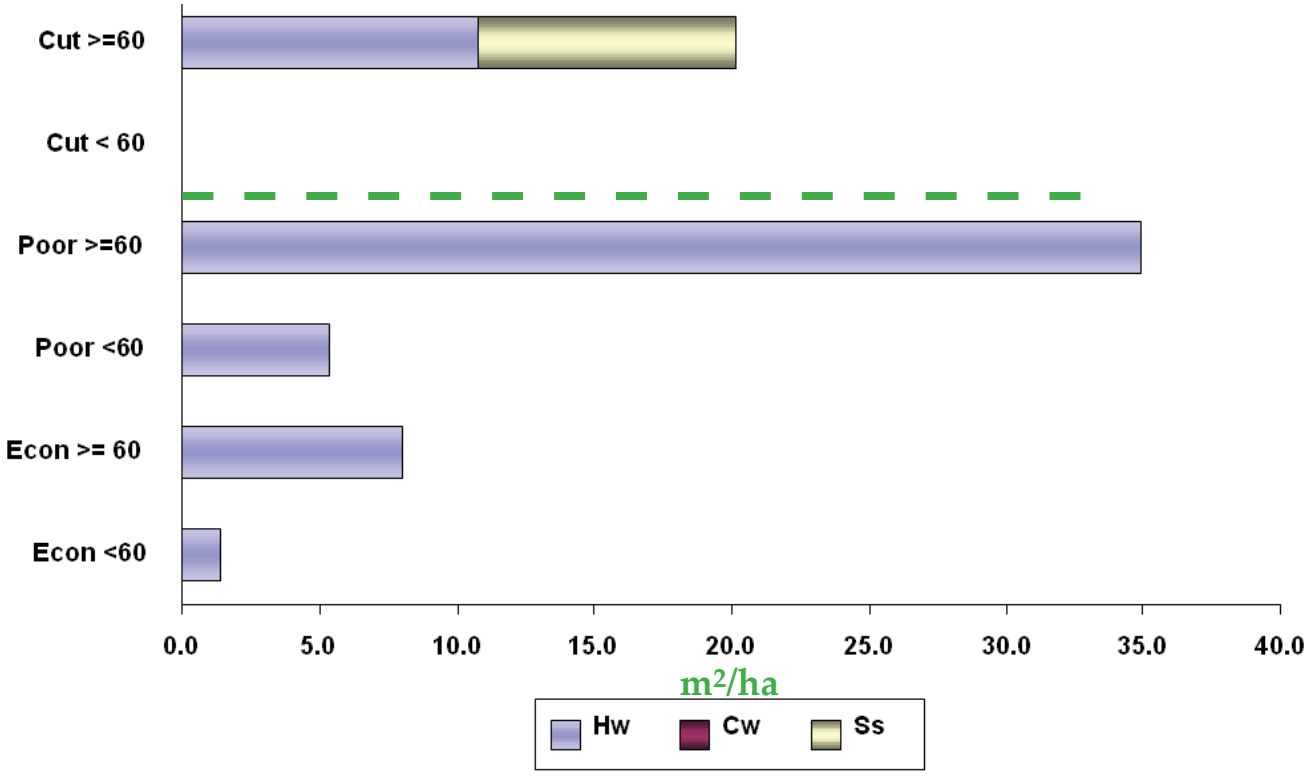

Figure 14: *Example 5, all spruce and economic hemlock has been extracted, leaving a poor quality hemlock stand.*

Most of the retained hemlock has experienced damage over time from wind, so large basal scars, forks, and other decay indicators are evident. Overstory mistletoe is common. This block was only partially stocked, with predominantly low vigour overstory trees. There is very little future potential harvest from this site.

Example 6 (Figure 15) is a stand with the cedar removed, now consisting of a hemlock overstory with significant mistletoe and slow growing hemlock understory, limiting the value of the future stand.

The silviculture plan put forward by the licensee proposed to maintain the species composition of the original stand, however, without planting, success is unlikely, as western hemlock will continue to dominate. Additional harvest options for this stand are limited due to the vigour and proportion of the hemlock in the remaining overstory, which will compromise understory growth.

If the retention were clumped into groups, or more emphasis was placed on creating gaps when harvesting, there would be more open area for regeneration containing the desired structure and species for diversity and timber production.

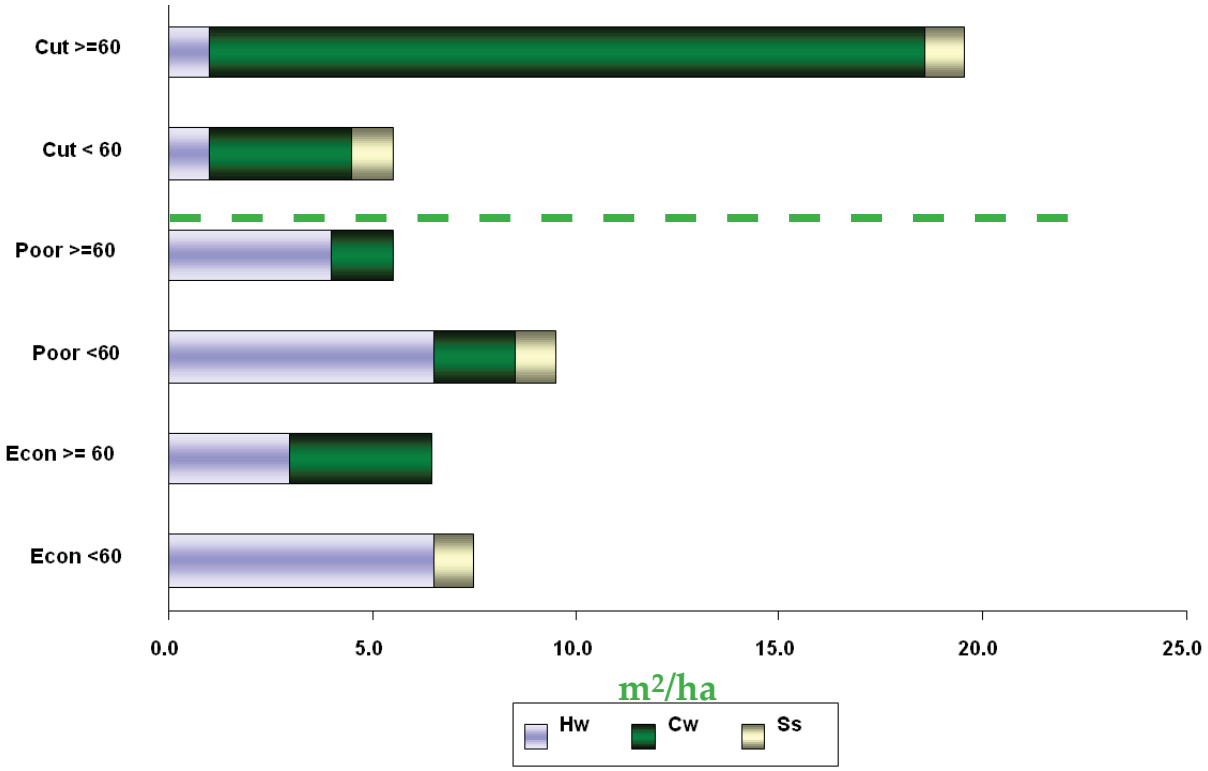

Figure 15: *Example 6, Block summary graph for a "health concern" block showing almost all large diameter cedar removed.*

Issues

Compliance Versus Effectiveness

This report illustrates the difference between compliance with legislation and effectiveness in managing a resource value. The Board recently audited compliance of one of the licensees whose blocks were examined in this report. The Board audit found that the licensee was, "in compliance with legislative requirements for planning, harvesting, road management, silviculture and fire protection."

While the audited blocks comply with forest practices laws because they met required stocking standards, they have not been effectively managed for future timber values. It is clear that the future stand will have low economic value because the current stocking standards allow residual, overmature, poor quality trees (mainly hemlock) to be counted as an acceptable, free-growing stock.

Implementing Prescribed Retention Levels

Presently, there is no methodology specified for determining if retention targets have been achieved post harvest. Where targets were provided they are often a percentage or percentage range of the original basal area. For these to be operationally examined, there needs to be a linkage to the original cruise BA, which can be translated into a post-harvest RBA range. Thus a range of RBA provides a means to describe the post harvest structure with a clearer indication of the impact of overstory on the understory.

Forecasting Volume Reductions

If the practice of high retention harvesting increases, then forecasting volume reduction from stands with significant retained overstory may become an important issue for timber supply review. For example, a stand with 20 square metres per hectare of dispersed retention, half cedar and half hemlock, could reduce merchantable volume yield at age 100 by approximately one-half compared to a fully-stocked, regenerated clearcut on a similar site.[12]

Potential for Species Shift

For most of the stands reviewed, there is a potential for species shift from high cedar component to lower value hemlock-dominated stands. Undisturbed forest floor, high slash loading and low overhead light favour establishment and growth of hemlock compared to either western red cedar or Sitka spruce.[13]

On the Queen Charlotte Islands, the deer population prevents the regeneration of unprotected cedar throughout the islands. The licensee maintains that, in partial cut blocks, the species shift will be the same, regardless of harvesting system.

[12]For example, TIPSY v. 3.2 indicates a reduction in merchantable volume at age 100 between 50 and 77 percent, using the Variable Retention reduction factor (for 20 and 40 m^2/ha dispersed RBA) for Cw/Hw stands in the CWH on the mid-coast (default site index with Hw as the refer ence species). Growth reductions will vary depending on site and stand factors.

[13]Klinka, K, J. Worrall, L. Skoda, and P. Varga. 2000. *The Distribution and Synopsis of Ecological and Silvical Characteristics of Tree Species of British Columbia's Forests*. Canadian Cartographics Ltd.

Figure 16: *Example 7, a cedar component has been retained.*

Where there is no regeneration potential and cedar and/or spruce is preferentially harvested, leaving hemlock and/or Amabilis fir, the species shift will be immediate. Depending upon the remaining timber value, there may be options for subsequent entries (Figure 16). Where cedar is being preferentially logged, it is often species other than cedar left on site, making subsequent entries unlikely.

There is even less likelihood of a second harvest for stands with 20 to 40 square metres per hectare RBA, as there is less timber available for a subsequent entry, and therefore, a higher likelihood of a species shift to hemlock in the understory of such stands. Hemlock grows much more slowly in such dense old stands than when grown in the open, so there will be both a value and volume impact over time. This is particularly important to compensate for high harvesting costs in stands with difficult access if a future harvest is expected.

Impacts on the Growth of Understory Regeneration

Understory trees require light, moisture and nutrients to grow to their potential. When old overstory trees are left on site, they occupy some, or potentially all, of the growing space, while providing little additional new growth to the stand.

For most of the stands with over 40 square metres per hectare RBA, understory growth is not relevant, as these stands are fully stocked with overstory stems; thus, the impact on the understory is not a concern at this time. However, for all stands between 20 and 40 square metres per hectare, the overstory will affect timber productivity in the understory, especially if the overstory has low economic value and is itself unlikely to be harvested or add appreciable volume over time.

Regeneration – Planting and Natural

Site plans indicated a general reliance on natural regeneration. Most indicated there would be a stocking survey conducted a number of years post-harvest and, if stocking were insufficient, planting would occur.

Helicopter logging often leads to high levels of slash, which can be a physical impediment for subsequent treatments. In areas where sub-merchantable trees are cut and left, rather than extracted, high slash loads will make planting difficult and potentially dangerous, which encourages acceptance of natural hemlock.

If western red cedar is planted a number of years post-harvest, competing vegetation and understory hemlock will challenge the survival of the cedar. Even if planted in gaps, cedar may still be affected by local competition, but the trees may ultimately be more valuable than open-grown trees because of smaller limbs and tighter grain. Growth will, however, take longer.

Overall, future planting must be operationally feasible to be a viable option. One concern that affects its viability is the low structural longevity of heli-pads used to access the blocks. Many were made of hemlock or Amabilis fir, both species that rot relatively quickly. Occasionally, heli-pads were buried by wind throw, rendering them inaccessible.

Forest Health – Dwarf Mistletoe (DMH)

In high retention stands, mistletoe reduces tree vigour and merchantability. Infection of understory is not, however, a major concern in the more closed stands, as there is limited space for regeneration to occur. Mistletoe is mostly a concern for timber productivity on the more open stands. This is especially true if the site is left after harvest to regenerate naturally.

All prescriptions examined by the Board identified mistletoe as a potential issue and described methods of dealing with it.

Figure 17 (2 photos): *Dwarf mistletoe resulting in stem swelling and reduced growth and value.*

Linking Site Plans to Harvesting Outcomes

It was noted during the investigation that there was often a discrepancy between the site plan and what was implemented on the ground, and it was difficult to determine a direct link between actual practices and reasoning behind the approach. Commonly, site plans used similar objectives, not necessarily relevant to site conditions. In other cases, the site plan described an elaborate multi-phase silvicultural system not suited to the actual stand conditions. In many cases, objectives appeared to be clear and reasonable, but were not well tied to the particular conditions or outcomes. An example from one plan states:

> ***"Within the Harvesting Plan - The objective is to provide benefits for a range of other resources such as: wildlife habitat attributes; hydro-riparian retention and stand level; and, biodiversity through retention of old forest attributes through the application of a retention silvicultural system that consists of group and dispersed retention.***
>
> ***Future stand structure/composition: Through retention and reforestation management strategies it is anticipated that the future stand will be similar in species composition to the current stand. Forest management activities (reforestation, etc) will generally target species other than Hw (Target species of Cw/Yc and Ba with a minor component of Ss) in an effort to maintain or increase the components of these species."***

In this example, the apparent intent is to manage for western red cedar, yellow cedar and Sitka spruce. However, the present level of overstory (39 square metres per hectare) will not allow for sustained growth of any of these species as understory. The stand will be modified, changing from having a significant level of western red cedar to having only a small amount of economic cedar, high levels of hemlock and uneconomic Sitka spruce and cedar (figure 18). Combined with the moderate to low levels of mistletoe on site, this does not correspond with the species management set out in the silvicultural prescription.

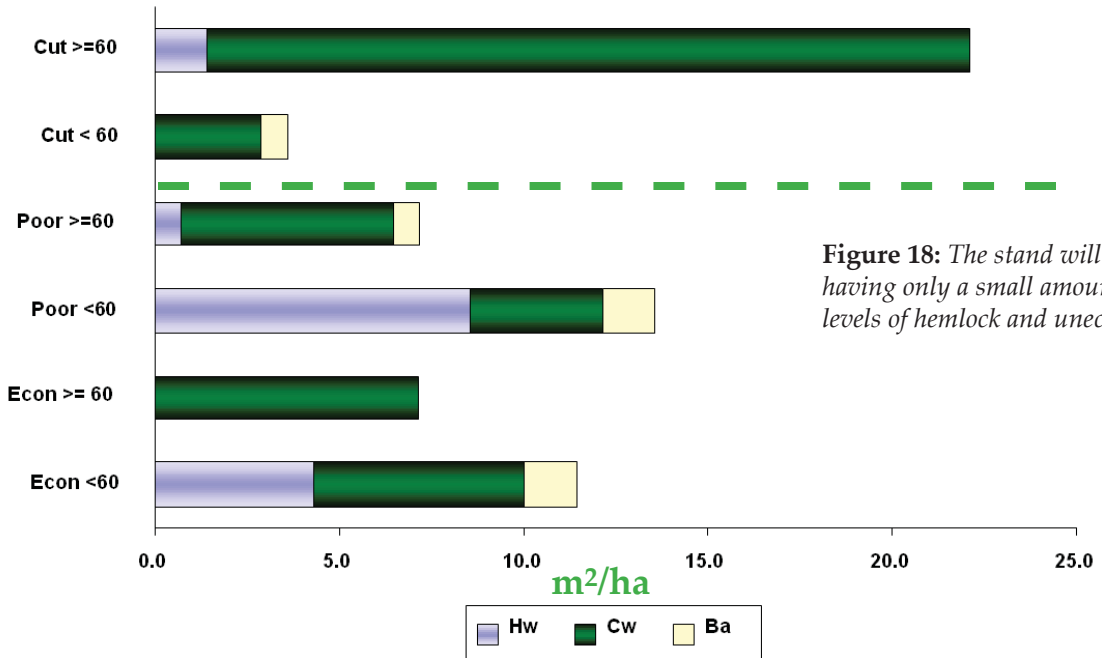

Figure 18: *The stand will be modified, from cedar to having only a small amount of economic cedar, high levels of hemlock and uneconomic spruce.*

Conclusions

The objective of this investigation was to examine timber sustainability in high retention stands on the BC Coast. While the use of high retention harvest systems appears to be small in scale and limited in its area, it is a practice that could grow as we move forward, particularly with ecosystem-based management. This investigation has pointed to some issues that need to be addressed sooner, rather than later. The Board found that high retention systems, if well applied, can maintain future economic harvest options while meeting other non-timber objectives.

However, the Board also found that high retention systems can be applied to extract nearly all timber value, and impair development of future crops. This presents two challenges for sustainability.

- First, a significant overstory was left that had insufficient value for a future harvest.
- Second, the overstory trees occupy the growing space, which precludes or significantly impacts the regeneration of a desirable species.

The Board concludes that high retention harvesting, while it is visually appealing and it meets many environmental and social objectives, is not always sustainable forestry as currently practiced. The practice may be appropriate in some situations, but practitioners need to be transparent about what they are doing, why they are doing it, and what the consequences are.

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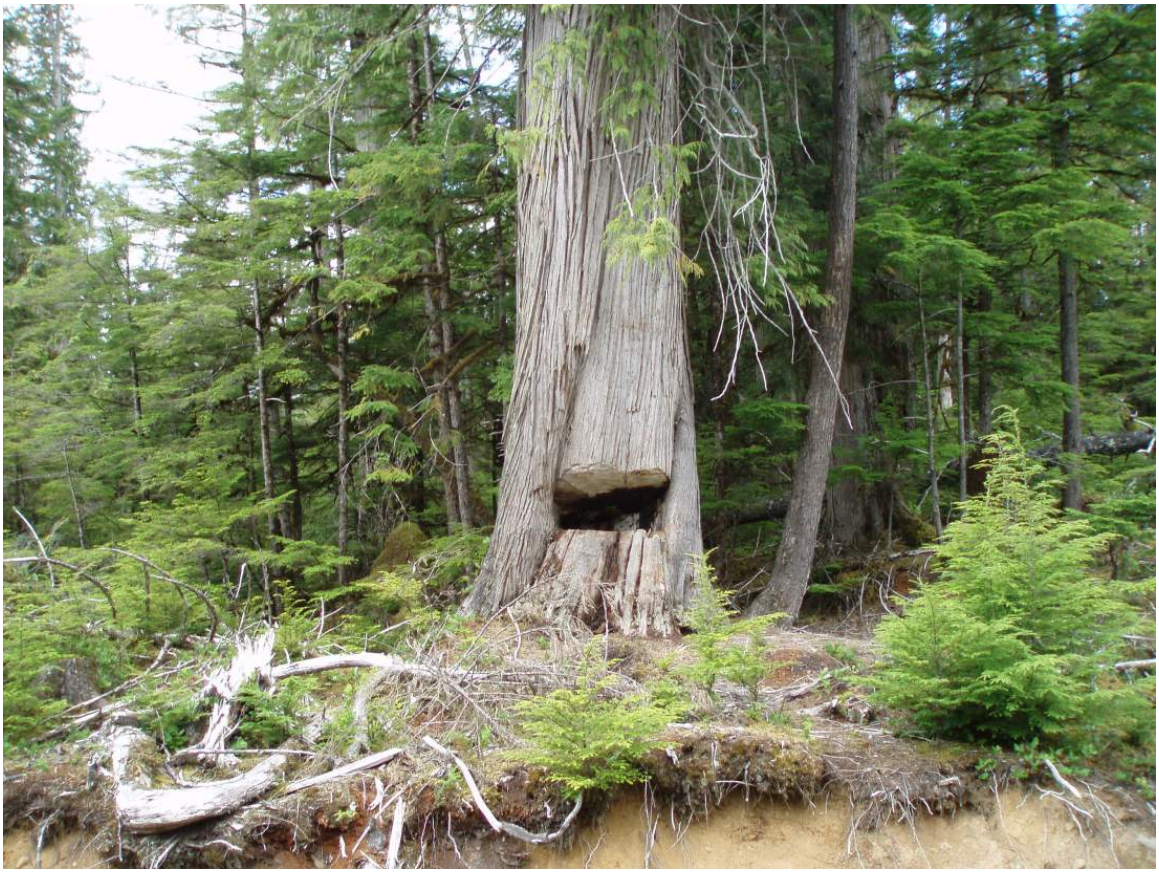
Western redcedar – issues for managing for desirable characteristics under retention of varying levels

Management to promote desired characteristics.



DRAFT: Version 1.1

Report for the Forest Practices Board

Attention: Steve Chatwin

By

Symmetree Consulting Group Ltd

March 2008

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Western redcedar potential in dispersed retention of varying levels[1].

Management to promote desired characteristics.

Western redcedar has many desirable characteristics. To some extent forest management has the ability to promote densities and shade levels that can promote or detract from those desirable characteristics. The Forest Practices Board in a special investigation on partial harvesting on the BC Coast found relatively high levels of residual stocking and limited planting of redcedar over their study area (Forest Practices Board, 2007). The question of whether the approaches assessed were conducive to the promotion of desired characteristics was raised. What follows is a discussion of what constitutes desirable attributes of redcedar and what management practices and silvicultural regimes are suited to achieving those characteristics. As a byproduct, regimes or strategies that do not promote the desired characteristics will be identified as well.

What makes western cedar unique and in many cases valuable:

Durability and appearance

Western redcedar is often sought after for its excellent durability and aesthetic appearance. First Nations refer to it as the Tree of Life for the myriad of uses it provides.

Figure 1. Examples of the use of clear redcedar - Black Bear Mask[2] and a cedar lined sauna.

[1] This review can be considered as background material for discussion on the suitability of high levels of dispersed retention and the long term management of redcedar.

[2] http://www.hickerphoto.com/indian-masks-7780-pictures.htm - A black bear mask carved by Stan C Hunt on Northern Vancouver Island and on display at Just Art Gallery in Port McNeill.

Clark et al, (2004)[3] report the total export value of western red-cedar products in British Columbia is $750 million. Much of this value is based on its natural durability, which is not fully understood. Durability was originally found associated with old growth redcedar heartwood and was attributed to naturally-occurring fungitoxic compounds particularly ß- and γ-thujaplicin.

Durability of second growth wood is not well understood. Products from second growth when grown over the relatively short rotations as indicated in most Timber Supply Analyses (e.g., 80 to 120 years) may not allow the buildup of the fungitoxic compounds that provide the desired durability. Presently there are more than 12 million redcedar seedlings planted in BC every year, their resistance to heart rot and long term durability are not known (Clark et al 2004). Therefore even with active management the desired durability may not occur without extended rotations.

The aesthetic quality of redcedar is often derived from its reddish color, grain pattern and wood free from knots. Similar to the issues on durability second growth redcedar will often have reduced heartwood and have limited clear wood unless managed specifically to create these desired characteristics of grain and color.

Figure 2. Cedar bolts to be used for shingles or shakes. Note the retention of redcedar in the group behind. Second growth trees will not have the characteristics of these large old trees, no matter how they are grown, unless rotations are lengthened.

Growing redcedar

Western redcedar grows along the Pacific Coast from Northern California to Alaska. In British Columbia it grows mainly in the Interior Cedar Hemlock and Coastal Western Hemlock biogeoclimatic zones. It grows over a range of soil moisture and nutrient conditions. While it will grow on low moisture and nutrient sites, best growth is found on wetter and richer sites[4].

[3] http://www.for.gov.bc.ca/hfd/library/FIA/2004/FSP_R04-013c.pdf
[4] http://testwww.for.gov.bc.ca/hfp/compendium/WesternRedcedar.htm#rangeAmplitude

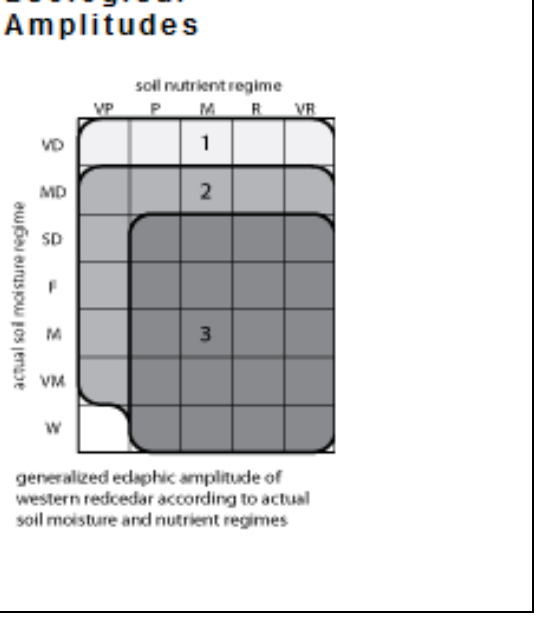

Figure 3. Geographic location Redcedar in BC and its ecological amplitude.

Table 1 Example Site Indices for Redcedar on a range of North Coast sites[5]

		Site Series Summary				
BGC Unit	**Site Series**	**Site Association**	**Species**	**Sample Size**	**Mean Site Index**	**Standard Error**
CWHvh2	01	CwHw - Salal	Ba		16.0	
CWHvh2	**01**	**CwHw - Salal**	**Cw**	**7**	**19.7**	**0.8**
CWHvh2	01	CwHw - Salal	Hw		20.0	
CWHvh2	01	CwHw - Salal	Pl		20.0	
CWHvh2	01	CwHw - Salal - Prince Rupert	Ss		16.0	
CWHvh2	01	CwHw - Salal - Vancouver	Ss		20.0	
CWHvh2	01	CwHw - Salal	Yc		16.0	
CWHvh2	04	HwSs - Lanky moss	Ba	33	27.3	
CWHvh2	**04**	**HwSs - Lanky moss**	**Cw**	**20**	**22.8**	
CWHvh2	04	HwSs - Lanky moss	Hw	43	27.0	
CWHvh2	04	HwSs - Lanky moss	Ss	43	31.6	
CWHvh2	05	CwSs - Sword fern	Ba		24.0	
CWHvh2	**05**	**CwSs - Sword fern**	**Cw**		**24.0**	
CWHvh2	05	CwSs - Sword fern	Hw		24.0	
CWHvh2	05	CwSs - Sword fern	Ss		28.0	
CWHvh2	**11**	**CwYc - Goldthread**	**Cw**		**12.0**	
CWHvh2	11	CwYc - Goldthread	Hw		16.0	
CWHvh2	11	CwYc - Goldthread	Pl		16.0	
CWHvh2	11	CwYc - Goldthread - Vancouver	Yc		8.0	
CWHvh2	11	CwYc - Goldthread - Prince Rupert	Yc		12.0	

Growth potential as indicated by Site Index at Breast Height age 50 for the range of growing sites on the BC coast ranges from 8 to 24 meters depending upon site[5]. The site series shown above were sampled during the Forest Practices Board Special Investigation

5 Site Index Estimates by Site Series found at:

http://www.for.gov.bc.ca/hre/sibec/reports/sisuBybgcUnit2007.xls

on dispersed harvesting. In all cases growth potential is somewhat less for redcedar than for the best species as identified for that site series. Thus cedar if grown using evenaged management with the associated species would form part of the intermediate and codominant layers (site series 1, 5 and 11) and likely an intermediate in site series 04 which is slightly drier than zonal in this wet subzone.

Growth characteristics

Reproduction and early growth

Western redcedar reproduces from seed as well as vegetatively by layering. Three types of vegetative reproduction occur, roots emerge from branches that touch the ground, fallen branches form roots and by the development of branches into stems from fallen trees. Germination and survival from seed is best on disturbed mineral soil substrates, unlike western hemlock that flourishes on decaying wood and organic substrates (Burns and Honkala, 1990).

Regeneration in partial harvest areas logged by helicopter

Partial harvesting in remote areas on the BC Coast is often done by helicopter and constituted the entire sample for the Forest Practices Board Special investigation (Forest Practices Board, 2007). Due to the aerial removal by the helicopter there is virtually no soil disturbance. This results in regeneration of redcedar mainly through vegetative reproduction. The incidence of fungal rot in vegetative regeneration is considered an issue for long-term value (Weetman et al 1988).

Planting is an option that would help minimize rot. However deer browsing of planted seedlings is a considerable issue throughout the BC coast and especially on the Queen Charlotte Islands. Options to manage deer browse are effective but are expensive. Present research indicates there may be genetic characteristics that reduce desirability for browsing (Russell, 2006 as cited by Klinka and Brisco, 2007). With future research and development this may allow for more cost effective artificial regeneration of redcedar.

Form

Western redcedar has the ability to survive and grow in low light conditions found in many old forest types (Klinka et al, 2000). When redcedar remains in the subcanopy, as it does with small gap partial cutting, it maintains its lower branches and has increased taper. This also occurs when it is grown in the open, holding it branches to the ground (Figure 4).

Figure 4. Note the wide low crown extending to the ground in the understory redcedar. Also note the size and longevity of branches in an open grown redcedar on the right. This form does not promote the growth of clear wood or the creation of Monumental Cedar characteristics desired by many coastal First Nations.

Silvicultural systems options

Due to the high shade tolerance of redcedar it has the ability to grow within a range of overstory conditions and therefore a range of silvicultural system options are available. The key then is what characteristics are we are trying to produce through management.

Traditional silvicultural systems are based on regeneration objectives. Even aged systems promote a single age class or cohort that regenerates over a relatively short period. To maximize growth of the cohort, where overstory trees were left to promote regeneration, they are removed once it is established. The size of opening created is usually large enough for full expression of growth, i.e., it is not light limited. Group and open dispersed retention systems fit within this approach.

Uneven aged management traditionally has two main approaches, group and single tree selection.

- Group selection creates gaps or small openings (often from 0.1 to 0.25 ha) within a managed area allowing for a matrix of different age classes in each of the gaps over time. This approach is essentially even age management on a smaller scale.
- Single tree selection is a system that promotes continuous forest cover and requires trees to grow in an understory position. The size of the opening and the amount of overstory retained is a balancing act between growth of overstory trees of all sizes and the ability for recruitment and growth in the regeneration layer.

Other non-silvicultural system options occur where a limited number of trees are removed and the stand remains fully stocked with no regeneration objective. These harvest entries (non silvicultural systems) leave the stand in a condition that can provide for a range of non-timber objectives providing an opportunity to obtain some volume and value from the stand. Due to the lack of regeneration, these entries are not necessarily sustainable for timber without additional harvest entries. If done in a way that removes

future harvest options, this is referred to as High Grading. This approach will not provide for future redcedar with desired characteristics within a reasonable timeframe.

What is it we are managing for?

Timber, monumental cedar, biodiversity, water quality, visuals, slope stability are all identified objectives in areas where redcedar is managed. The list is significant often with overlapping objectives. While the non-timber objectives are important it is also instructive to identify options that create conditions that promote value over time and can meet identified non-timber objectives.

Managers need to ask what conditions are needed for desired redcedar growth and form that will provide desired wood quality characteristics: for example trees with limited lower branches, less taper and increased durability. Crown derived wood has significantly different characteristics than non-crown derived wood, often referred to as mature wood (Jozsa and Middleton, 1994). Juvenile wood in redcedar has a higher relative density (heavier and less insulating properties) than mature wood and has more knots. It therefore has fewer options for use and is less valuable (e.g., TIPSY v 4.1 economic output).

While information on durability is complex and not completely clear for second growth (Clark et al 2004), there is compelling information on growth characteristics and form within various stand structures.

How to manage redcedar to meet timber value objectives

Some questions to ponder:

1. What opening size is suited to sustained growth of redcedar?
2. How does redcedar respond to overstory removal?
3. What would constitute a regime that promotes desired relatively clear wood and few lower branches?
4. What happens when redcedar grows in mixed stands with faster growing species?

What opening size is suited to sustained growth of redcedar?

Western redcedar saplings are shade tolerant and will increase in height growth under relatively low light levels. Drever and Lertzman (2002) found increased height growth as light increased from 0 to 20% full sun. Even with increased height, trees that remain in the subcanopy will often have poor form, i.e., heavy branching and a tapered bole (Klinka et al 2000). Thus opening size is important to allow trees to grow together as a cohort or to remain in the stand for long periods (many hundreds of years) to allow for crown lifting.

How does redcedar respond to overstory removal?

Where redcedar is managed in mixed species stands or using single tree selection it is often overtopped by faster growing species such as western hemlock, true firs and sitka spruce (and of course Douglas-fir where they grow together). Burns and Honkala (1990) suggest that while redcedar tolerates understory conditions it should not be given

excessive crown space. They indicated that thinning from below is preferred as removal of the overstory results in most of the growth allocated to large branches and a spreading crown rather than on the desired stem wood.

Coates (2000) found that for regenerating trees to grow near their full capacity in the ICH biogeoclimatic zone required openings of 0.1 ha if the surrounding canopy trees were 30 m tall. For taller coastal stands he estimated that openings 0.2 to 0.3 ha would be needed to obtain near full growth potential. For example a square opening that measures 0.2 ha would be approximately 45 m by 45m.

To get an indication of opening sizes in areas where harvesting was focused on removal of selected trees, residual basal area is often used to gauge the site occupancy and provide a measure of openness. The following table provides intertree distances based on a range of high retention level basal areas.

RBA m^2/ha	Average DBH of leave trees (cm)	Number of trees per ha	Approximate Intertree distance (m)
40	60	141	8.5
	100	51	14
50	60	177	7.5
	100	64	12.5
60	60	212	6.8
	100	76	11.8

Table 2. Average number of dispersed stems and intertree distance based on a uniform distribution of like sized trees.

As the residual basal area increases the number of stems to make up the BA increases and the amount of open space decreases. As table 2 indicates with a RBA of 40 m^2/ha (considered the low end of high retention) and trees with an average diameter of 60 cm would have an average intertree distance of 8.5 m. While there is not intact forest between these trees the gap size created by this distribution is less than 0.01 ha. If the average leave trees were larger, for example 100 cm in diameter this would equate to 51 sph with an average intertree spacing of 14 m (creating a gap of approximately 0.02 ha). Both of these opening sizes are much smaller than the estimated open sizes suggested for full growth potential. These opening sizes will promote branch retention and high taper in understory redcedar.

What would constitute a regime that promotes relatively clear wood and few lower branches?

For redcedar to provide clear-wood Klinka et al (2000) recommends relatively high initial stocking levels (>2000 sph) with delayed density control once the stems are into the stem exclusion stage. This is a true silviculture regime intended to meet a desired timber

objective. Will other approaches create similar desired outcomes? To some extent time will provide the conditions that create clear wood and large trees. The assumption is that most stands will have some healthy cedar and with enough time the trees will provide for the desired characteristics. When natural regeneration is relied upon in areas of low ground disturbance, much of the regeneration will be vegetative and have internal rot, this may not be a wise assumption.

Figure 5. Pure even aged redcedar stand that is on a trajectory to provide desired characteristics (photo credit Klinka et al 2000).

Time frames to provide a minimum of 30% high value wood

While there is no magic number on when a stand is considered economic, stands that require expensive harvesting methods such as helicopter yarding require a significant portion of high value wood. The following example uses 30% H grade or better. Below is an example printout by log grade based on TIPSY 4.1 of a pure redcedar stand.

		Log Vol. (m3/ha) [10 cm top/12.5+]						
TIPSY Age (yr)	Top Ht (m)	All Grades	Grade H	Grade I	Grade J	Grade U	Grade X	Grade Y
0.0	0.3	0	0	0	0	0	0	0
20.0	7.9	0	0	0	0	0	0	0
40.0	15.5	125	0	0	64	43	14	4
60.0	21.4	379	1	0	277	80	19	2
80.0	25.9	573	19	0	451	83	18	2
100.0	29.4	758	83	0	571	83	19	2
120.0	32.2	900	187	0	610	83	18	2
140.0	34.4	1042	323	0	616	82	18	3
160.0	36.3	1165	453	0	612	79	18	3
180.0	37.7	1258	552	1	605	80	17	3
200.0	39.0	1331	633	1	598	80	16	3

Figure 6. TIPSY4.1[6] output indicating log grades for a Site Index 20 site of pure redcedar planted at 1600 sph.

Note that it is not until the stand reaches 140 years that more than 30% of the volume is from the higher value H grade (estimated value at $150 per cubic meter compared with $100 for J grade). The actual values vary over time, but remain relative due to the desired characteristics of H vs J grade. H grade is a larger log with more clear wood than J grade which is considered a good sawlog[7].

What happens when redcedar grows in mixed stands with faster growing species?

Redcedar will often become relegated to an understory position, resulting in maintenance of the crown and retention of lower branches. Canham et al (2004) report significant competitive effects of hemlock on redcedar growth. They suggest it may occur from a combination of below ground competition and hemlock's negative influence on forest floor nutrient dynamics as its abundance increases in mixed stands. Their study found with increasing amounts of western hemlock there was a strong negative effect on redcedar growth; this was not reciprocal, as added redcedar did not significantly reduce hemlock growth. This has significant consequences where redcedar is being left to regenerate naturally in areas of little or no soil disturbance as western hemlock will dominate the regeneration layer and restrict redcedar growth.

What is the likely future trajectory for high retention partial cut stands?

From the information collected on the growth and form of cedar grown in understory conditions it appears evident that in many cases western hemlock will outgrow it.

[6] http://www.for.gov.bc.ca/hre/software/tipsy.htm
[7] http://www.for.gov.bc.ca/hva/timberp/infopapers/CoastLogPrices_Nov4.pdf

Redcedar when subjugated to an understory role will retain many of its lower branches resulting in lower long-term value. Without active management to promote relatively high early densities followed by well thought out thinning regimes it is not realistic to assume high quality timber from stands for a minimum of 140 years.

Decision tool for cedar management

Determine the objective: If

Other than timber – options are open, choose the system to maintain or enhance the desired objective.

Low value timber – options are open, redcedar will grow under a range of conditions including under high overstory conditions.

1. Mixed wood stands with dense hemlock component. Hemlock will generally outcompete the redcedar resulting in fewer larger more valuable cedar at rotation.
2. Overstory removal in partial harvests will promote wide crowns and large branches in redcedar.
3. Natural regeneration versus planting in areas with minor soil disturbance will promote vegetative reproduction and associated potential for fungal rot.

High value timber – management is required.

1. Create gaps at a minimum of 0.2 ha.
2. Stock with planted cedar and protect against browsing. This could be achieved using browse control devises or using browse resistant stock when available.
3. Use high densities to promote smaller lower branches and crown lift. Western redcedar self-prunes where side shading is complete or nearly so.
4. Thinning should be done with the final product in mind. Oliver et al (1988 as cited by Klinka and Brisco 2007) suggested thinning be delayed until lower branches die to avoid their survival and adding growth. Literature from the 1970's and 1980's (Hamilton and Christie 1971 and Nystrom 1980 as cited in Klinka and Brisco 2007) suggest delaying thinning to age 21 and as late as 30 years leaving 350 sph on high productivity sites to 750 sph on low productivity sites.
5. In mixed stands group or clump cedar when planting to promote competition between the cedar not the faster growing matrix species.
6. Fertilization can improve growth. For effective response an understanding of the nutrient requirements on a site specific basis are needed as growth can be limited by deficiencies in both macro and micro-nutrients.
7. Choose redcedar management based on site specific and landscape level direction.

Where would blocks from Forest Practices Board report on high retention fit within the above process?

The Board found three general categories of retention and future trajectories.

Type 1. Stocked by overstory, value removal does not exceed volume removal (harvesting the profile).

This set of blocks remains stocked and has little or no available space for the regeneration of understory stems. It is therefore in a holding pattern that allows for additional harvest. In some cases significant levels of valuable redcedar were left.

Type 2. Stocked by overstory, value removal greatly exceeds volume removal (high-grading); inadequate sites for regeneration.

This set of blocks had moderate to high levels of retention, much of which is not considered economic. The approach did not create open space to promote redcedar growth. In most cases there was not a clear regeneration strategy indicating desired characteristics of future crop trees.

Type 3. Stocked by overstory, value removal exceeds volume removal; substantial forest health problems due to dwarf mistletoe.

This set of blocks is similar to those in type 2, with an added issue of hemlock dwarf mistletoe. While the mistletoe may provide a competitive advantage to redcedar in some cases the blocks were not opened up to promote growth and were often left for natural regeneration that will be mainly hemlock.

For most blocks examined they would fall into the

- Other than timber or
- Low value options.

In no cases with high retention were openings sufficiently large enough or density of redcedar conducive to creation of high value cedar products.

Conclusion: Active Management is required to obtain redcedar with desired characteristics.

In order to achieve desired characteristics in western redcedar specific management practices must be used. Cedar grown in unmanaged stands will not produce clear wood without relatively high densities of regenerating cedar. Three management practices that could be effective are:

- Open up the stands, create gaps a minimum of 0.2 ha
- Plant redcedar at higher densities, plan on thinning once lower limbs begin to die.
- Choose your sites for managing redcedar based on growth potential and logistics. In some cases active management may not be desirable and managing for other objectives may be the best option.

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Forest Practices Board

File: 97325/20-2006-05

January 16, 2009

Sharon Glover
Chief Executive Officer
Association of BC Forest Professionals
1030-1188 West Georgia St.
Vancouver, BC V6E 4A2

Dear Sharon Glover:

Re: Response to the Board's High Retention Harvesting Report, SR 20

Thank-you for your response of September 8, 2008 to the Forest Practices Board recommendations in our special investigation report on High Retention Harvesting on the BC Coast. Since we received your letter, we have made revisions to the report in response to issues raised by Interfor, and have just now reposted the report on our website. We very much appreciate the involvement of the association in the discussions that have taken place regarding the report revisions.

As these revisions did not affect our original recommendations, we accept your July letter as the association's response. We are pleased that you are working with industry and government to strengthen professional practice and implementation to promote sound stewardship of our forest resources.

Thank-you for your attention to these issues, and for informing us of your progress in addressing them.

Yours sincerely,

Bruce Fraser, PhD
Chair

Forest Practices Board

File: 97325/20-2006-05

October 3, 2008

Doug Konkin
Deputy Minister
Ministry of Forests and Range
PO Box 9525 Stn Prov Govt
Victoria, BC
V8W 9C3

Dear Doug Konkin:

Re: Response to the Board's High Retention Harvesting Report, SR 20

Thank-you for your response of July 30, 2008, to the Forest Practices Board recommendations in our special investigation report on high retention harvesting on the BC Coast. We are pleased that government has recognized the issues raised by this investigation, and is working with industry and the ABCFP to respond.

The Board would be interested in an update on progress in both the strategic direction for high retention harvesting and the discussion paper on appropriate stocking standards. I will have staff follow-up in a year or so to check on progress with the ongoing initiatives.

We recognize that this is a complex issue and that adaptive management will be an important consideration in finding solutions. We hope our report does not lead to a stifling of innovation or a prohibition on the practice of high retention harvesting or the use of multi-story stocking standards while guidance is being developed. We fully appreciate that trade-offs must be made between the economic benefits of harvesting and the environmental and social constraints some of these sites can pose, but we believe those trade-offs should be made explicit where they are the reason for the harvest system.

Yours sincerely,

Bruce Fraser

Bruce Fraser, PhD
Chair

Forest Practices Board

File: 97325/20-2006-05

January 16, 2009

Doug Konkin
Deputy Minister
Ministry of Forests and Range
PO Box 9525 Stn Prov Govt
Victoria, BC V8W 9C3

Dear Doug Konkin:

Re: Response to the Board's High Retention Harvesting Report, SR 20

Thank-you for your response of July 30, 2008, to the recommendations in our special investigation report on High Retention Harvesting on the BC Coast. Since we received your letter, we have made revisions to the report in response to issues raised by Interfor, and have just now reposted the report on our website. We very much appreciate the involvement of Forest Ministry staff and executive in the discussions that have taken place regarding the report revisions.

As these revisions did not affect our original recommendations, we accept your July letter as the Ministry's response. We are pleased that government has recognized the issues raised by this investigation, and is working with industry and the ABCFP to address them.

The Board would be interested in an update on progress in both the strategic direction for high retention harvesting and the discussion paper on appropriate stocking standards. I will have staff follow-up in a year or so to check on progress with the ongoing initiatives.

Yours sincerely,

Bruce Fraser

Bruce Fraser, PhD
Chair

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Dr. Bruce Fraser, Chair
Forest Practices Board
PO Box 9905 St Prov Govt
Victoria, British Columbia
V8W 9R1

Dear Dr. Fraser:

Re: Government's response to recommendations 1, 3 and 4
Special Investigation Report 20, January 2008

On behalf of the Ministry of Forests and Range (MFR), please accept this letter as government's response to Recommendations 1, 3, and 4 included in the Forest Practices Board special investigation report 20, *High Retention Harvesting and Timber Sustainability on the British Columbia Coast (January 2008).*

In developing this response, the MFR considered legislative direction from the *Ministry of Forests and Range Act*, the *Forest Act* and the *Forester's Act* as well as the *Forest and Range Practices Act* (FRPA). It is our view that the issues identified in the report should be addressed in consideration to all of the relevant legal and non-legal tools. We believe this approach is necessary to find the most efficient and effective means of addressing the identified issues.

Recommendation 1
The current regulations and policies do not provide strategic direction to help determine when silvicultural systems and/or harvest approaches with high amounts of retention should be used. The Ministry of Forests and Range should provide strategic direction to guide licensees on appropriate approaches for high retention, based on clear strategic objectives for the full range of values over time, including timber species /values.

Ministry's Response
The MFR agrees that the strategic direction provided in current legislation does not specifically address silvicultural systems or harvesting approaches. The MFR further

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agrees that lower level strategic direction on a management unit basis would be a valuable tool that the prescribing professional can use when determining which silvicultural systems (and associated stocking standards) should be applied in achieving identified resource values, including timber objectives.

Currently, the MFR is piloting two new strategic plans which focus on the management of the timber harvesting land-base for timber values. As part of the Coast Action Plan, a pilot is being undertaken in the Strathcona Timber Supply Area (TSA). While the pilot is primarily focussed on the transition from old growth timber harvesting to second growth, the concept of this plan also looks at various planning, practices and investment options and could be used to analyse the use of various silvicultural systems to achieve various objectives set by government. Another strategic plan being piloted in the Kamloops TSA is under the Chief Foresters' new Future Forest Strategy. This new initiative will also look at timber management and timber flows more strategically. Both of these plans would feed information into the Timber Supply Review process and may be used operationally in other TSAs at some point in the not too distant future. Subject to ministry decision to implement one or both of these planning tools, we will explore the opportunity to include silvicultural system strategic direction as part of these strategic plan initiatives.

In the interim, the MFR will offer to meet with licensee groups in the Haida Gwaii (Queen Charlotte), North Coast and North Island-Central Coast forest districts to outline the context of the issues identified in the Board report and the implications at the local level, e.g. long term impact on AAC and changes to the operable land base. This discussion will include an opportunity for local licensee steering committee groups to work with district and regional MFR staff to develop strategic plans that set landscape level timber objectives and stand characteristic targets that will guide the implementation of silvicultural systems. This has been done with some success in the Haida Gwaii Queen Charlotte district to address western hemlock sanitation issues and western red cedar management issues and could be extended to other districts to address specific operational planning needs. The goal is to find solutions to address identifiable timber sustainability problems. In addition to efforts to meet with licensee groups at the district level, the MFR will conduct analysis of timber supply impacts associated with high retention silvicultural system application and share this with licensee groups for their operational consideration and incorporation into timber supply reviews.

In support of strategic planning initiatives (proposed and ongoing), the MFR feels that there is a strong need to ensure that we have an ongoing understanding of the nature and scope of the issue and that we are communicating with appropriate forest professionals. As mentioned in the Board report, the MFR (through the CRIT and other initiatives) has been proactive in identifying and addressing this issue. In support of this, the MFR continues to fulfill the following commitments:

- monitoring and promoting professional understanding and application of high retention silvicultural systems by the joint agency/licensee CRIT silviculture working group.
- promoting professional understanding and dialog around the application of silvicultural systems specifying high levels of dispersed retention through the CRIT silviculture working group.

- work with licensees to compile and report stand level retention data, including retention tree pattern distribution, into RESULTS necessary to accurately determine the extent and impact of high retention silvicultural system on timber supply within the Coast Forest Region.
- pilot the FREP "RSM[1] Timber evaluation protocol in partial cut stands" silvicultural system project as part of local monitoring efforts in the Haida Gwaii Forest District.
- conduct Compliance and Enforcement (C&E) free-to-grow inspections on blocks harvested under high retention silvicultural systems consistent with risk rating priority.
- complete C&E staff multi-layer stocking standard free-to-grow assessment training, and
- include MFR/Licensee discussion with respect to high retention silvicultural system stocking standards as part of the FSP approval process.

Recommendation 3

The Ministry of Forests and Range should require clear, achievable and measurable up - front targets for post - harvest retention levels. Stocking standards should require the use of residual basal area ranges with compliance limits at both the lower and upper end. Some characterization of vigour and economic viability should be used to allow trees to contribute to stocking. Ultimately, retention stocking standards must be designed so they can be audited for compliance, and monitored for effectiveness.

Ministry's Response

The MFR agrees that clear, measurable and achievable stocking standards, including retention standards, are important to determine compliance and for monitoring of effectiveness. This issue has been raised and addressed by the CRIT in the form of the *Silvicultural System and Partial Cut Harvesting Issues in the Coast Forest Region DISCUSSION PAPER produced by the Silviculture Systems Issues Working Group of the Coast Region Implementation Team May 15, 2006.* This document was recently endorsed by the ABCFP as an example of how professionals can work together to address FRPA implementation issues. The professional association endorsement of this type of peer reviewed guidance document is a powerful tool for managing implementation issues such as this.

The MFR believes that the multi storied stocking standard designed for a single tree selection silvicultural system in dry belt interior Douglas Fir areas (see *Reference Guide to Forest Development Plan Stocking Standard*) is being used inappropriately in the coast region. It is the intention of the MFR to edit the reference guide to address high retention silvicultural system stocking standard in coastal applications. To do this, the MFR will rely on the efforts of the CRIT. As part of its 2008/09 draft Terms of Reference, the CRIT has identified the development of a peer reviewed stocking standards discussion paper to be tasked to the silviculture working group. The CRIT will be asked to provide direction to the silviculture working group to address high retention silvicultural system applications or other intermediate cutting applications with no regeneration obligation.

[1] Resource Stewardship Monitoring

The CRIT will be asked to confirm the following direction to the silviculture working group:

- identify an appropriate stocking standard or set of stocking standard development principles for high retention silvicultural systems on the coast.
- develop an appropriate survey methodology to accurately describe and measure post harvest stand structure of high retention silvicultural systems. The new survey methodology will assist with compliance inspections and effectiveness evaluations.
- request ABCFP to endorse this discussion paper and survey methodology upon completion and acceptance by CRIT.

Recommendation 4
The Ministry of Forests and Range should develop policy about 'opportunity cuts' with no expectations of future yield (and therefore no silvicultural system) which could be considered, for example, in areas constrained from harvest due to other objectives, such as slope stability concerns.

Ministry's Response
The MFR agrees that guidance concerning the concept of "opportunity cut" where either a physical or non-timber value precludes the application of a silvicultural system with a reasonable chance of success. Key to determining success is a need for sufficient information to help professionals balance forest values (economics, environmental and social).

The concept of "opportunity cut" is not new and has been discussed as part of workshops specific to partial cutting. Most recently, a CRIT sponsored field based training session, specific to high retention silvicultural systems, held in Tofino in October 2007, discussed opportunity cutting in some detail. As a result of one of the recommendations from the Tofino workshop, the CRIT tasked the silviculture working group to develop an "opportunity wood" options paper. The purpose of the paper is to provide information and options on how opportunity cutting may be managed in the Coast Forest Region. A number of issues and considerations concerning the feasibility and implications of opportunity cutting will be presented as well as management options to be considered. The final paper will be presented to the Coast Region Management Team for consideration and implementation decision by November 2008 and may be used to develop policy around opportunity cutting.

Response Summary
As discussed above, many of our response commitments are associated with efforts already initiated. In order to ensure that we follow through on all commitments, the MFR will carry out an annual review of the status of these commitments and will develop workplan(s) specific to commitments as necessary.

Additional Comments
In addition to the three recommendations addressed in this letter, the MFR would like to offer support to the concept of more discussion about the quality and diligence professional foresters put into the development and implementation of high retention silvicultural systems

(Board report recommendation #2). As part of the MFR process of responding to the Board report, we noticed several opportunities for professional reliance to be used to address the issues identified in the report. Through the CRIT, the MFR has been and will continue to work closely with the ABCFP to strengthen the professional reliance and accountability foundation critical to supporting the FRPA legislative regime.

Thank you for the opportunity to respond to the Board report recommendations. Please be assured that the MFR understands the nature of the issues identified in the Board report and has been taking steps to address them. This is evidenced in the Chief Forester's March 12, 2008, letter addressed to coastal licensees and licensee groups that discusses these issues and lends support to the efforts of CRIT. It is noted in this letter that we are seeing meaningful changes in the field based largely on professional dialogue and willingness of professionals to learn from their colleagues. I believe this type of approach is working to ensure appropriate forest management.

Please contact the Forest Practices Branch member Dave Weaver (250 387-4768) or the Coast Forest Region team of Chuck Rowan (250 751-7096) or Craig Wickland (250 751-7094) with any questions or requests for additional information.

Yours truly,

Doug Konkin
Deputy Minister

pc: Honorable Pat Bell, Minister of Forests and Range
Tim Sheldan, ADM, Operations Division, MFR
Lorne Bedford, A/Director, Forest Practices Branch, MFR
Dan Graham, Director, Compliance and Enforcement Branch, MFR
Jim Langridge, Director, Resource Tenures and Engineering Branch, MFR
Jim Gowriluk, Regional Executive Director, Coast Forest Region, MFR
Dave Bewick, District Manager, North Coast Forest District, MFR
Len Munt, District Manager, Haida Gwaii (Queen Charlotte) Forest District, MFR
Andrew Ashford, District Manager, North Island-Central Coast Forest District, MFR
Dave Weaver, Forest Practices Branch, MFR
Chuck Rowan, Coast Forest Region, MFR
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