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.
Letter From the Chair

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 (m²/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. 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.

- 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.

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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.


\(^4\)See definition on page six of this report.
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.
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 (m²/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 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 m²/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 (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.
Introduction

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 Zielke7 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.

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Introduction

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.
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.
**Introduction**

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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Rob Volkman, RFT, CEA(SFM), CCEP, Forest Practices Board
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.

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\(^8\)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 m\(^2\)/ha to greater than 100 m\(^2\)/ha.
Introduction

Table 1 - Criteria used to assess vigour of leave trees

<table>
<thead>
<tr>
<th>GOOD/ ECON¹⁰</th>
<th>HIGH VIGOR – HIGH PROBABILITY OF PERSISTING THROUGH ROTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• No heartrot suspected.</td>
</tr>
<tr>
<td></td>
<td>• AND 40%+ live crown (H, Ba, C, Y) / 30%+ (Fd, P) / 25%+ (broadleaf).</td>
</tr>
<tr>
<td></td>
<td>• AND foliage has normal, healthy color.</td>
</tr>
<tr>
<td></td>
<td>• AND tree is highly windfirm – there is a high chance that the tree will remain standing until the end of the rotation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FAIR / ECON</th>
<th>MODERATE VIGOR – MODERATE PROBABILITY OF PERSISTING THROUGH ROTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Heartrot unlikely or insignificant.</td>
</tr>
<tr>
<td></td>
<td>• AND 20%+ live crown (all conifers) / variable - (broadleaf).</td>
</tr>
<tr>
<td></td>
<td>• AND foliage has normal, healthy color.</td>
</tr>
<tr>
<td></td>
<td>• AND tree is moderate to highly windfirm – there is a reasonable chance that the tree will remain standing until the end of the rotation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POOR / UNECON</th>
<th>POOR VIGOR – LOW PROBABILITY OF PERSISTING THROUGH ROTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Heartrot is significant.</td>
</tr>
<tr>
<td></td>
<td>• OR &lt; 20%+ live crown (all conifers) / variable - (broadleaf).</td>
</tr>
<tr>
<td></td>
<td>• OR foliage is patchy and sparse.</td>
</tr>
<tr>
<td></td>
<td>• OR foliage has an abnormal, unhealthy color.</td>
</tr>
<tr>
<td></td>
<td>• OR tree is NOT windfirm – there is a low chance that the tree will remain standing until the end of the rotation.</td>
</tr>
</tbody>
</table>

**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.

¹⁰Economic 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.
Results

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).

<table>
<thead>
<tr>
<th>Type</th>
<th>Average Residual BA (m²/ha)</th>
<th>Average RBA Fair and Good (m²/ha)</th>
<th>Total # of stands</th>
<th>% of all stands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher retention</td>
<td>55</td>
<td>27</td>
<td>15</td>
<td>38%</td>
</tr>
<tr>
<td>More open</td>
<td>33</td>
<td>17</td>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>ALL STANDS</td>
<td>51</td>
<td>25</td>
<td>18</td>
<td>46%</td>
</tr>
</tbody>
</table>

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.’
Results

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.](image)

![Figure 7: Example 1, light removal, value remains.](image)
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 8: Example 2, light dispersed harvest.

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

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.
Results

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).

<table>
<thead>
<tr>
<th>Type</th>
<th>Average Residual BA (m²/ha)</th>
<th>Average RBA Fair and Good (m²/ha)</th>
<th>Total # of stands</th>
<th>% of all stands</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Retention</td>
<td>48</td>
<td>17</td>
<td>8</td>
<td>21%</td>
</tr>
<tr>
<td>More Open</td>
<td>28</td>
<td>11</td>
<td>13</td>
<td>33%</td>
</tr>
<tr>
<td>ALL STANDS</td>
<td>36</td>
<td>13</td>
<td>21</td>
<td>54%</td>
</tr>
</tbody>
</table>

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.
Results

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.
Results

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.
**Results**

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.

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**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.

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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 m²/ha dispersed RBA) for Cw/Hw stands in the CWH on the mid-coast (default site index with Hw as the reference species). Growth reductions will vary depending on site and stand factors.

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.
**Issues**

### 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.
**Issues**

**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](image-url)
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.