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Resource Stewardship Monitoring: Stand-level Biodiversity Analysis of 2005/2006 Field Season Data by Biogeoclimatic Zone

Nancy Densmore & Amanda F. Linnell Nemec

Photo credit: Loretta Drolet, Prince George Forest District

PREMIER'S AWARD
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BRITISH COLUMBIA
The Best Place on Earth

Sustainability of Forest and Range Resources Through Science and Stewardship

MINISTRY OF FORESTS AND RANGE
FOREST AND RANGE EVALUATION PROGRAM

Resource Stewardship Monitoring: Stand-level Biodiversity Analysis of 2005/2006 Field Season Data by Biogeoclimatic Zone

Nancy Densmore & Amanda F. Linnell Nemec

FREP'S MISSION IS TO BE A WORLD LEADER IN RESOURCE STEWARDSHIP MONITORING AND EFFECTIVENESS EVALUATIONS; PROVIDING THE SCIENCE-BASED INFORMATION NEEDED FOR DECISION-MAKING AND CONTINUOUS IMPROVEMENT OF BRITISH COLUMBIA'S FOREST AND RANGE PRACTICES, POLICIES AND LEGISLATION

PREMIER'S AWARD
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BRITISH COLUMBIA
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Management of forest and range resources is a complex process that often involves the balancing of ecological, social, and economic considerations. This evaluation report represents one facet of this process. Based on monitoring data and analysis, the Timber resource value team offers the following recommendations to those who develop and implement forest and range management policy, plans, and practices.

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EXECUTIVE SUMMARY

This report presents an analysis of resource stewardship monitoring (RSM) results for stand-level biodiversity done within the forest and range evaluation program (FREP). Results are presented for stand-level biodiversity monitoring in 643 cutblocks from eight biogeoclimatic (BEC) zones. The monitoring was done during the 2005 and 2006 field seasons. The sampled cutblocks were harvested during the years 1998 to 2004. The legislation in effect to guide forestry practices during that period was the *Forest Practices Code of British Columbia Act*.

The sampling methodology used is described in the *Protocol for Stand-level Biodiversity Monitoring: Steps for Field Data Collection and Administration* (Province of British Columbia 2007). Data collected includes information on tree and coarse woody debris (CWD) retention, plus general information on retention patch size and location, ecological anchors (e.g. hollow trees, cavity nests), windthrow and invasive plants.

Tree indicators from the RSM-sampled cutblocks were compared against baseline data derived from British Columbia Timber Sales timber cruise data. CWD indicators in the harvested areas of the RSM sampled cutblocks are compared against the CWD indicators measured in retention patches. Data from cutblocks within each BEC zone are presented together.

Average block area retention of trees by zone ranged from 11.5% (Boreal White and Black Spruce zone) to 26.6% (Interior Douglas-fir zone). On average, 23% (Sub-Boreal Pine–Spruce zone) to 64% (Coastal Western Hemlock zone) of the patch retention found in these sampled cutblocks was considered constrained for reasons such as riparian retention or poor timber merchantability. Of all the sampled BEC zones, the cutblocks from the Sub-Boreal Pine–Spruce zone showed the best representation of large trees (> 50 cm dbh) and large snags (dead trees > 30 cm dbh and > 10 m height) compared to representative baseline data (from recent timber cruise data in the same subzones). The Coastal Western Hemlock zone lacked large trees (> 70 cm dbh) and large snags compared to the cruise baseline. A general biodiversity strength for all zones is the amount of coarse woody debris volume left on site after harvesting. However, the quality of this debris could be improved by leaving a higher density of long pieces (>10 m long).

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This report wouldn't have been possible without the able field presence of district staff, assessing stand-level biodiversity throughout B.C. Alanya Smith was key in sleuthing out availability of BCTS timber cruise data in a format usable for this project. Taylor Knight laboriously and carefully collected this cruise data from the British Columbia Timber Sales Official Notices website.

Susan Bannerman edited and hugely improved the logic and flow of the document. Any garbled sentences still present undoubtedly were inserted after Susan finished her review. Julianne Mullin formatted the document, dealing calmly with the many changes requested to the figures.

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1.0 INTRODUCTION

This report presents, by biogeoclimatic ecosystem classification (BEC) zone, the results for the Forest and Range Evaluation Program (FREP) stand-level biodiversity (SLBD) monitoring during the 2005 and 2006 field seasons. Sampled cutblocks were randomly chosen from a population of blocks harvested under the Forest Practices Code (FPC) during the years 1998 to 2004. Results are presented for 643 cutblocks from eight biogeoclimatic (BEC) zones.

This document will be periodically updated to include the data collected during future sampling years. Monitoring results from cutblocks harvested under the *Forest and Range Practices Act (FRPA)* will be analyzed and reported on in a separate document.

The purpose of stand-level biodiversity monitoring under FREP is to evaluate whether practices are meeting the intent of government objectives (e.g. *FRPA* objectives) for this resource value. This will help determine whether forest and range practices, and the legislation itself, are meeting government's broader intent for the sustainable use of British Columbia's natural resources. Although the SLBD results presented in this report do not originate from cutblocks harvested under *FRPA*, they do represent the chosen biodiversity indicators that were left under the FPC. One of *FRPA*'s objectives is to maintain high levels of protection for forest values including watersheds and wildlife habitat. It also creates efficiencies for both government and industry through streamlined planning processes (http://www.for.gov.bc.ca/code/). Therefore, establishing a baseline of FPC biodiversity management outcomes will help us understand any changes that take place due to management practices under *FRPA*.

The field sampling methodology is outlined in the Protocol for Stand-level Biodiversity Monitoring: Steps for Field Data Collection and Administration (Province of British Columbia 2007). Plots are established to collect information on standing tree structure and coarse woody debris (CWD). Other information is also collected outside of these plots and includes the presence of rarer ecological attributes, such as stick nests, hollow trees, and large witches' brooms.

Dispersed Retention – Genevieve Lachance Arrow Boundary Forest District.

2.0 METHODOLOGY

2.1 *Indicators for Assessment of the Biodiversity Resource Value*

Field data is collected and summarized for a number of indicators. These include:

- **Percentage area retained:** Calculated as percentage tree cover in relation to the gross cutblock area. This includes wildlife tree patches (WTPs), dispersed trees, and other patch retention not labelled as WTP, as long as these are anticipated to be maintained for at least one rotation.
- **Individual retention patch size:** Expressed in hectares.
- **Patch location:** Patches can be internal (completely surrounded by harvested area), or on the edge of the cutblock (partially surrounded by harvest area), or external to the cutblock (not physically connected to the block).

- **Presence of ecological anchors (other than veteran trees):** Ecological anchors include hollow trees, cavity nests, and active wildlife trails. Expressed as the number of ecological anchors per hectare of patch retention.
- **Presence of veteran trees:** An estimate of the density of veteran trees (i.e., trees that are significantly bigger and older than the harvested stand) for each patch on a cutblock. Expressed as presence or absence.
- **Number of tree species:** Expressed as a count of unique tree species retained in a cutblock.
- **Big, dead trees:** Expressed as Wildlife Tree Class 3+ stems per hectare; must be ≥ 30 cm in diameter and ≥ 10 m in height.
- **Live or dead large diameter trees:** Expressed as stems per hectare of large diameter trees (all classes); must be ≥ 50 cm (interior) or ≥ 70 cm (coast).
- **Coarse woody debris (CWD) volume in retention patches:** Expressed as cubic metres per hectare.
- **CWD volume in harvest area:** Expressed as cubic metres per hectare.
- **Long CWD pieces in retention patches:** Expressed as the number of pieces per hectare ≥ 10 m long in patch area.
- **Long CWD pieces in harvest area:** Expressed as number of pieces per hectare ≥ 10 m long in harvest area.
- **Presence of invasive species:** Expressed as the presence or absence of such species as Canada thistle, dalmation toadflax, hound's tongue, and knapweed.
- **Windthrow:** Expressed as the percentage of retained trees windthrown.

These indicators are used to assess how well SLBD attributes have been maintained on harvested cutblocks. This methodology is best applied when assessing groups of cutblocks across a landscape or BEC zone, rather than for a block-by-block analysis. The Wildlife Tree Retention: Management Guidance released in 2006 provides current views on the traits of valuable wildlife tree retention (British Columbia Ministry of Forests and Range 2006). This guidance suggests three important considerations when locating wildlife tree retention:

1. Protect trees with valuable wildlife tree attributes (see highlighted box).
2. Where there are few trees with valuable attributes, locate retention in areas most suitable for long-term wildlife tree recruitment.
3. Where there are no opportunities for current or future valuable wildlife tree attributes, locate wildlife tree retention to be representative of the pre-harvest stand.

Attributes of a High-value Wildlife Tree

- Internal decay (heart rot or natural/excavated cavities present)
- Crevices present (loose bark or cracks suitable for bats)
- Large brooms present
- Active or recent wildlife use
- Tree structure suitable for wildlife use (e.g., large nest, hunting perch, bear den)
- Large trees for the site (height and diameter) and veterans
- Locally important wildlife

Plot Center in Wildlife Tree Patch – Christina Mardell North Island Forest District.

Some indicators used in assessing biodiversity value help to determine how well the provincial guidance is being implemented. For example, over a number of cutblocks we can determine whether large trees and large dead trees (likely to be current or future high value wildlife trees) are maintained in retention areas in levels comparable to pre-harvest density.

The analysis reported here covers only retention areas that were established for the full rotation length. Some retention is short term, and these areas are designated as "temporary retention" for the purposes of FREP's resource stewardship monitoring (RSM). These areas may form a component of a silvicultural system (e.g., shelterwood trees scheduled for harvest after the regeneration layer is well established). In areas affected by the mountain pine beetle, temporary retention areas may contain non-pine species which are designated for mid-term harvest prior to rotation end. Biodiversity values in these temporary retention areas can be assessed in a future analysis.

2.2 *Baseline Comparison*

To assess the quality of stand structure retention, several indicators in the RSM-sampled cutblocks were compared to the same indicators derived from timber cruise data. This comparison was done by BEC zone. For this baseline comparison, timber cruise plot data was obtained for British Columbia Timber Sales (BCTS) blocks through the BCTS Official Notices System. BEC zone and subzone was determined for each block, usually on the site plan map included on the Official Notices System. The cruised blocks were all surveyed in 1997 or later, with most surveyed in 2003 or later. This time frame overlaps with the harvest dates of the sampled blocks (1998 to 2004). These cruise samples are distinct from the cutblocks sampled for FREP RSM.

One risk associated with the BCTS timber cruise data is that it may not accurately represent the full spectrum of harvesting going on in a particular BEC zone. If it does not, a potential bias exists within the baseline data; however, a BCTS goal is to provide a credible reference point for costs and pricing of timber harvested from public land in B.C. This is demonstrated in the BCTS Quarterly Timber Representativeness Analysis (British Columbia Ministry of Forests and Range 2008c). As improved baseline data is collected, the RSM data can be re-analyzed to assess the comparison against the new baseline. The data presented in this report assumes that the data set of BCTS cruise information reasonably represents the pre-harvest state of the cutblocks sampled for FREP RSM. Data from 926 cruise baseline blocks was used for this report.

2.21 Large dead trees ≥ 30 cm dbh and ≥ 10 m height

Large dead trees are important habitat for wildlife tree users. For the purposes of bird nesting and reproduction, a dead tree requires a minimum size of 20 cm dbh and 10 m height (British Columbia Ministry of Forests and Range 2005). Observations of nesting use of stubs by birds in the southern interior of British Columbia indicate a preference for larger diameter (36–45 cm) trees (Harris 2001). The 30 cm diameter cut-off chosen for this indicator meets the functional dead tree description and is close to preferred diameters.

2.22 Large trees

Large size is one of the main considerations for determining a high value wildlife tree (British Columbia Ministry of Forests and B.C. Ministry of Environment, Lands and Parks 1995; British Columbia Ministry of Forests and Range 2006). Maintaining large trees for a site, either dead or live, provides immediate habitat value. The greater than or equal to 50 cm dbh cut-off chosen for this indicator defines a large tree for all but the Coastal Western Hemlock (CWH) zone, where a 70 cm cut-off is used. For some areas of the province, a smaller cut-off may be required. For example, a 40 cm cut-off will be implemented in future years for the Montane Spruce (MS), Sub-boreal Pine Spruce (SBPS), and the Sub-boreal Spruce (SBS) zones.

2.23 Number of tree species on the cutblock

The *Biodiversity Guidebook* states that: "The maintenance of the diversity of naturally occurring plant species is key to the maintenance of biological diversity within landscape units" (British Columbia Ministry of Forests and B.C. Ministry of Environment, Lands and Parks 1995). For this indicator, the number of unique tree species found on sampled cutblocks in the RSM plots is compared to that found in the timber cruise plots.

Wildlife Tree Patch – Nadina Forest District.

2.2.4 Coarse woody debris

Indicators include the volume and the number of long pieces of CWD. Coarse woody debris found in the retention patches (more natural) are compared to those found in the harvested area (less natural, particularly if no planning for CWD retention). Using the average CWD indicators from the retention patch data may under-represent these indiators compared to the average CWD on a site prior to harvest. An evaluation of wildlife tree retention (British Columbia Ministry of Forests and B.C. Ministry of Water, Land and Air Protection, 2003) found an overall decrease in average tree height and tree diameter when comparing these indicators between the cruise summary for 128 blocks and the measured tree data in the retention left post-harvest on the same set of blocks. Such a potential decrease in tree size would likely translate into a decrease in CWD size. Looking at pre-harvest CWD levels is itself a surrogate baseline. A more direct comparison for CWD immediately post-harvest might be CWD immediately post-natural disturbance, or CWD requirements for habitat purposes. This weakness is acknowledged, and likely results in a small overestimate of the quality of CWD found on harvested sites. Data can be reanalyzed with future improvements to baseline datasets.

Long pieces of CWD are more valuable than short pieces of a similar diameter because they last longer (Stone et al. 1998) before they have decayed into soil. Compared to smaller pieces, they can better perform their habitat and soil stability functions during the time it takes for the pieces to decay (Harmon et al. 1986).

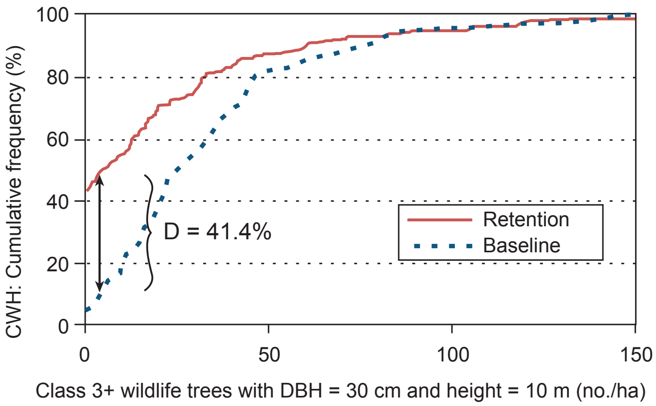
3.0 ANALYSIS AND DATA PRESENTATION

The indicators with baseline data (other than number of tree species) are presented by BEC zone in cumulative distribution charts in Section 5. Descriptive statistics and, where appropriate, a Kolmogorov-Smirnov two-sample test are also provided. Presenting the data in this fashion is done to emphasize the distribution of the values among all the data (block means for the RSM-sampled blocks and baseline) available for a BEC zone. The descriptive statistics of standard deviation, and maximum and minimum of each indicator value are presented to show the variability in the data. The mean of all the indicator data by BEC zone is also presented, but it is actually of lesser importance than the description and graphing of the variability. A key biodiversity attribute is to maintain the range of variability such as that found in more natural settings. An overall summary of the indicators by BEC zone is presented in Section 4 (Table 1).

Indicator values are ranked from lowest to highest and presented as a cumulative distribution, where the rank of a particular value is given as the percentage of cutblocks with lesser or equal values of the indicator. Cumulative distributions for the baseline data and the RSM sample data are presented separately (i.e., as two curves in each chart). In general, a retention curve that is shifted to the left of the baseline curve is bad for biodiversity (i.e., the retention indicators tend to fall below the baseline values). The example in Figure 1 shows a data set in which the baseline cruise blocks have a higher density of large snags than that found in retention areas within the RSM-sampled cutblocks (e.g., 80% of the RSM-sampled blocks have 32 or fewer snags/ha while only 60% of the baseline blocks have 32 or fewer snags/ha).

A Kolmogorov-Smirnov two-sample test (K-S test) was used to assess the validity of the null hypothesis that the cruise and stand-level biodiversity cutblock means are samples from the same distribution (or population). The K-S statistic (D) is the maximum separation of the two cumulative distributions. The K-S statistic is highlighted in Figure 1. This maximum separation can be seen as the largest vertical distance separating the two lines. A probability is given that, under the assumption that the null hypothesis is true, the separation would be equal to or greater than D. For the example in Figure 1, there is less than a 0.01% chance (Prob $\geq D < 0.0001$) that the separation would be 41.4% or greater (i.e., a separation value as big as 41.4% is unlikely under the null hypothesis of no difference). In some cases, a conclusion that the two populations are different is good for biodiversity. For example, a higher density of large trees overall may be detected in the population of retention within RSM-sampled cutblocks compared to baseline blocks. In some cases, this conclusion may not be good for biodiversity. For example, a lower density of large trees overall may be detected in the retention population compared to the baseline. A conclusion that fails to reject the null hypothesis (i.e., the two populations are similar) may indicate that retention choices favoured sites representative of the pre-harvest blocks.

Figure 1. Example of a cumulative distribution chart with K-S statistic shown.



In this report, data from 926 cruise baseline blocks and 643RSM-sampled retention cutblocks are analyzed. The baseline data set is not balanced by subzone when compared to the RSM-sampled cutblocks. To analyze the effect of BEC subzone, the data in Section 5 is presented in two ways. First, comparisons were made by zone with all blocks weighted equally, and second, to adjust for possible subzone effects, the test was repeated with the retention cutblocks weighted according to the baseline distribution of subzones (i.e., weights were applied to the retention cutblocks so that the relative contribution of each subzone matched the baseline distribution). In both cases, statistical significance was evaluated by randomly rearranging sample (i.e., retention or baseline) labels within subzones and assessing the effect on the K-S statistic. If the null hypothesis that the baseline and RSM blocks are from the same population is true then random rearrangement of the sample labels is expected to have little effect on the K-S value. To determine whether the two samples are consistent with this hypothesis, 10,000 random permutations of the sample labels were generated and the proportion ("Prob ≥ D") of K-S values greater than or equal to the actual value was calculated, where tied values randomly included or excluded from the numerator. (Note: small Prob ≥ D casts doubt on the null hypothesis). This type of randomization method, with a random rule for breaking ties, generalizes the K-S test to discrete or mixed continuous and discrete distributions (Dufour and Farhat 2001).

The number of species found on site depends highly on the sampling effort, particularly in areas with rarely occurring species (British Columbia Ministry of Forests and Range 2008a). Therefore, for comparisons against a baseline, it is important that the same sampling intensity (plots per hectare and BAF) is used. The cruise data used as a baseline has "reasonably" close sample intensity to the RSM evaluation. Recommended cruise plot intensity often defaults to one plot per hectare (British Columbia Ministry of Forests and Range 2008b). The cruise data used as baseline for this study averaged about 0.7 plots per hectare. The FREP RSM-sample blocks averaged about 0.8 plots per hectare of retention. Recommended plot intensity for RSM is one plot per hectare of patch retention (B.C. Ministry of Forests and Range 2007 Province of British Columbia 2007.)

Total number of species is presented in Section 5, both as the number of sampled species per block (RSM-sampled plots and cruise plots) and as the estimated number of species for the baseline and RSM-sampled plots using the "Chao2" biased-corrected lower limit (Chao 1984). The distribution of the number of species per cutblock is compared for the baseline and RSM samples using histograms rather than cumulative distribution charts because of the discrete nature of the data (i.e., 1, 2, or 3 species). The "Chao2" correction will occasionally produce extreme corrections giving large difference between sampled and estimated number of species particularly when the number of sampled species is more than about 4 and most of the species occur in only 1 plot. This situation implies (under the Chao model assumptions) that species are quite likely to be have been missed (otherwise species would have occurred in more than 1 plot) hence the need for a large upward adjustment. For example, one RSM-sampled cutblock in the Kootenay Lake Forest District had 7 tree species sampled and all of these occurred in only 1 of three plots. Any or all of these species could have easily been missed if the one plot with all the species had been replaced with a different plot. If the seven sampled species are "typical" of all species in the block then the Chao method assumes that there is a good chance that other species were missed altogether – and therefore the model estimated a potential for 21 species on that block. This estimate is likely too high. The problem of estimating number of species is a difficult one, especially when the sampling design is more complicated than a simple random sample; therefore, the Chao estimates should be considered to be a first approximation.

The CWD indicators were presented as paired and unpaired data. Paired data is only available from cutblocks with both harvest area and patch area data for CWD. A two-sample K-S randomization test was also used to compare CWD indicators for harvested (dispersed retention and clearcut) and unharvested (patches with < 15% windthrown trees) strata in the 2005–2006 SLBD survey cutblocks. Separate tests were carried out for each zone, with sample labels (harvested or unharvested) randomized within subzones (i.e., assuming no correlation between harvested and unharvested areas in a given block) and all blocks weighted equally (i.e., ignoring any differences in the distribution among subzones due to inclusion of blocks that contained only one type of strata). To account for possible correlation within blocks, a paired K-S randomization test was also performed by randomizing sample labels within blocks for those that included both harvested and unharvested strata. Estimated *p*-values (10,000 permutations) were calculated as described above.

4.0 SUMMARY OF STAND-LEVEL BIODIVERSITY MONITORING RESULTS

A 7% default level of stand-level retention is listed in the *Forest Planning and Practices Regulation* under *FRPA*. Licensees harvesting timber under the *FRPA* legislation must abide by this default unless they have an alternate result or strategy to retain wildlife trees that is approved in their forest stewardship plan. Overall, the amount of retention left on cutblocks is high when compared to the *FRPA* default of 7% (Table 1). The average retention amounts are in the lower category of Huggard's assessment of research on forest-dwelling bird species. That is, stand retention levels of 15–20% may be sufficient to maintain abundance of those bird species that are of low sensitivity (e.g. American robin, black-capped chickadee, downy woodpecker) to harvesting (Huggard 2006). Other more sensitive species (e.g. mountain chickadee, northern parula, tufted titmouse) would require retention of 35 to 40% of the stand for species abundance to be maintained. Average cutblock area retention of trees by BEC zone ranged from 11.5% (BWBS) to 26.6% (IDF). The IDF was the only zone that had more retention coming from dispersed trees than from patch retention. Conversely, the BWBS had the lowest amount of retention coming from dispersed trees. Trees left dispersed on a cutblock are valuable as future CWD input and potentially as a source of ectomycorrhiza fungi (Kranabetter, 1999).

The average percentage of patch area considered as "constrained" (i.e., constrained from harvest due to riparian management area, sensitive terrain, low timber merchantability, or other reasons) ranged from 23% (SBPS) to 64% (CWH) of the retention patch. This likely indicates a preferential choice to establish retention areas in already-constrained parts of the cutblock.

Retention areas contained, on average, less than 10% (range: 5–11%) windthrow. Considering that future CWD is one common objective of maintaining wildlife trees, this amount of windthrow is not a concern for biodiversity. However inputs of down wood are more useful later in the rotation when exisiting down wood is becoming well-decayed

Table 1. Summary of stand-level biodiversity monitoring results in FREP RSM-sampled cutblocks

	Average descriptors of stand-level biodiversity								Ranked indicators[a]				
BEC zone[b]/ no. RSM cutblocks	Retention from patches (%)	Patch retention constrained (%)	Retention from dispersed (%; BAE[c])	Average retention (%)	Cutblocks with retention (%)	Patches < 2 ha (%)	Average windthrow (%)	Cutblocks with invasive plants (%)	Large snags	Large trees	No. tree species	CWD volume	CWD density of long pieces
BWBS/48	11.2	29.7	0.3	11.5	87.5	54.4	7.8	8.3	2	2.5	2	4	0
CWH/163	17.1	63.6	1.5	18.6	91.4	78.5	7.9	14.7	0.5	0	3.5	4	0
ESSF/57	13.7	40.2	1.5	15.2	82.5	55.1	8.5	5.3	1.5	2.5	3	4	0
ICH/64	11.2	46.6	1.5	12.7	84.4	63.2	5.5	35.9	1.5	0.5	2	4	0.5
IDF/54	11.4	32.6	15.2	26.6	96.3	57.8	7.8	61.1	1	2.5	3	3	0
MS/35	9.9	31.4	7.0	16.9	97.1	69.8	4.6	42.8	2	3.5	4	4	0
SBPS/35	10.5	22.6	7.5	18.0	91.4	51.9	10.9	17.1	4	4	4	4	0
SBS/187	10.6	34.4	5.0	15.6	89.3	61.3	9.2	17.6	2.5	4	4	3	0

[a] Ranking goes from 0 (poor in comparison to baseline) to 4 (good in comparison to baseline). See Section 5 for a full explanation of the assessment of indicators against baseline. The use of the 0 to 4 rating system is an attempt to summarize the charts from section 5. A ranking of "4" means that 100% of the sampled cutblocks are equivalent or "better" than 100% of the baseline data. A ranking of "1" means that about 25% of the sampled cutblocks are better or equivalent to 25% of the baseline data (or inversely, 75% of the cutblocks are worse than baseline).

[b] BEC zones sampled: BWBS = Boreal White and Black Spruce zone; CWH = Coastal Western Hemlock zone; ESSF = Engelmann Spruce–Subalpine Fir zone; ICH = Interior Cedar–Hemlock zone; IDF = Interior Douglas-fir zone; MS = Montane Spruce zone; SBPS = Sub-Boreal Pine–Spruce zone; SBS = Sub-Boreal Spruce zone.

[c] Dispersed retention area is given as basal area equivalent (i.e., a scaling down of the actual dispersed area). This can be thought of as a conversion of dispersed retention to an equivalent amount of solid area retention. For example, if a dispersed area contains 20% of the pre-harvest basal area, then

reduce the actual area by 80%. Because we do not have pre-harvest data, we used the basal area from wildlife tree patches on the same opening for comparison, or if there are no patches, the average basal area for all other wildlife tree patches in the same BEC subzone.

4.1 *Strengths and Weaknesses by Biogeoclimatic Zone*

A general biodiversity strength for all BEC zones is the amount of CWD volume left on the cutblocks after harvesting. However, the quality (ecological value) of this CWD could be improved by leaving a higher density of long pieces (≥ 10 m long).

Boreal White and Black Spruce (BWBS)

Strength: Invasive plants were found on 8.3% of the sampled cutblocks, one of the lower percentages amongst the BEC zones.

Weakness: Very little dispersed retention is present in this zone, which could potentially affect future CWD recruitment. The density of large snags and number of retained tree species is low compared to the baseline blocks. The average retention of 11.5% is low. Twelve percent of cutblocks did not have any retention. Therefore, increasing the percentage of cutblocks with retention is an important consideration for this zone.

Coastal Western Hemlock (CWH)

Strength: Total retention is high at 18.6%. A potential concern regarding timber supply impacts is counteracted by the high proportion of retention patches considered constrained. Sixty-four percent of patch area is considered constrained, i.e., even if an area was not designated as a wildlife tree patch, it is unlikely that it would have been harvested due to other reasons. The number of different tree species retained was generally equal to that found in the baseline blocks.

Weakness: The sampled retention lacked large snags and large trees compared to the baseline data. The CWH zone has the highest percentage (78.5%) of patches less than 2 ha in size, which may make it difficult to leave large snags. Large snags are often dangerous to workers involved in harvesting operations when they are located on or near retention area edges.

Engelmann Spruce–Subalpine Fir (ESSF)

Strength: A good split exists between large and small patches; about 45% of the sampled patches were larger than 2 ha. Cutblocks with invasive plants are low, averaging 5.3%

Weakness: About 40% of the cutblocks sampled in this zone lacked large snags compared to the baseline. No retention was noted in 17% of the sampled cutblocks. Increasing the percentage of cutblocks with retention is an important consideration for this zone.

Interior Cedar–Hemlock (ICH)

Strength: Windthrow in retention areas is low, averaging 5.5%.

Weakness: The density of large snags and large trees, and the numbers of retained tree species is low compared to baseline blocks. The average retention is low at 12.7%. No retention was noted in about 16% of sampled cutblocks. Increasing the percentage of cutblocks with retention is an important consideration for this zone.

Interior Douglas-fir (IDF)

Strength: Average retention is high averaging 26.6% and 96% of all sampled cutblocks contained retention. There was a high percentage of retention from dispersed retention (15.2%).

Weakness: Sixty-one percent of all sampled cutblocks contained invasive plants, the highest percentage of invasive plant presence among all zones.

Montane Spruce (MS)

Strength: Ninety-seven percent of all sampled cutblocks contained retention. Windthrow was low (average: 4.6%). The density of large trees and number of different tree species was close to that found in the baseline blocks. There is a fairly even split between patch retention (9.9%) and dispersed retention (7.0%).

Weakness: The percentage of cutblocks with invasive plants was high at 42.8%. A high percentage of patches (69.8%) are smaller than 2 ha.

Sub-boreal Pine–Spruce (SBPS)

Strength: Overall, retention is high at 18%, with a fairly even split between patch retention (10.5%) and dispersed retention (7.5%). A high percentage (48%) of patches were larger than 2 ha. These factors may have contributed to the very good representation of large snags, large trees, and number of different tree species retained compared to the baseline blocks.

Weakness: Average windthrow is high at 10.9%.

Sub-boreal Spruce (SBS)

Strength: A similar or higher density of large trees and tree species diversity was maintained in the sampled cutblocks compared to the baseline blocks.

Weakness: Average windthrow is high at 9.2%.

5.0 DETAILED STAND-LEVEL BIODIVERSITY MONITORING RESULTS BY BIOGEOCLIMATIC ZONE

This section presents detailed stand-level biodiversity monitoring results by biogeoclimatic zone. The following information is included for each zone:

- a general description of the sampled retention cutblocks
- timber cruise data used for baseline comparisons
- analysis of the indicators used to assess quality of stand structure retention

For most of indicators assessed, results are presented as cumulative distribution charts. The exception is species presence. Because of the stepwise nature of this data, this indicator is illustrated using a histogram. Descriptive statistics are also provided and, where appropriate, the Kolmogorov-Smirnov two-sample tests are discussed.

5.1 *Boreal White and Black Spruce Zone*

This section presents results from 48 harvested cutblocks sampled in the Boreal White and Black Spruce (BWBS) zone using the FREP stand-level biodiversity RSM protocol during the 2005 and 2006 field seasons. Figures 2–7 illustrate the results for the indicators assessed in this zone.

5.1.1 General description of cutblocks sampled in the BWBS zone

- 48 cutblocks sampled
- 42 cutblocks with retention (87.5%), 6 cutblocks with no retention (12.5%) (3 of the 6 no retention cutblocks had a few trees retained but the percentage is rounded to 0.0)
- 2132.1 ha total gross area
- 239.3 ha of patch retention (11.2% of gross area)
- 71.1 ha of constrained patch retention (29.7% of patch retention is constrained)
- 7.5 ha of dispersed retention (0.3%) (calculated as basal area equivalent[1])
- Average retention 11.5%
- 43 retention patches less than or equal to 2 ha (54.4%)
- 36 retention patches greater than 2 ha (45.6%)
- Average of 1.4 ecological anchors per hectare of patch strata (range: 1–5)[2]
- Average of 7.8% windthrow for cutblocks with retention (56% of blocks ≤ 5% windthrow; 36.6% of blocks ≥ 10% windthrow)
- 22 patches internal to cutblock boundary (30.5%); and 50 patches on the edge of the cutblock (69.4%) (missing data for 7 patches)
- Invasive species found on 4 cutblocks (8.3%)

5.1.2 Timber cruise data used for BWBS zone baseline comparisons

	No. blocks	
BEC subzone	Retention	Baseline
BWBSwk	0	15
BWBSmw	41	36
BWBSdk	7	0
Total	48	51
Total with positive weight[a]	41	36

[a] Blocks with subzone samples for both the RSM-sampled cutblocks (retention) and the timber cruise blocks (baseline).

5.1.3 BWBS – Large dead trees

Stems per hectare of dead trees ≥ 30 cm dbh and ≥ 10 m height

	N	Mean	Standard deviation	Minimum	Maximum

1 Dispersed retention area is given as basal area equivalent area (i.e., a scaling down of the actual dispersed area). This can be thought of as a conversion of dispersed retention to an equivalent amount of solid area retention. For example, if a dispersed area contains 20% of the pre-harvest basal area, then reduce the actual area by 80%. Because no pre-harvest data is available, the basal area from wildlife tree patches on the same opening or, if no patches, the average basal area for all other wildlife tree patches in the same BEC subzone, is used for comparison.

2 This average number merely gives an indication that some ecologically valuable attributes such as, large witches brooms, hollow trees, active wildlife trails or cavity nests, have been protected. Collection of this data is not plot-based, rather it is an overall count by the assessor as they walk through a stratum.

Baseline	51	6	7	0	33
Retention	48	8	18	0	83
Adjusted retention	41	8	16	0	79

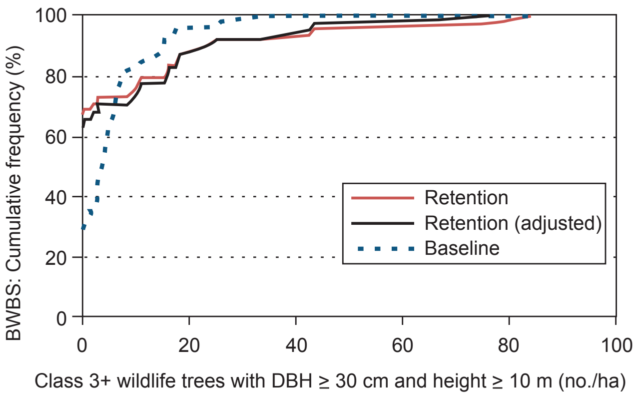


Figure 2. Cumulative distribution of large dead trees in the BWBS zone.

K-S test (unadjusted)			**K-S test (adjusted)**		
x_D	D%	Prob ≥ D	x_D	D%	Prob ≥ D
0.2	39.3	0.0005	0.2	36.4	0.0042

x_D = value at which maximum difference occurs
D = K-S statistic, the maximum vertical distance between the two lines

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large dead trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 39.3% or greater is 0.0005 (Prob ≥ *D* < 0.0005). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 0.2 stems per hectare of large dead trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0042, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

Approximately 65–70% of the RSM-sampled retention cutblocks (adjusted and unadjusted) were found to have no large dead trees compared to about 30% in the cruise baseline (Figure 2). However, the top 30% of the RSM-sampled cutblocks had higher density of large dead trees compared to the cruise baseline. This shows a large variability around the mean for the retention data, with the majority of cutblocks having no large snags and a smaller portion of cutblocks having a high density of large snags. Two of the RSM sampled blocks had very high densities of large dead trees, 83 and 79 stems per hectare. This was due to a high density of large dead aspen in one block and a high density of large dead spruce in the other.

5.1.4 BWBS – Large trees

Stems per hectare of live and dead trees ≥ 50 cm dbh

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	51	6	6	0	27
Retention	48	8	15	0	84
Adjusted retention	41	9	16	0	84

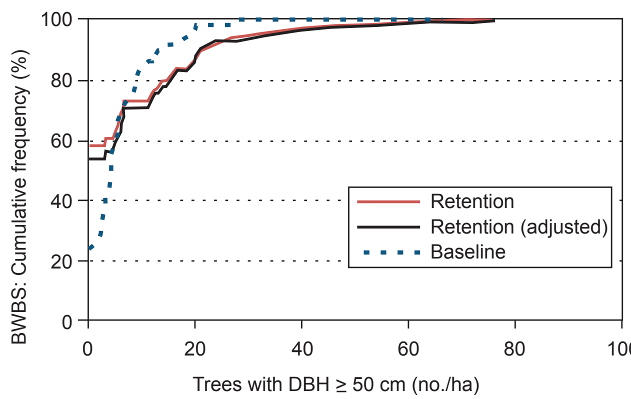


Figure 3. Cumulative distribution of large trees (dead and alive) in the BWBS zone.

K-S test (unadjusted)			**K-S test (adjusted)**		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
0.0	34.8	0.0023	0.0	30.1	0.0391

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for the density of large trees are samples from the same distribution (or population). For the unadjusted data, the probability the K-S statistic (*D*) being 34.8% or greater is 0.0023 (Prob ≥ *D* < 0.0023). Therefore, such a separation is unlikely under the null hypothesis of no difference. The value with the highest separation is 0.0 stems per hectare of large trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0391, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

About 55–60% of the RSM-sampled retention cutblocks (adjusted and unadjusted) have no large trees compared to about 25% in the cruise baseline (Figure 3). However, the top 40% of the data has equal or larger density of large trees in the RSM-sampled cutblocks compared to the cruise baseline. This shows a large variability around the mean for the retention data, with the majority of the cutblocks having no large trees, and a smaller portion of cutblocks having a high density of large trees.

5.1.5 BWBS – Number of tree species as sampled

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	51	4	1	2	7
Retention	48	3	2	0	7
Adjusted retention	41	3	2	0	7

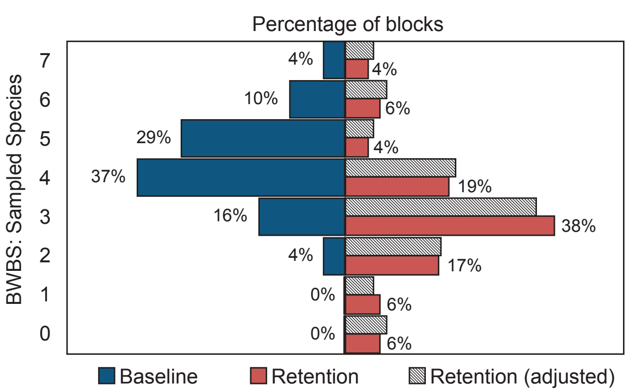


Figure 4. Number of sampled tree species in the BWBS zone.

K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
3	47.1	0.0004	3	43.8	0.0004

The sampled species (Figure 4) have not been changed to account for differing sampling intensity.

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for the number of sampled tree species are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 47.1% or greater is 0.0004 (Prob ≥ *D* < 0.0004). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 3 sampled tree species.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

Sixty-seven percent of the unadjusted RSM-sampled cutblocks have 3 or fewer sampled tree species compared to 20% in the cruise baseline (Figure 4). RSM-sampled cutblocks that had no trees retained are included in figure 4 and 5, resulting in 6% of blocks with zero tree species. Overall, fewer tree species were found in the RSM-sampled cutblocks compared to the cruise baseline.

5.1.6 BWBS – Number of tree species corrected for plot density

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	51	5	1	2	9
Retention	48	4	3	0	16
Adjusted retention	41	4	3	0	16

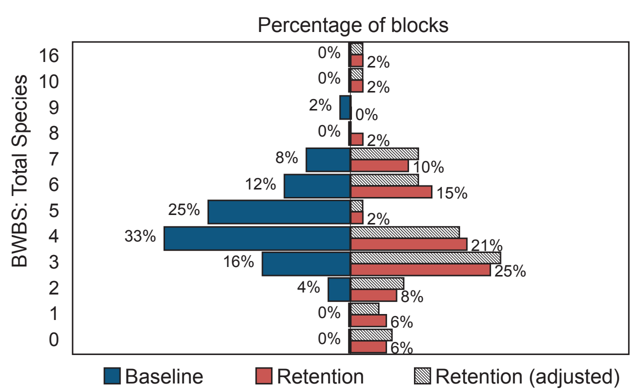


Figure 5. Estimated number of tree species in the BWBS zone.

K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
3	26.2	0.0113	3	29.2	0.0105

Figure 5 shows the number of tree species estimated (see section 3) to compensate for differing plot sample density between the RSM-sampled cutblocks and the cruise baseline (for both adjusted and unadjusted data to highlight potential BEC subzone data imbalance). This has resulted in increased estimates of tree species compared to the actual sampled number of tree species. The probability has increased only slightly from the sampled number of tree species (0.0113). Overall, however, the retention areas within the RSM-sampled cutblocks had fewer tree species than was estimated for the cruise baseline blocks.

5.1.7 BWBS – Coarse woody debris volume

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	35	97	92	0	419
Harvest areas	48	103	66	23	374

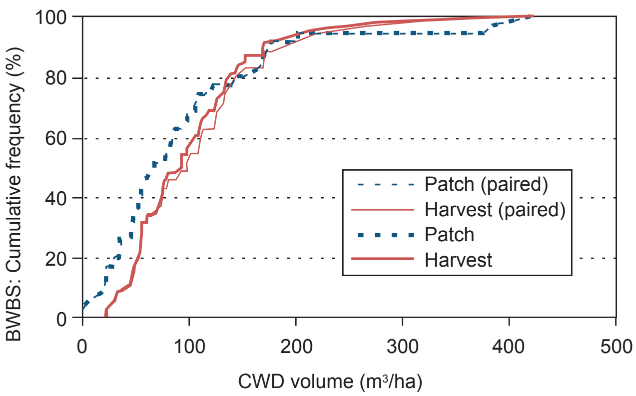


Figure 6. Cumulative distribution of coarse woody debris volume in the BWBS zone.

K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
53	21.3	0.2648	108	20.0	0.2818

The null hypothesis is that CWD volume in the retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 21.3% or greater is 0.2648 (Prob ≥ *D* < 0.2648). Therefore, such a separation value is possible under the null hypothesis of no difference.

When the paired data is used to account for the potential correlation within blocks, the paired K-S test has a probability of 0.2818, which does not change the outcome of the decision. Therefore, it is still possible that the null hypothesis is correct and that the CWD volume found in patches and in the harvested areas is similar (Figure 6).

5.1.8 BWBS – Coarse woody debris density of long pieces

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	35	91	59	0	280
Harvest areas	48	34	41	0	192

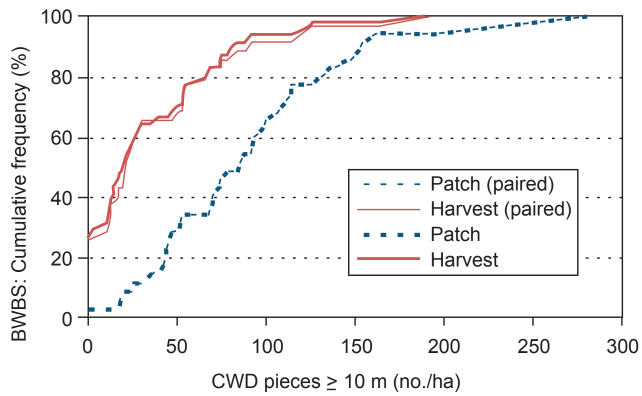


Figure 7. Cumulative distribution of coarse woody debris density of long pieces in the BWBS zone.

K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
30	0.532	0.0001	30	0.543	0.0001

The null hypothesis is that density of long CWD pieces in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 53.2% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value would be unlikely under the null hypothesis of no difference.

When the paired data is used to account for the potential correlation within blocks, the paired K-S test has the same probability of 0.0001, which does not change the outcome of the decision.

A lower density of long CWD pieces was found in the harvested areas of the RSM-sampled cutblocks compared to the retention patches (Figure 7).

5.2 *Coastal Western Hemlock Zone*

This section presents results from 163 harvested cutblocks sampled in the Coastal Western Hemlock (CWH) zone using the FREP stand-level biodiversity RSM protocol during the 2005 and 2006 field seasons. Figures 8–13 illustrate the results for the indicators assessed in this zone.

5.2.1 General description of cutblocks sampled in the CWH zone

- 163 cutblocks sampled
- 149 cutblocks with retention (91.4%), 14 cutblocks with no retention (8.6%)
- 3762.8 ha total gross area
- 643.4 ha of patch retention (17.1% of gross area)
- 409.5 ha of constrained patch retention (63.6% of patch retention is constrained)
- 57.4 ha of dispersed retention (1.5%) (calculated as basal area equivalent
- Average retention 18.6%
- 366 retention patches less than or equal to 2 ha (78.5%)
- 100 retention patches greater than 2 ha (21.5%)
- Average of 4.2 ecological anchors per hectare of patch strata (range: 0–52)
- Average of 7.9% windthrow for cutblocks with retention (60.5% of blocks ≤ 5%; 24.5% of blocks ≥ 10% windthrow)
- 176 patches internal to cutblock boundary (39.6%); 254 patches on the edge of the cutblock (57.2%); and14 patches non-contiguous with cutblock boundary (3%)
- Invasive species found on 24 cutblocks (14.7%)

5.2.2 Timber cruise data used for CWH zone baseline comparisons

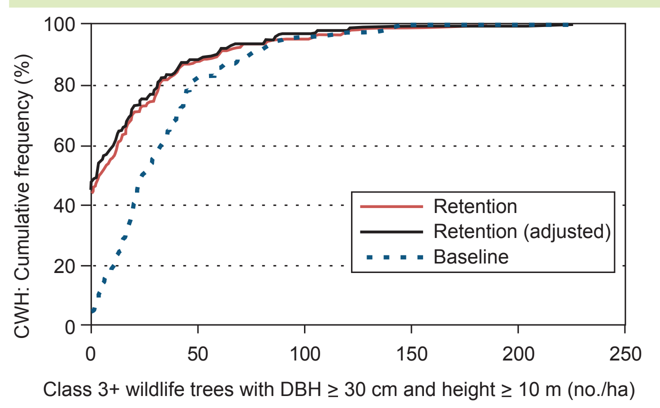
	No. blocks	
BEC subzone	**Retention**	**Baseline**
CWHdm	12	13
CWHds	13	0
CWHmm	3	2
CWHms	17	2
CWHvh	19	18
CWHvm	46	64
CWHwh	19	10
CWHws	15	10
CWHxm	15	25
Total	**159***	**144**
Total with positive weight	**146**	**144**

* four blocks could not be used for this baseline comparison, two blocks had no tree data collected, though there was retention in the blocks, and, two blocks had incomplete BEC information.

5.2.3 CWH – Large dead trees

Stems per hectare of dead trees ≥ 30 cm dbh and ≥ 10 m height.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	144	34	31	0	146



Retention	159	21	35	0	226
Adjusted retention	146	18	32	0	226

Figure 8. Cumulative distribution of large dead trees in the CWH zone.

K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
3.8	41.4	0.0001	3.8	45.6	0.0001

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large dead trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 41.4% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 3.8 stems per hectare of large dead trees.

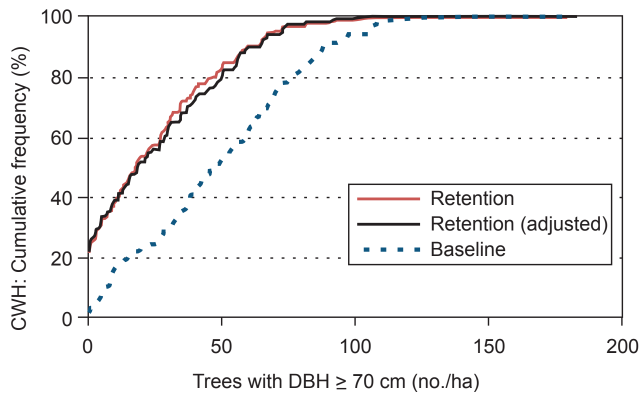
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

For approximately the first 95% of the RSM data, lower densities of retained large dead trees per hectare were evident compared to the cruise pre-harvest data (Figure 8). A decrease in density of large snags in the retention areas of harvested cutblocks was also evident. The high percentage of small retention patches (78.5% of patches ≤ 2 ha) may be limiting opportunities to leave potentially dangerous trees. Retention patches have not focused on large snags and could be improved.

5.2.4 CWH – Large trees

Stems per hectare of live and dead trees ≥ 70 cm dbh

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	144	49	32	0	144



	N	Mean	Standard deviation	Minimum	Maximum
Retention	159	25	27	0	181
Adjusted retention	146	26	26	0	181

Figure 9. Cumulative distribution of large trees (dead and alive) in the CWH zone.

K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
31.0	37.4	0.0001	31.0	34.9	0.0001

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for the density of large trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 37.4% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a value is unlikely under the null hypothesis of no difference. The value with the highest separation is 31.0 stems per hectare of large dead trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

A lower density of large trees is evident in the retention areas of harvested RSM-sampled cutblocks compared to the cruise baseline (Figure 9).

5.2.5 CWH – Number of tree species as sampled

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	144	4	1	2	7
Retention	159	3	1	0	7
Adjusted retention	146	3	1	0	7

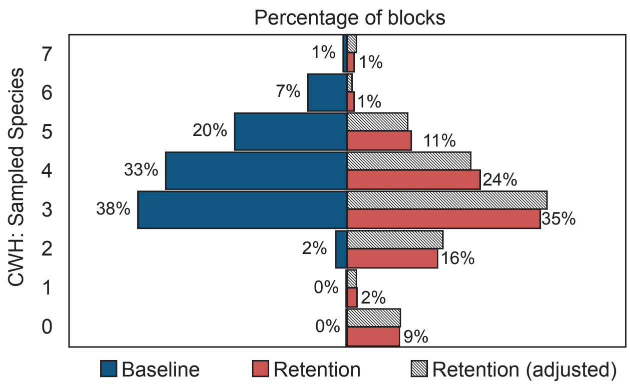


Figure 10. Number of sampled tree species in the CWH zone.

K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
2	25.6	0.0001	2	26.4	0.0001

The sampled species (Figure 10) have not been changed to account for differing sample intensity.

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for number of sampled tree species are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 25.6% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 2 sampled tree species.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

Thirty-one percent of the RSM-sampled cutblocks have 2 or fewer sampled tree species compared to 2% in the cruise baseline (Figure 10). RSM-sampled cutblocks that had no trees retained are included in figure 10 and 11, resulting in 9% of blocks with zero tree species. Overall, fewer tree species were found in the RSM-sampled cutblocks (average 3 tree species) compared to the cruise baseline (average 4 tree species).

5.2.6 CWH – Number of tree species corrected for plot density

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	144	4	1	2	7
Retention	159	4	2	0	13
Adjusted retention	146	4	2	0	13

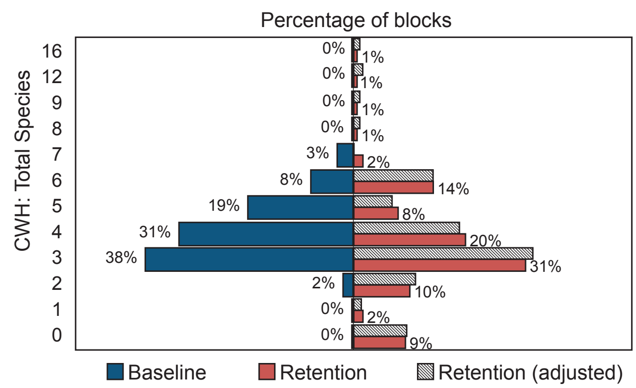


Figure 11. Estimated number of tree species in the CWH zone.

K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
2	19.3	0.0003	2	20.2	0.0018

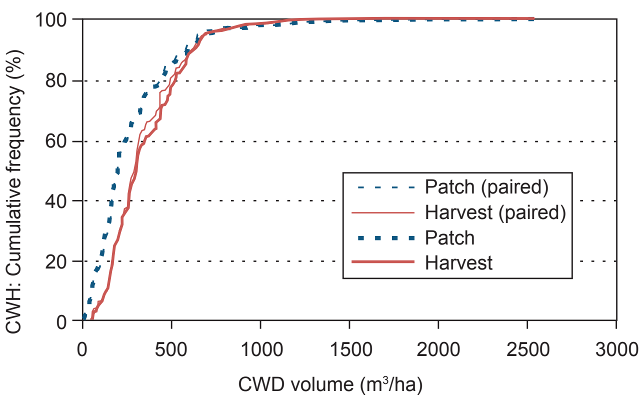
Figure 11 shows the number of tree species estimated to compensate for differing plot sample density between the RSM-sampled cutblocks and the cruise baseline (for both adjusted and unadjusted data to highlight potential BEC subzone data imbalance). This has resulted in increased estimates of tree species compared to the actual sampled number of tree species. The probability has increased somewhat from the sampled number of tree species, particularly for the adjusted data set. However, it is still unlikely that the null hypothesis is correct.

Overall, the retention areas within the RSM-sampled cutblocks have the same average number of tree species (4) as the cruise baseline blocks. However, the retention areas have a higher number of blocks with 2 or fewer tree species present compared to the cruise baseline.

5.2.7 CWH – Coarse woody debris volume

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	130	283	308	0	2508
Harvest areas	151	349	217	41	1241

Figure 12. Cumulative distribution of coarse woody debris volume in the CWH zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
203	27.0	0.0001	203	26.2	0.0001

The null hypothesis is that CWD volume in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 27.0% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference.

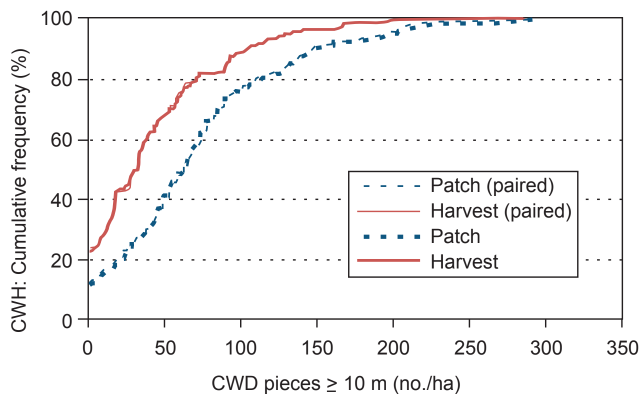
When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability does not change, and the outcome does not change.

An overall increase was evident in the volume of CWD found in the harvested areas of the RSM-sampled cutblocks compared to the retention patches (Figure 12). There is a large range and variability in levels of CWD in both the retention areas and the harvested areas. The harvested areas have higher mean levels of CWD but much lower maximum levels.

5.2.8 CWH – Coarse woody debris density of long pieces

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	130	72	60	0	291
Harvest areas	151	41	44	0	202

Figure 13. Cumulative distribution of coarse woody debris density of long pieces in the CWH zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
43	32.0	0.0001	43	33.6	0.0001

The null hypothesis is that density of long CWD pieces in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 32.0% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value would be unlikely under the null hypothesis of no difference.

When the paired data is used to account for the potential correlation within blocks, the paired K-S test has the same probability of 0.0001, which does not change the outcome of the decision.

A lower density of long CWD pieces was found in the harvested areas of the RSM-sampled cutblocks compared to the retention patches (Figure 13).

5.3 *Engelmann Spruce–Subalpine Fir Zone*

This section presents results from 57 harvested cutblocks sampled in the Engelmann Spruce–Subalpine Fir (ESSF) zone using the FREP stand-level biodiversity RSM protocol during the 2005 and 2006 field seasons. Figures 14–19 illustrate the results for the indicators assessed in this zone.

5.3.1 General description of cutblocks sampled in the ESSF zone

- 57 cutblocks sampled
- 47 cutblocks with retention (82.5%), 10 cutblocks with no retention (17.5%) (3 of the 6 no retention cutblocks had a few trees retained but the percentage rounded to 0.0)
- 2329.5 ha total gross area
- 318.3 ha of patch retention (13.7% of gross area)
- 128 ha of constrained patch retention (40.2% of patch retention is constrained)
- 36.5 ha of dispersed retention (1.5%) (calculated as basal area equivalent)
- Average retention 15.2%
- 54 retention patches less than or equal to 2 ha (55.1%)
- 44 retention patches greater than 2 ha (44.9%)
- Average of 2.0 ecological anchors per hectare of patch strata (range: 0–12)
- Average of 8.5% windthrow for cutblocks with retention (61.7% of blocks ≤ 5%; 23.4% of blocks ≥ 10% windthrow)
- 49 patches internal to cutblock boundary (50.0%); 47 patches on the edge of the cutblock (47.9%); and 2 patches non-contiguous with cutblock boundary (2.0%)
- Invasive species found on 3 cutblocks (5.3%)

5.3.2 Timber cruise data used for ESSF zone baseline comparisons

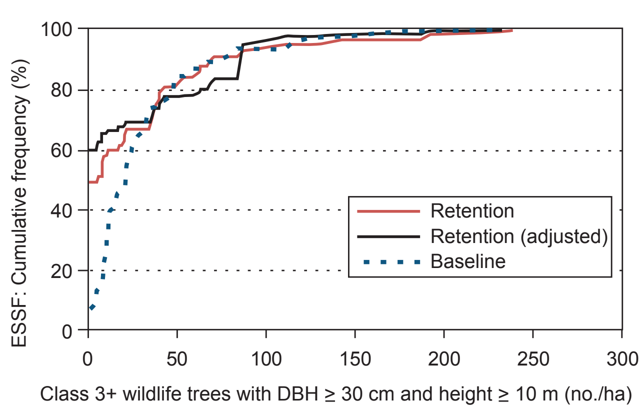
	No. blocks	
BEC subzone	**Retention**	**Baseline**
ESSFdc	2	10
ESSFdk	1	7
ESSFdv	2	0
ESSFmc	9	1
ESSFmm	1	0
ESSFmv	21	10
ESSFmw	2	1
ESSFvc	1	0
ESSFvv	1	0
ESSFwc	10	11
ESSFwk	3	3
ESSFwm	3	1
ESSFwv	0	2
ESSFxv	1	0
Total	**57**	**46**
Total with positive weight	**51**	**44**

5.3.3 ESSF – Large dead trees

Stems per hectare of dead trees ≥ 30 cm dbh and ≥ 10 m height.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	46	31	37	0	186
Retention	57	27	48	0	239
Adjusted retention	51	25	41	0	239

Figure 14. *Cumulative distribution of large dead trees in the ESSF zone.*



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
0.0	42.6	0.0002	0.0	53.4	0.0001

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large dead trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 42.6% or greater is 0.0002 (Prob ≥ *D* < 0.0002). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is at 0 stems per hectare of large dead trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

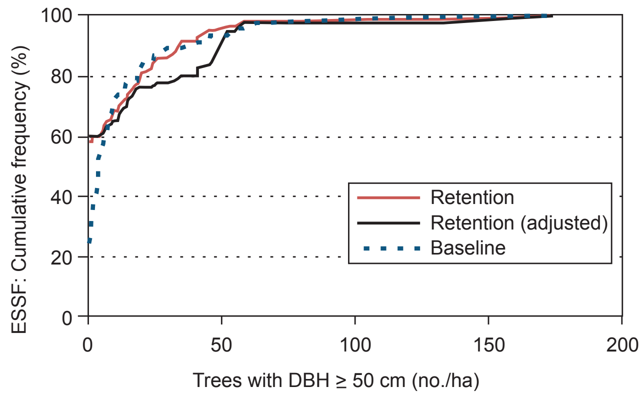
Approximately 50% of the unadjusted RSM-sampled cutblocks had no large dead trees compared to 7% for the cruise baseline (Figure 14). Included with these RSM-sampled cutblocks containing no large snags is a high percentage of cutblocks (17.5%) with no retention of any type. However, more than 30% of the RSM-sampled blocks did contain retention even though they did not have any large snags. The top 30% of the cruise baseline and RSM-sampled blocks seem comparable when considering the density of large snags.

5.3.4 ESSF – Large trees

Stems per hectare of live and dead trees ≥ 50 cm dbh.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	46	13	23	0	129
Retention	57	12	26	0	175
Adjusted retention	51	16	32	0	175

Figure 15. Cumulative distribution of large trees (dead and alive) in the ESSF zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
0.0	34.0	0.0030	0.0	36.0	0.0317

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for the density of large trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 34.0% or greater is 0.003 (Prob ≥ *D* < 0.003). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 0 stems per hectare of large trees.

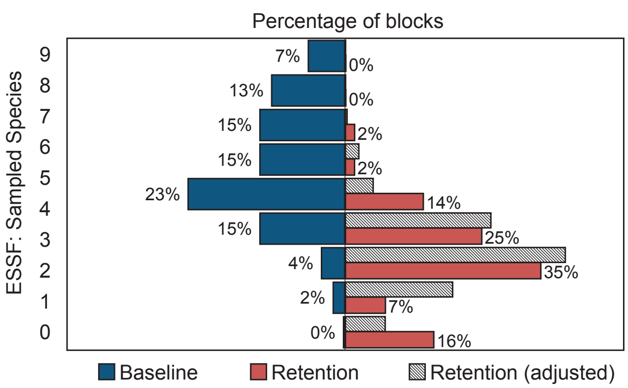
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0317. This indicates a small increase in the likelihood that the null hypothesis is correct, though the verdict does not change and the null hypothesis is not accepted.

Approximately 60% of the RSM-sampled cutblocks had no large trees compared to 25% in the cruise baseline (Figure 15). Of the 60% of RSM-sampled cutblocks with no large trees, 17.5% had no retention of any type.

5.3.5 ESSF – Number of tree species as sampled

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	46	5	2	1	8
Retention	57	2	1	0	6
Adjusted retention	51	2	1	0	6

Figure 16. Number of sampled tree species in the ESSF zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
3	60.7	0.0001	3	70.5	0.0001

The sampled species (Figure 16) have not been changed to account for differing sample intensity.

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for the number of sampled tree species are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (D) being 60.7% or greater is 0.0001 (Prob $\geq D < 0.0001$). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 3 sampled tree species.

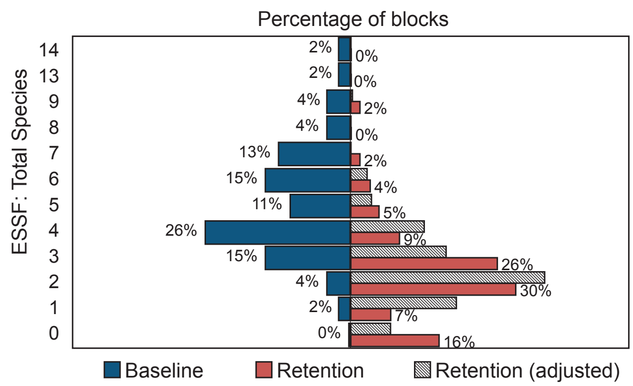
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

Overall, fewer tree species were found in the RSM-sampled cutblocks compared to the cruise baseline (Figure 16). Only 4% of RSM-sampled cutblocks had more than 4 species whereas over 50% of baseline blocks had more than 4 species.

5.3.6 ESSF – Number of tree species corrected for plot density

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	46	5	3	1	14
Retention	57	3	2	0	9
Adjusted retention	51	2	2	0	9

Figure 17. Estimated number of tree species in the ESSF zone.



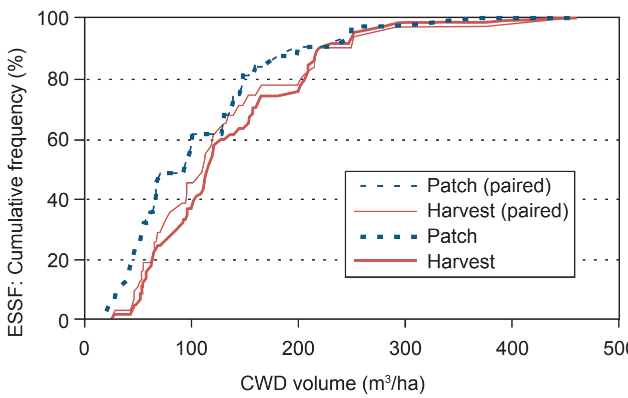
K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
3	57.2	0.0001	3	56.9	0.0001

Figure 17 shows the number of tree species estimated to compensate for differing plot sample density between the RSM-sampled cutblocks and the cruise baseline (for both adjusted and unadjusted data to highlight potential BEC subzone data imbalance). The probability has not changed from the sampled number of tree species. Overall, the retention areas within the RSM-sampled cutblocks had fewer tree species than was estimated for the cruise baseline blocks. Only 13% of the RSM-sampled cutblocks had more than 4 tree species retained compared to 51% of the baseline blocks.

5.3.7 ESSF – Coarse woody debris volume

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	31	109	79	21	371
Harvest areas	57	136	79	29	460

Figure 18. Cumulative distribution of coarse woody debris volume in the ESSF zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
71	23.8	0.1883	71	19.4	0.3664

The null hypothesis is that CWD volume in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 23.8% or greater is 0.1883 (Prob ≥ *D* < 0.1883). Therefore, such a separation is possible under the null hypothesis of no difference.

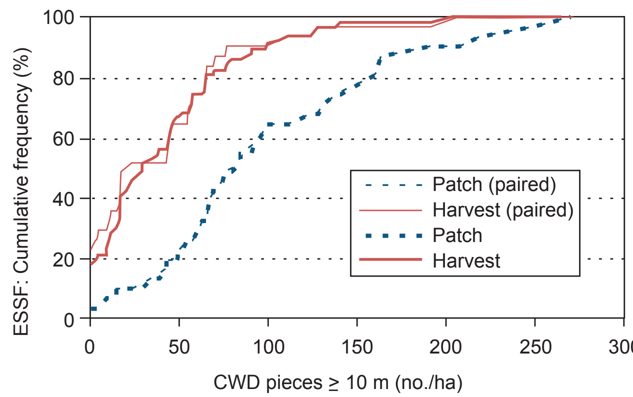
When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability increased to 0.3664. This further increases the likelihood of accepting the null hypothesis.

Overall, the volume of CWD found in the RSM-sampled cutblocks was very similar between the retention patches and the harvested areas (Figure 18).

5.3.8 ESSF – Coarse woody debris density of long pieces

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	31	101	68	0	270
Harvest areas	57	42	43	0	207

Figure 19. Cumulative distribution of coarse woody debris density of long pieces in the ESSF zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
66	48.4	0.0006	66	51.6	0.0016

The null hypothesis is that density of long CWD pieces in retention patches and in harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 48.4% or greater is 0.0006 (Prob ≥ *D* < 0.0006). Therefore, such a separation value is unlikely under the null hypothesis of no difference.

When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability increases slightly to 0.0016, although this does not change the outcome of the decision.

A lower density of long CWD pieces was found in the harvested areas of the RSM-sampled cutblocks compared to t the retention patches (Figure 19).

5.4 *Interior Cedar–Hemlock Zone*

This section presents results from 64 harvested cutblocks sampled in the Interior Cedar–Hemlock (ICH) zone using the FREP stand-level biodiversity RSM protocol during the 2005 and 2006 field seasons. Figures 20–25 illustrate the results for the indicators assessed in this zone.

5.4.1 General description of cutblocks sampled in the ICH zone

- 64 cutblocks sampled
- 54 cutblocks with retention (84.4%), 10 cutblocks with no retention (15.6%)
- 1738.7 ha total gross area
- 194.6 ha of patch retention (11.2% of gross area)
- 90.8 ha of constrained patch retention (46.6% of patch retention is constrained)
- 25.8 ha of dispersed retention (1.5%) (calculated as basal area equivalent)
- Average retention 12.7%
- 55 retention patches less than or equal to 2 ha (63.2%)
- 32 retention patches greater than 2 ha (36.8%)
- Average of 3.7 ecological anchors per hectare of patch strata (range: 0–26)
- Average of 5.5% windthrow for cutblocks with retention (76.8% of blocks ≤ 5%; 10.7% of blocks ≥ 10% windthrow)
- 30 patches internal to cutblock boundary (50.0%); 55 patches on the edge of the cutblock (47.9%); and 1 patch non-contiguous with cutblock boundary (2.0%)
- Invasive species found on 23 cutblocks (35.9%)

5.4.2 Timber cruise data used for ICH zone baseline comparisons

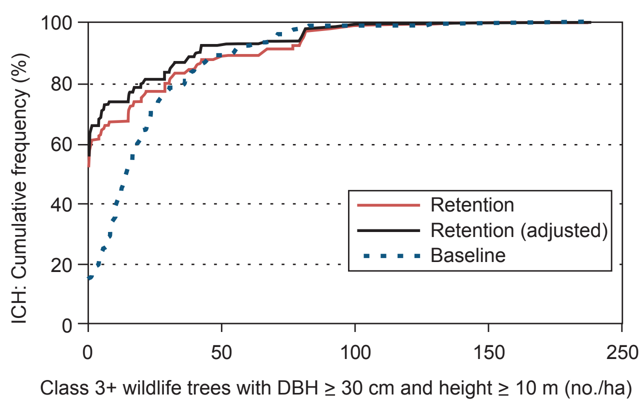
	No. blocks	
BEC subzone	**Retention**	**Baseline**
ICHdw	3	12
ICHmc	8	22
ICHmca	1	0
ICHmk	14	41
ICHmm	1	0
ICHmw	26	54
ICHvc	0	1
ICHvk	5	7
ICHwk	6	6
Total	**64**	**143**
Total with positive weight	**62**	**142**

5.4.3 ICH – Large dead trees

Stems per hectare of dead trees ≥ 30 cm dbh and ≥ 10 m height.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	143	22	26	0	189
Retention	64	16	29	0	126
Adjusted retention	62	13	25	0	126

***Figure 20.** Cumulative distribution of large dead trees in the ICH zone.*



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
1.4	45.6	0.0001	1.4	50.4	0.0001

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large dead trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 45.6% or greater is 0.0001 (Prob ≥ *D*<0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 1.4 stems per hectare of large dead trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

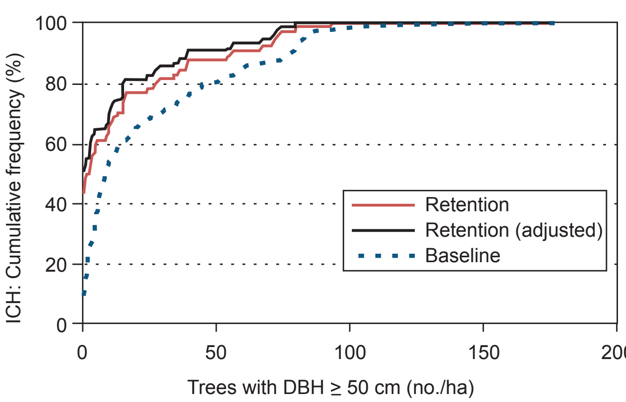
Approximately 50% of the RSM-sampled (unadjusted) cutblocks had no large dead trees compared to 15% for the cruise baseline (Figure 20). Included with these RSM-sampled cutblocks containing no large snags is a high percentage of cutblocks (15.6%) with no retention of any type. However, more than 30% of the RSM-sampled blocks did contain retention even though they did not have any large snags. The top 30% of the cruise baseline and RSM-sampled blocks seem comparable when considering the density of large snags.

5.4.4 ICH – Large trees

Stems per hectare of live and dead trees ≥ 50 cm dbh

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	143	43	54	0	308
Retention	64	26	42	0	163
Adjusted retention	62	21	37	0	139

Figure 21. Cumulative distribution of large trees (dead and alive) in the ICH zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
0.2	36.9	0.0001	0.2	42.2	0.0001

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for the density of large trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 36.9% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation is unlikely under the null hypothesis of no difference. The value with the highest separation is 0.2 stems per hectare of large trees.

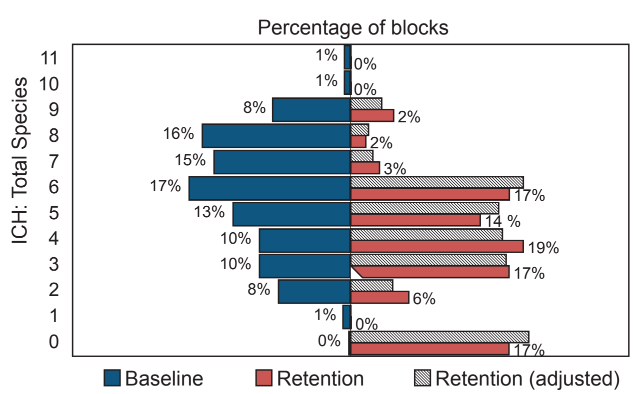
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

Approximately 45% of the RSM-sampled cutblocks had no large trees compared to about 10% for the cruise baseline (Figure 21). Of the 45% of RSM-sampled cutblocks, 15.6% had no retention of any type, leaving about 30% with retention, but no large trees.

5.4.5 ICH – Number of tree species as sampled

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	143	6	2	1	11
Retention	64	4	2	0	9
Adjusted retention	62	4	2	0	9

Figure 22. Number of sampled tree species in the ICH zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
5	32.2	0.0001	6	33.2	0.0001

The sampled species (Figure 22) have not been changed to account for differing sample intensity.

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for number of sampled tree species are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 32.2% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 5 sampled tree species.

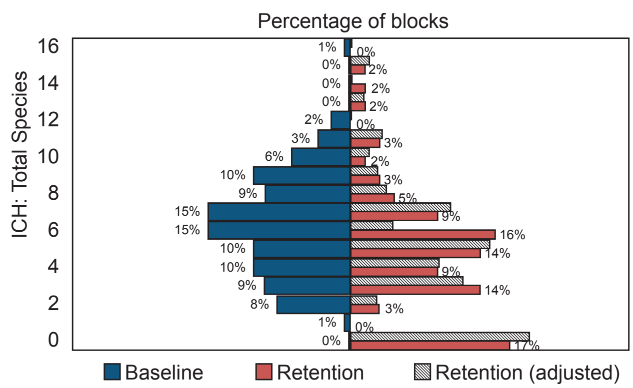
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

Seventy-six percent of the RSM-sampled cutblocks had 5 or fewer sampled tree species compared to 42% for the cruise baseline (Figure 22). Overall, fewer tree species were found on the RSM-sampled cutblocks compared to the cruise baseline. Only 9% of the RSM-sampled blocks had more than 6 species retained compared to 41% of the baseline sample blocks.

5.4.6 ICH – Number of tree species corrected for plot density

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	143	6	3	1	16
Retention	64	5	3	0	15
Adjusted retention	62	5	3	0	15

Figure 23. Estimated number of tree species in the ICH zone.



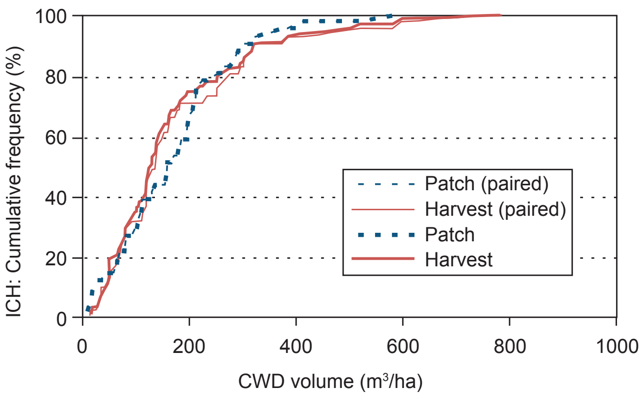
K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
5	21.0	0.0017	5	21.3	0.0089

Figure 23 shows the number of tree species estimated to compensate for differing plot sample density between the RSM-sampled cutblocks and the cruise baseline (for both adjusted and unadjusted data to highlight potential BEC subzone data imbalance). This has resulted in increased estimates of tree species compared to the actual sampled number of tree species. The probability has increased (0.0117) from the sampled number of tree species (0.0001), this increase is not enough to accept the null hypothesis. Overall, the retention areas within the RSM-sampled cutblocks had fewer tree species than found in the cruise baseline.

5.4.7 ICH– Coarse woody debris volume

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	41	169	119	6	579
Harvest areas	63	169	148	14	783

Figure 24. Cumulative distribution of coarse woody debris volume in the ICH zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
152	19.6	0.1762	152	17.1	0.4588

The null hypothesis is that CWD volume in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 19.6% or greater is 0.1762 (Prob ≥ *D* < 0.1762). Therefore, such a separation value is possible under the null hypothesis of no difference.

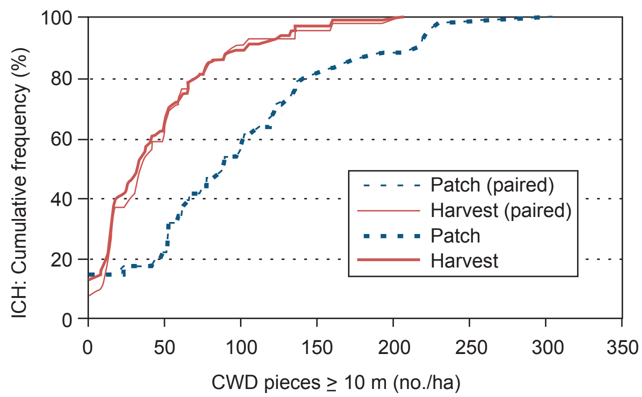
When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability increased to 0.4588. This indicates an increased likelihood of accepting the null hypothesis.

Overall, the volume of CWD found on the RSM-sampled cutblocks is very similar between the retention patches and the harvested areas (Figure 24).

5.4.8 ICH – Coarse woody debris density of long pieces

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	41	98	73	0	302
Harvest areas	63	45	43	0	205

Figure 25. Cumulative distribution of coarse woody debris density of long pieces in the ICH zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
51	46.3	0.0001	51	43.9	0.0006

The null hypothesis is that density of long CWD pieces in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 46.3% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference.

When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability increases slightly to 0.0006, which does not change the outcome of the decision.

A lower density of long CWD pieces was found in the harvested areas of the RSM-sampled cutblocks compared to the retention patches (Figure 25).

5.5 *Interior Douglas-fir Zone*

This section presents results from 54 harvested cutblocks sampled in the Interior Douglas-fir (IDF) zone using the FREP stand-level biodiversity RSM protocol during the 2005 and 2006 field seasons. Figures 26–31 illustrate the results for the indicators assessed in this zone.

5.5.1 General description of cutblocks sampled in the IDF zone

- 54 cutblocks sampled
- 52 cutblocks with retention (96.3%), 2 cutblocks with no retention (3.7%)
- 1826 ha total gross area
- 208 ha of patch retention (11.4% of gross area)
- 67.8 ha of constrained patch retention (32.6% of patch retention is constrained)
- 278.4 ha of dispersed retention (15.2%) (calculated as basal area equivalent)
- Average retention 26.6%
- 48 retention patches less than or equal to 2 ha (57.8%)
- 35 retention patches greater than 2 ha (42.2%)
- Average of 4.1 ecological anchors per hectare of patch strata (range: 0–28)
- Average of 7.8% windthrow for cutblocks with retention (70.4% of blocks ≤ 5%; 18.5% of blocks ≥ 10% windthrow)
- 29 patches internal to cutblock boundary (35.8%); 52 patches on the edge of the cutblock (64.2%); and 1 patch non-contiguous with cutblock boundary (1.2%)
- Invasive species found on 33 cutblocks (61.1%)

5.5.2 Timber cruise data used for IDF zone baseline comparisons

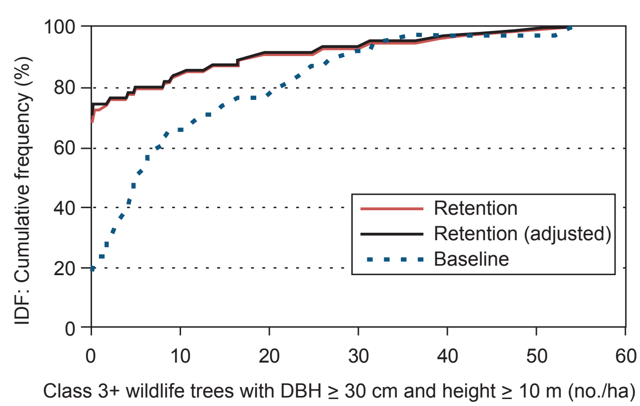
	No. blocks	
BEC subzone	**Retention**	**Baseline**
IDFdk	39	28
IDFdm	8	3
IDFmw	2	6
IDFww	2	1
IDFxh	2	0
IDFxm	1	0
Total	**54**	**38**
Total with positive weight	**51**	**38**

5.5.3 IDF – Large dead trees

Stems per hectare of dead trees ≥ 30 cm dbh and ≥ 10 m height.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	38	11	13	0	54
Retention	54	5	12	0	52
Adjusted retention	51	5	11	0	52

Figure 26. Cumulative distribution of large dead trees in the IDF zone.



The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large dead trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 51.9% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 0.1 stems per hectare of large dead trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

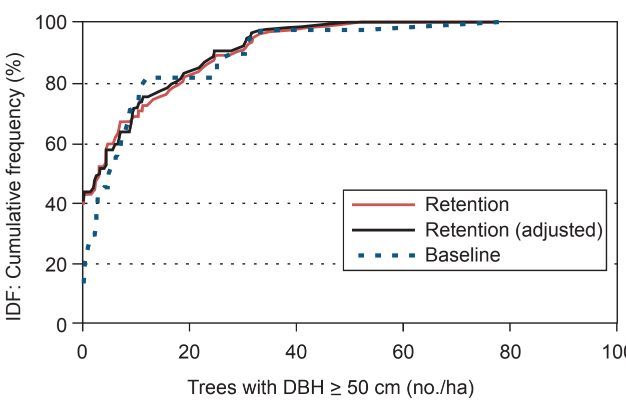
Approximately 70% of the RSM-sampled cutblocks (unadjusted) had no large dead trees compared to 20% for the cruise baseline (Figure 26). Only the top 10% of the baseline and RSM-sampled blocks seem comparable when considering density of large snags.

5.5.4 IDF – Large trees

Stems per hectare of live and dead trees ≥ 50 cm dbh.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	38	10	15	0	78
Retention	54	9	13	0	51
Adjusted retention	51	9	12	0	51

Figure 27. Cumulative distribution of large trees (dead and alive) in the IDF zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
0.2	29.4	0.0543	0.2	30.2	0.0389

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic being 29.4% or greater is 0.0543 (Prob ≥ *D* < 0.0543). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 0.2 stems per hectare of large trees.

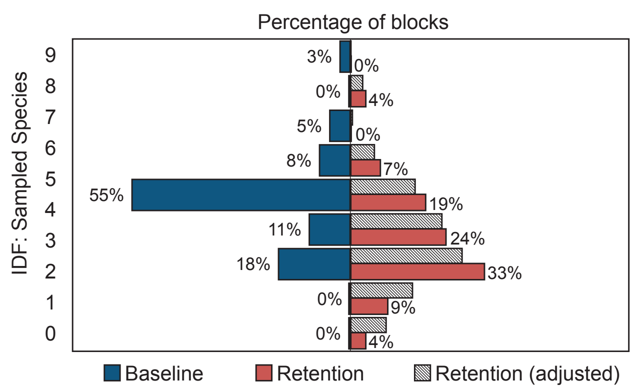
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test probability decreases to 0.0389, which indicates that the acceptance of the null hypothesis is less likely and there is an even more significant difference in distributions.

Approximately 40% of the RSM-sampled cutblocks had no large trees per hectare compared to 20% for the cruise baseline (Figure 27). The top 40% of both RSM-sampled and baseline blocks seem comparable when considering the density of large trees.

5.5.5 IDF – Number of tree species as sampled

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	38	4	1	2	9
Retention	54	3	2	0	7
Adjusted retention	51	2	2	0	7

Figure 28. Number of sampled tree species in the IDF zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
3	41.4	0.0001	3	46.0	0.0001

The sampled species (Figure 28) have not been changed to account for differing sample intensity.

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for number of sampled tree species are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 41.4% or greater is 0.0001 (Prob ≥ *D*<0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 3 sampled tree species.

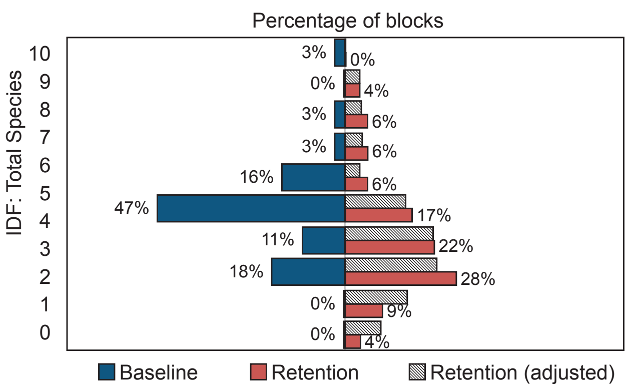
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

Overall, fewer tree species were found in the RSM-sampled cutblocks compared to the cruise baseline blocks.

5.5.6 IDF – Number of tree species corrected for plot density

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	38	4	2	2	10
Retention	54	3	2	0	8
Adjusted retention	51	3	2	0	8

Figure 29. Estimated number of tree species in the IDF zone.



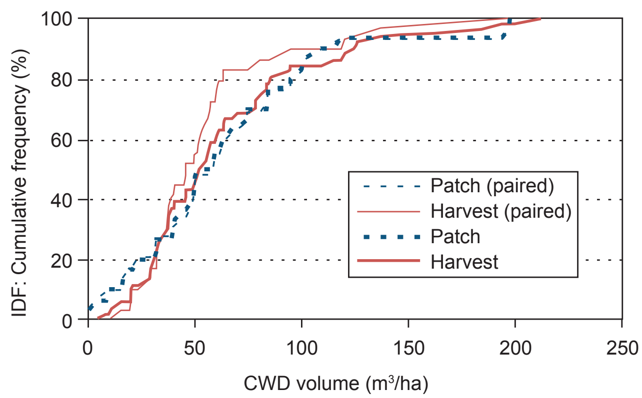
K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
3	34.0	0.0014	3	40.3	0.0006

Figure 29 shows the number of tree species estimated to compensate for differing plot sample density between the RSM-sampled cutblocks and the cruise baseline (for both adjusted and unadjusted data to highlight potential BEC subzone data imbalance). Overall, the retention areas had fewer numbers of tree species compared to the cruise baseline.

5.5.7 IDF – Coarse woody debris volume

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	30	65	48	0	198
Harvest areas	51	65	46	8	212

Figure 30. Cumulative distribution of coarse woody debris volume in the IDF zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
20	10.8	0.9577	58	24.1	0.2424

The null hypothesis is that CWD volume in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic being 10.8% or greater is 0.9577 (Prob ≥ *D* < 0.9577). Therefore, such a separation value is possible under the null hypothesis of no difference.

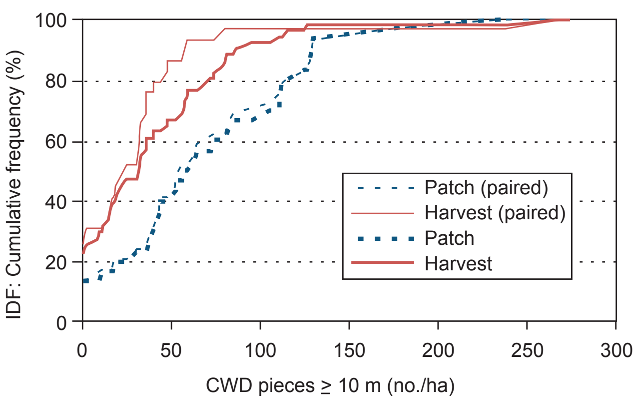
When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability decreased to 0.2424. Although this indicates a decreasing likelihood of accepting the null hypothesis, it still gives a reasonable probability of accepting it.

Overall, the volume of CWD found on the RSM-sampled cutblocks is very similar between the retention patches and the harvested areas (Figure 30).

5.5.8 IDF – Coarse woody debris density of long pieces

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	30	72	56	0	235
Harvest areas	51	41	48	0	272

Figure 31. Cumulative distribution of coarse woody debris density of long pieces in the IDF zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
36	37.5	0.0084	36	51.7	0.0004

The null hypothesis is that density of long CWD pieces in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 37.5% or greater is 0.0084 (Prob ≥ *D* < 0.0084). Therefore, such a separation value is unlikely under the null hypothesis of no difference.

When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability decreases to 0.0004, which does not change the outcome of the decision.

A lower density of long CWD pieces was found in the harvested areas of the RSM-sampled cutblocks compared to the retention patches (Figure 31).

5.6 *Montane Spruce Zone*

This section presents results from 35 harvested cutblocks sampled in the Montane Spruce (MS) zone using the FREP stand-level biodiversity RSM protocol during the 2005 and 2006 field seasons. Figures 32–37 illustrate the results for the indicators assessed in this zone.

5.6.1 General description of cutblocks sampled in the MS zone

- 35 cutblocks sampled
- 34 cutblocks with retention (97.1%), 1 cutblock with no retention (2.9%)
- 982.4 ha total gross area
- 97 ha of patch retention (9.9% of gross area)
- 30.5 ha of constrained patch retention (31.4% of patch retention is constrained)
- 68.8 ha of dispersed retention (7.0%) (calculated as basal area equivalent)
- Average retention 16.9%
- 30 retention patches less than or equal to 2 ha (69.8%)
- 13 retention patches greater than 2 ha (30.2%)
- Average of 4.4 ecological anchors per hectare of patch strata (range: 0–28)
- Average of 4.6% windthrow for cutblocks with retention (68.6% of blocks ≤ 5%; 20% of blocks ≥ 10% windthrow)
- 12 patches internal to cutblock boundary (28.6%); 28 patches on the edge of the cutblock boundary (66.7%); and 2 patches non-contiguous with cutblock boundary (4.8%)
- Invasive species found on 15 cutblocks (42.8%)

5.6.2 Timber cruise data used for MS zone baseline comparisons

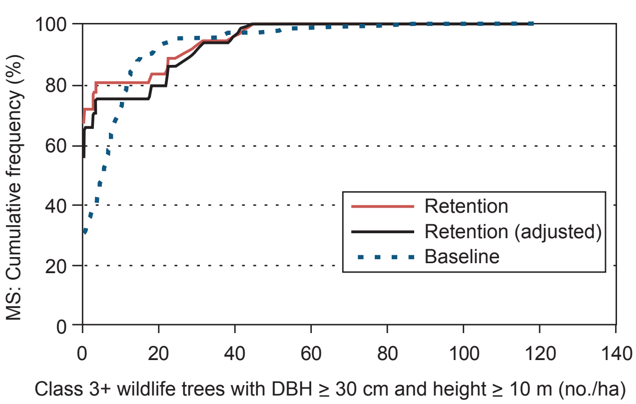
BEC subzone	No. blocks	
	Retention	Baseline
MSdc	1	0
MSdk	10	51
MSdm	13	33
MSxk	8	60
MSxv	3	15
Total	**35**	**159**
Total with positive weight	**34**	**159**

5.6.3 MS – Large dead trees

Stems per hectare of dead trees ≥ 30 cm dbh and ≥ 10 m height.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	159	8	14	0	119
Retention	35	6	13	0	45
Adjusted retention	34	8	13	0	45

Figure 32. Cumulative distribution of large dead trees in the MS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
0.2	41.2	0.0002	0.2	35.0	0.0021

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large dead trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 41.2% or greater is 0.0002 (Prob ≥ *D* < 0.0002). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 0.2 stems per hectare of large dead trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0021, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

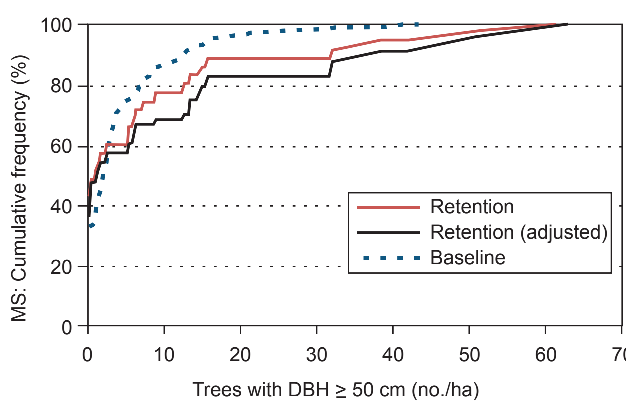
Approximately 70% of the unadjusted RSM-sampled cutblocks had no large dead trees compared to 30% for the cruise baseline (Figure 32).

5.6.4 MS – Large trees

Stems per hectare of live and dead trees ≥ 50 cm dbh.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	159	4	7	0	41
Retention	35	8	15	0	63
Adjusted retention	34	11	18	0	63

Figure 33. Cumulative distribution of large trees (dead and alive) in the MS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
0.4	15.2	0.4091	12.1	21.5	0.1406

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 15.2% or greater is 0.4091 (Prob ≥ *D* < 0.4091). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 0.4 stems per hectare of large trees.

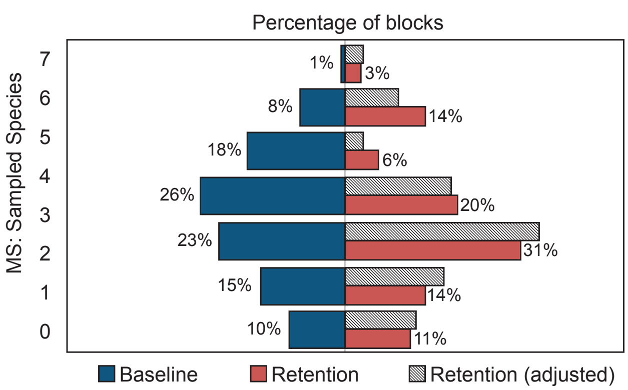
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.1406, which does not change the outcome of the decision. The K-S statistic is still likely to be obtained if the null hypothesis is correct.

Overall, retention areas in the RSM-sampled cutblocks had a higher density of large trees compared to the cruise baseline (Figure 33).

5.6.5 MS – Number of tree species as sampled

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	159	4	1	1	7
Retention	35	3	2	1	7
Adjusted retention	34	3	2	1	7

Figure 34. Number of sampled tree species in the MS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
3	9.3	0.6519	3	17.2	0.1167

The sampled species (Figure 34) have not been changed to account for differing sample intensity.

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for number of sampled tree species are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic being 9.3% or greater is 0.6535 (Prob ≥ *D* < 0.6519). Therefore, such a separation value is likely under the null hypothesis of no difference. The value with the highest separation is at 3 sampled tree species, but the distributions are similar.

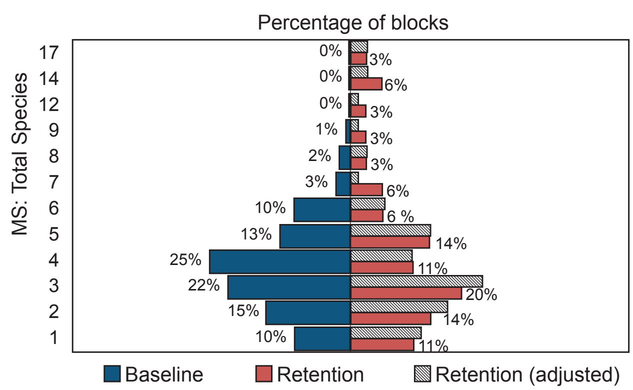
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.1167. Although this indicates a decrease in the probability, there is still a significant likelihood of accepting the null hypothesis.

Overall, the number of tree species found in the RSM-sampled cutblocks is similar to the cruise baseline (Figure 34).

5.6.6 MS – Number of tree species corrected for plot density

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	159	4	2	1	9
Retention	35	5	4	1	17
Adjusted retention	34	4	4	1	17

Figure 35. Estimated number of tree species in the MS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
6	17.8	0.1513	7	10.3	0.5678

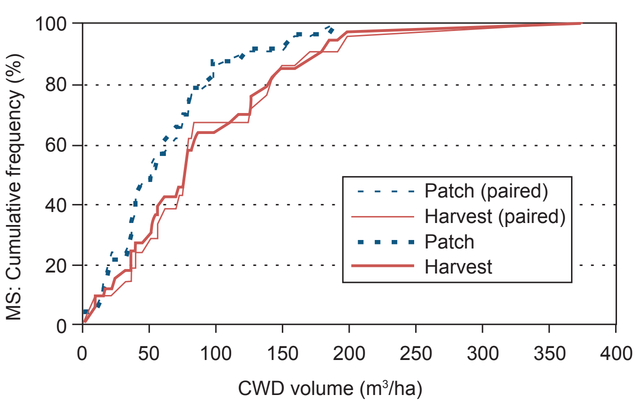
Figure 35 shows the number of tree species estimated to compensate for differing plot sample density between the RSM-sampled cutblocks and the cruise baseline (for both adjusted and unadjusted data to highlight potential BEC subzone data imbalance). This has resulted in increased estimates of tree species compared to the sampled number of tree species, particularly for the RSM-sampled cutblocks. The probability of accepting the null hypothesis is significant, chiefly for the adjusted for BEC subzone imbalance data set.

Overall, retention areas within the RSM-sampled cutblocks have similar numbers of tree species compared to the cruise baseline.

5.6.7 MS – Coarse woody debris volume

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	23	63	47	0	191
Harvest areas	33	93	75	4	376

Figure 36. Cumulative distribution of coarse woody debris volume in the MS zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
76	24.1	0.3096	56	28.6	0.3063

The null hypothesis is that CWD volume in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 24.1% or greater is 0.3096 (Prob ≥ *D* < 0.3096). Therefore, such a separation value is possible under the null hypothesis of no difference.

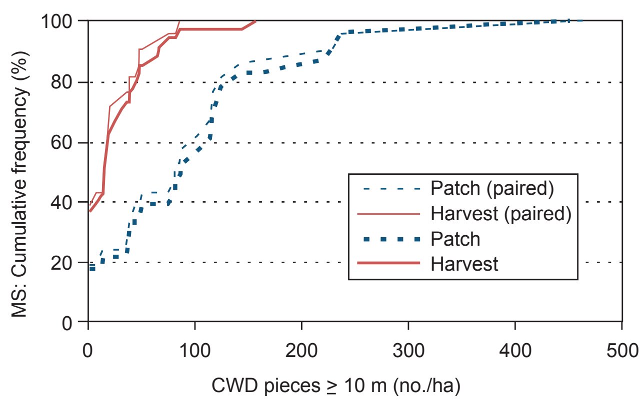
When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability remained essentially the same.

Overall, the volume of CWD found on the RSM-sampled cutblocks was very similar between the retention patches and the harvested areas (Figure 36).

5.6.8 MS – Coarse woody debris density of long pieces

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	23	105	106	0	463
Harvest areas	33	26	34	0	158

Figure 37. Cumulative distribution of coarse woody debris density of long pieces in the MS zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
75	54.8	0.0002	75	52.4	0.0040

The null hypothesis is that density of long CWD pieces in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 54.8% or greater is 0.0002 (Prob ≥ *D* < 0.0002). Therefore, such a separation value is unlikely under the null hypothesis of no difference.

When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability increases to 0.0040, which does not change the outcome of the decision.

A lower density of long CWD pieces was found in the harvested areas of the RSM-sampled cutblocks compared to the retention patches (Figure 37). Forty percent of the of the harvested areas had no peices above 10 m compared to 20% of the patches.

5.7 *Sub-Boreal Pine–Spruce Zone*

This section presents results from 35 harvested cutblocks sampled in the Sub-Boreal Pine–Spruce (SBPS) zone using the FREP stand-level biodiversity RSM protocol during the 2005 and 2006 field seasons. Figures 38–43 illustrate the results for the indicators assessed in this zone.

5.7.1 General description of cutblocks sampled in the SBPS zone

- 35 cutblocks sampled
- 32 cutblocks with retention (91.4%), 3 cutblocks with no retention (8.6%)
- 1467.5 ha total gross area
- 154.1 ha of patch retention (10.5% of gross area)
- 34.8 ha of constrained patch retention (22.6% of patch retention is constrained)
- 109.8 ha of dispersed retention (7.5%) (calculated as basal area equivalent)
- Average retention 18.0%
- 28 retention patches less than or equal to 2 ha (51.9%)
- 26 retention patches greater than 2 ha (48.1%)
- Average of 2.4 ecological anchors per hectare of patch strata (range: 0–28)
- Average of 10.9% windthrow for cutblocks with retention (67.6% of blocks ≤ 5%; 26.4% of blocks ≥ 10% windthrow)
- 12 patches internal to cutblock boundary (23.1%); 38 patches on the edge of the cutblock (73.1%); and 2 patches non-contiguous with cutblock boundary (3.8%)
- Invasive species found on 6 cutblocks (17.1% of blocks)

5.7.2 Timber cruise data used for SBPS zone baseline comparisons

	No. blocks	
BEC subzone	**Retention**	**Baseline**
SBPSdc	3	1
SBPSmc	3	0
SBPSmk	11	44
SBPSxc	18	21
Total	**35**	**66**
Total with positive weight	**31**	**66**

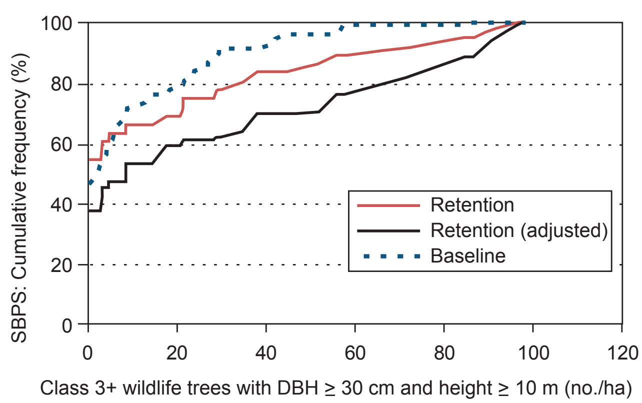
* one SBPSxc block originally had the wrong BEC subzone applied and so was not included as a positive weight.

5.7.3 SBPS – Large dead trees

Stems per hectare of dead trees ≥ 30 cm dbh and ≥ 10 m height.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	66	11	17	0	86
Retention	35	18	29	0	98
Adjusted retention	31	30	36	0	98

Figure 38. Cumulative distribution of large dead trees in the SBPS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
29.4	13.8	0.6399	29.4	29.6	0.0611

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large dead trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 13.8% or greater is 0.6399 (Prob ≥ *D* < 0.6399). Therefore, such a separation value is possible under the null hypothesis of no difference. The value with the highest separation is 29.4 stems per hectare of large dead trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test probability decreased to 0.0611. This adjustment represents a substantial difference between the cruise baseline and RSM-sampled cutblocks, and changes the outcome of the decision. There is likely a difference between the two populations with the retention areas having higher density of large dead trees compared to the baseline.

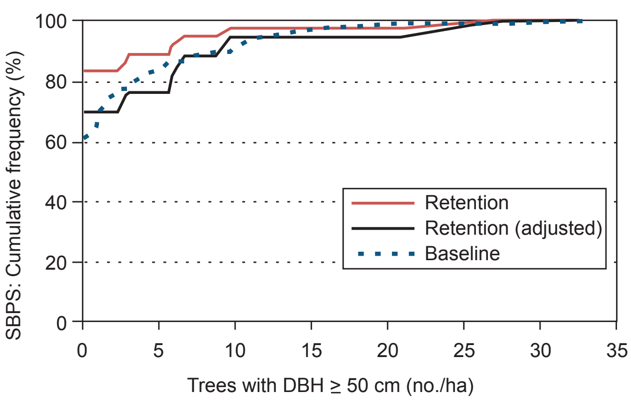
Overall, retention areas in RSM-sampled cutblocks had a higher density of large dead trees compared to the cruise baseline (Figure 38).

5.7.4 SBPS – Large trees

Stems per hectare of live and dead trees ≥ 50 cm dbh.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	66	3	6	0	33
Retention	35	2	5	0	28
Adjusted retention	31	3	7	0	28

Figure 39. Cumulative distribution of large trees (dead and alive) in the SBPS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
0.0	22.3	0.3593	5.6	10.6	0.8607

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 22.3% or greater is 0.3593 (Prob ≥ *D* < 0.3593). Therefore, such a separation value is possible under the null hypothesis of no difference. The value with the highest separation is 0.0 stems per hectare of large trees.

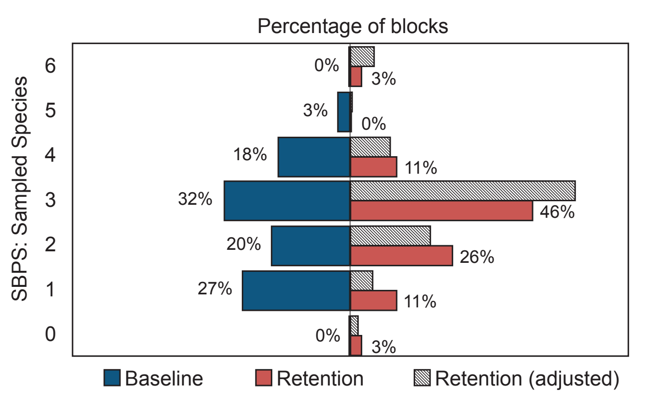
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.8607, which does not change the outcome of the decision.

The density of large trees is similar between the RSM-sampled cutblocks and the cruise baseline. However, a smaller definition of a "large tree" is necessary for the SBPS zone and will be applied in further analyses.

5.7.5 SBPS – Number of tree species as sampled

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	66	3	1	1	5
Retention	35	3	1	0	6
Adjusted retention	31	3	1	0	6

Figure 40. Number of sampled tree species in the SBPS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
1	13.0	0.8231	1	19.8	0.0978

The sampled species (Figure 40) have not been changed to account for differing sample intensity.

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for number of sampled tree species are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 13% or greater is 0.8231 (Prob ≥ *D* < 0.8231). Therefore, such a separation value is possible under the null hypothesis of no difference. The value with the highest separation is 1 sampled tree species.

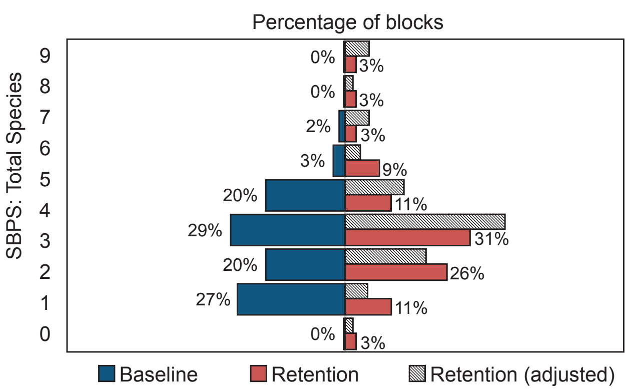
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test probability decreases to 0.0978, though it is still possible to accept the null hypothesis of no difference.

Overall, a similar number of tree species was found in the RSM-sampled cutblocks compared to the cruise baseline.

5.7.6 SBPS – Number of tree species corrected for plot density

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	66	3	1	1	6
Retention	35	3	2	0	9
Adjusted retention	31	3	2	0	9

Figure 41. Estimated number of tree species in the SBPS zone.



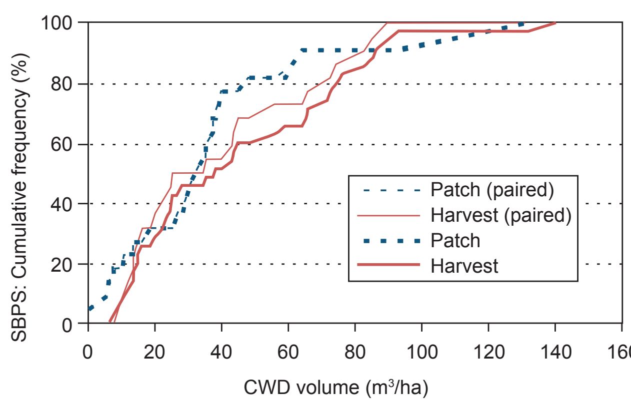
K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
1	13.0	0.8354	1	19.8	0.1240

Figure 41 shows the tree species estimated to compensate for differing plot sample density between the RSM-sampled cutblocks and the cruise baseline (for both adjusted and unadjusted data to highlight potential BEC subzone data imbalance). This has resulted in only minor changes to the estimates of tree species compared to the sampled number of tree species. For the unadjusted data, the K-S probability is high, indicating a high probability of accepting the null hypothesis. The lower probability for the adjusted data indicates a potentially higher number of tree species overall in the RSM-sampled cutblocks compared to the cruise baseline, even though the two populations are still very similar (Figure 41).

5.7.7 SBPS – Coarse woody debris volume

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	22	37	32	0	131
Harvest areas	35	46	32	8	140

Figure 42. Cumulative distribution of coarse woody debris volume in the SBPS zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
40	25.8	0.2521	40	22.7	0.4893

The null hypothesis is that CWD volume in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 25.8% or greater is 0.2521 (Prob ≥ *D* < 0.2521). Therefore, such a separation value is possible under the null hypothesis of no difference.

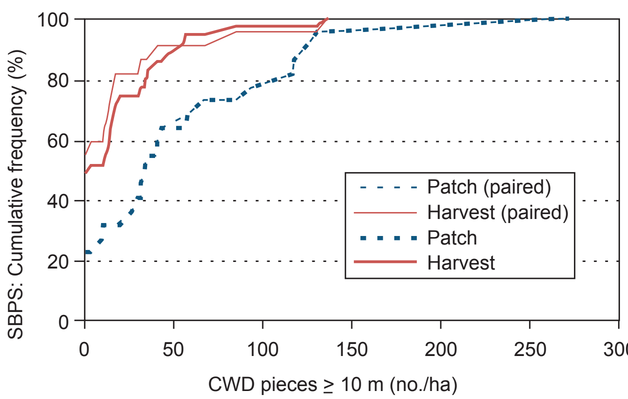
When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability increased, supporting the probability that the null hypothesis is correct.

Overall, the volume of CWD found in the RSM-sampled cutblocks is very similar between the retention patches and the harvested areas (Figure 42).

5.7.8 SBPS – Coarse woody debris density of long pieces

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	22	56	65	0	271
Harvest areas	35	18	29	0	136

Figure 43. Cumulative distribution of coarse woody debris density of long pieces in the SBPS zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
19	42.5	0.0071	19	42.5	0.0071

The null hypothesis is that density of long CWD pieces in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 42.5% or greater is 0.0071 (Prob ≥ *D* < 0.0071). Therefore, such a separation value is unlikely under the null hypothesis of no difference.

When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability decreases to 0.0032, which does not change the outcome of the decision.

A lower density of long CWD pieces was found in the harvested areas of the RSM-sampled cutblocks compared to the retention patches (Figure 43).

5.8 Sub-Boreal Spruce Zone

This section presents results from 188 harvested cutblocks sampled in the Sub-Boreal Spruce (SBS) zone using the FREP stand-level biodiversity RSM protocol during the 2005 and 2006 field seasons. Figures 44–47 illustrate the results for the indicators assessed in this zone.

5.8.1 General description of cutblocks sampled in the SBS zone

- 187 cutblocks sampled
- 167 cutblocks with retention (89.3%), 20 cutblocks with no retention (10.7%)
- 7191.0 ha total gross area
- 763.4 ha of patch retention (10.6% of gross area)
- 262.8 ha of constrained patch retention (34.4% of patch retention is constrained)
- 357.8 ha of dispersed retention (5.0%) (calculated as basal area equivalent)
- Average retention 15.6%
- 198 retention patches less than or equal to 2 ha (61.3%)
- 125 retention patches greater than 2 ha (38.7%)
- Average of 2.3 ecological anchors per hectare of patch strata (range: 0–8.9)
- Average of 9.2% windthrow for cutblocks with retention (65.6% of blocks ≤ 5%; 28% of blocks ≥ 10% windthrow)
- 141 patches internal to cutblock boundary (46.5%); 145 patches on the edge of the cutblock (47.8%); and 17 patches non-contiguous with cutblock boundary (5.6%)
- Invasive species found on 33 cutblocks (17.6% of blocks)

5.8.2 Timber cruise data used for SBS zone baseline comparisons

	No. blocks	
BEC subzone	**Retention**	**Baseline**
SBSdh	2	7
SBSdk	29	59
SBSdw	65	64
SBSmc	34	72
SBSmk	21	26
SBSmw	15	41
SBSvk	2	0
SBSwk	18	10
Total	**186***	**279**
Total with positive weight	**184**	**279**

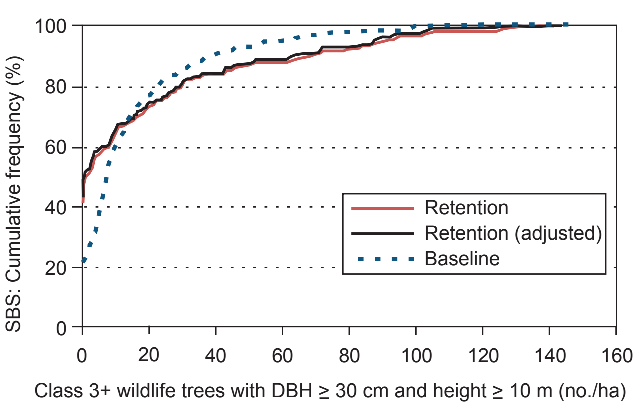
* One block could not be used for the baseline comparison since there was no tree data collected, though there was retention.

5.8.3 SBS – Large dead trees

Stems per hectare of dead trees ≥ 30 cm dbh and ≥ 10 m height.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	279	15	22	0	122
Retention	187	19	32	0	147
Adjusted retention	184	18	30	0	147

Figure 44. Cumulative distribution of large dead trees in the SBS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
1.0	27.5	0.0001	1.2	28.8	0.0001

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large dead trees are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 27.5% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 1.0 stems per hectare of large dead trees.

When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

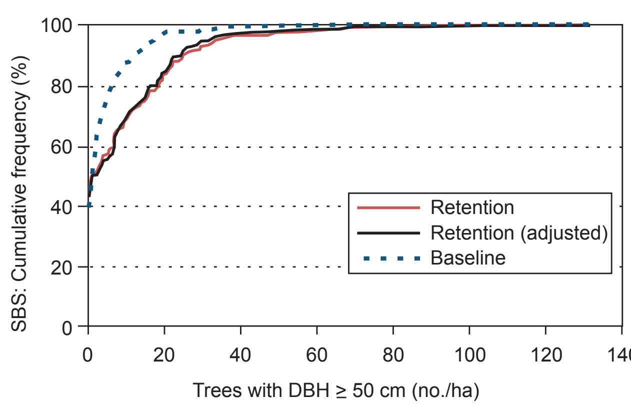
Approximately 45% of the unadjusted RSM-sampled cutblocks had no large dead trees compared to 20% for the cruise baseline (Figure 44). Included with these RSM-sampled cutblocks that contain no large snags is a percentage of blocks (10.6%) that had no retention of any type. The top 30% of the cruise baseline and RSM-sampled blocks seems comparable when considering density of large snags.

5.8.4 SBS – Large trees

Stems per hectare of live and dead trees ≥ 50 cm dbh.

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	279	4	7	0	52
Retention	187	10	16	0	133
Adjusted retention	184	9	16	0	133

Figure 45. Cumulative distribution of large trees (dead and alive) in the SBS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
6.3	21.8	0.0001	6.3	23.9	0.0001

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for large trees are samples from the same distribution (or population). For the unadjusted data, the probability of K-S statistic (*D*) being 21.8% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 6.3 stems per hectare of large trees.

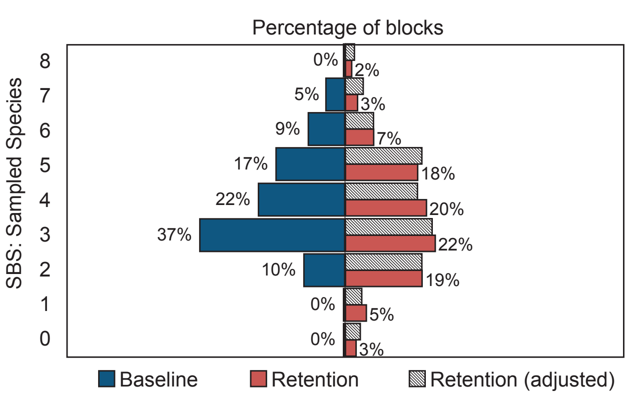
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

Overall, the RSM-sampled cutblocks have a higher density of large trees compared to the cruise baseline (Figure 45).

5.8.5 SBS – Number of tree species as sampled

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	279	4	1	2	7
Retention	187	4	2	0	8
Adjusted retention	184	4	2	0	8

Figure 46. Number of sampled tree species in the SBS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
2	16.9	0.0001	2	16.8	0.0001

The sampled species (Figure 46) have not been changed to account for differing sample intensity.

The null hypothesis is that baseline (timber cruise) and retention (RSM stand-level biodiversity) block means for number of sampled tree species are samples from the same distribution (or population). For the unadjusted data, the probability of the K-S statistic (*D*) being 16.9% or greater is 0.0001 (Prob ≥ *D* < 0.0001). Therefore, such a separation value is unlikely under the null hypothesis of no difference. The value with the highest separation is 2 sampled tree species.

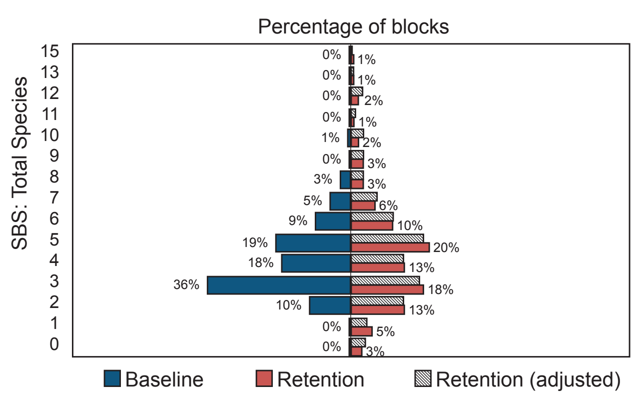
When the weighted retention data is used to account for the unbalanced baseline data, the adjusted K-S test has a probability of 0.0001, which does not change the outcome of the decision. The K-S statistic is still unlikely to be obtained if the null hypothesis is correct.

The mean number of tree species is the same for the baseline and the unadjusted and adjusted RSM-sampled data.

5.8.6 SBS – Number of tree species corrected for plot density

	N	Mean	Standard deviation	Minimum	Maximum
Baseline	279	4	2	2	12
Retention	187	5	3	0	15
Adjusted retention	184	5	3	0	15

Figure 47. Estimated number of tree species in the SBS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
4	11.2	0.0238	5	13.6	0.0049

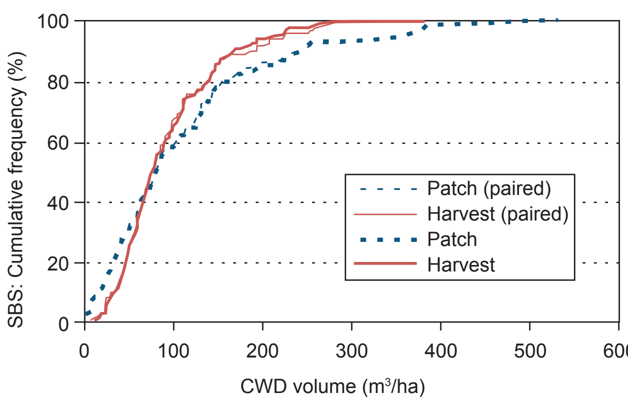
Figure 47 shows the number of tree species estimated to compensate for differing plot sample density between the RSM-sampled blocks and the cruise baseline (for both adjusted and unadjusted data to highlight potential BEC subzone data imbalance). This has resulted in increased estimates of tree species in the retention areas compared to the actual sampled number of tree species. Although the probability has increased slightly from the sampled number of tree species, the increase is not enough to accept the null hypothesis.

After correction for sampling density, there are more tree species found in the retention areas compared to the cruise baseline.

5.8.7 SBS – Coarse woody debris volume

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	107	113	104	0	531
Harvest areas	184	93	60	8	381

Figure 48. Cumulative distribution of coarse woody debris volume in the SBS zone.



K-S test (unadjusted)			K-S test (adjusted)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
40	13.0	0.1698	40	14.2	0.1145

The null hypothesis is that CWD volume in retention patches and in the harvested areas of cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 13.0% or greater is 0.1698 (Prob ≥ *D* < 0.1698). Therefore, such a separation value is possible under the null hypothesis of no difference.

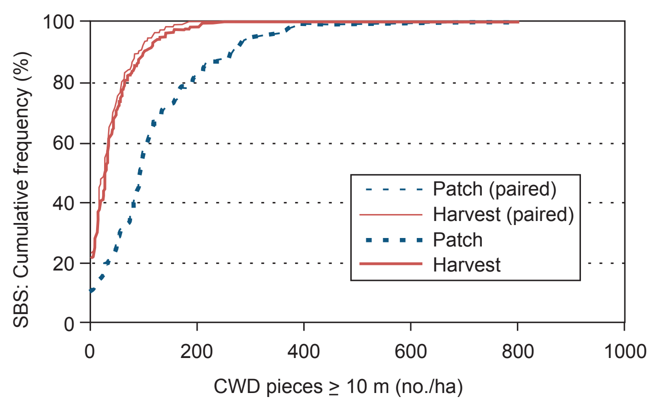
When the paired data is used to account for the potential correlation within blocks, the paired K-S test probability decreased slightly, although it is still high enough to support the possibility of the null hypothesis being true.

Overall, the volume of CWD found on the RSM-sampled cutblocks is very similar between the retention patches and the harvest areas (Figure 48).

5.8.8 SBS – Coarse woody debris density of long pieces

	N	Mean	Standard deviation	Minimum	Maximum
Retention patches	107	120	114	0	801
Harvest areas	184	43	46	0	245

Figure 49. Cumulative distribution of coarse woody debris density of long pieces in the SBS zone.



K-S test (unpaired)			K-S test (paired)		
x_D	D %	Prob ≥ D	x_D	D %	Prob ≥ D
71	49.4	0.0001	70	50.9	0.0001

The null hypothesis is that density of long CWD pieces in the retention patches and in the harvested areas of the cutblocks are samples from the same distribution (or population). For the unpaired data, the probability of the K-S statistic (*D*) being 49.4% or greater is 0.0001 (Prob ≥ *D* < 0.001). Therefore, the null hypothesis should be rejected, the distributions are different. Overall, the retention patches contain a higher density of long CWD pieces compared to the harvested areas of the RSM-sampled cutblocks.

6.0 CONCLUSIONS AND RECOMMENDATIONS

This analysis is based on 643 cutblocks that were harvested between 1998 and 2004 and surveyed during the 2005 and 2006 field seasons. The BEC zone results reported here are therefore influenced by the Forest Practices Code legislation, which was in effect when these blocks were harvested. This legislation has since been replaced by the *Forest and Range Practices Act* (*FRPA*).

This analysis provides information about the character/attributes of retention on blocks governed by the FPC to enhance forest profesionals knowledge and awareness, develop baseline information for comparison of practices, identify trends, and, look for opportunities for the continuous improvement of forest practices, policies and legislation under *FRPA*. To meet these goals, the information should be communicated in a variety of ways to emphasize the biodiversity outcomes from the Code years, so forest management can continue the positive outcomes and evolution of forestry practices. In addition to documents such as this report, communication should include discussions between district staff and licensees within their area and presentations within government.

A biodiversity strength found in this analysis include the good density of large trees (≥ 50 cm dbh) found in the retention within the central interior of the Province (SBPS, SBS and MS BEC zones). This may be linked to district and regional guidance to retain Douglas-fir, and, or an outcome of preferred tree size for sawmills. Regardless of the reason, the result is a benefit to biodiversity, and in particular to wildlife habitat. Another biodiversity strength is the number of retained tree species is generally consistent with that found in pre-harvest timber cruise. This seems to be the case in the SBS, SBPS, MS, CWH, and to a somewhat lesser extent IDF and ESSF BEC zones. However, the number of tree species retained appears to be lower in the BWBS and ICH BEC zones. These two zones also have the lowest average retention of the 8 BEC zones assessed (11.5 and 12.7% respectively), potentially making it difficult to maintain the full range of tree species.

CWD volume on the harvested sites is good across all BEC zones. However, the density of long pieces of CWD (≥ 10 m.), is low compared to that found in wildlife tree patches (a unmanaged area being used as a baseline surrogate). The longer CWD pieces decay slower, and can better provide their functions of providing habitat and soil stability than shorter and smaller pieces.

Large snags (≥ 30 cm dbh and ≥ 10 m ht) are generally much fewer than what we could expect based on the baseline, for all but the SBPS BEC zone. The SBPS, with the best picture for large snag density also had the highest percentage of patches larger than 2 hectares. The CWH BEC zone had the worst picture for large snag density and also had the lowest percentage of patches larger than 2 hectares. Presumably the larger patches make it easier to retain these large, but potentially dangerous, snags.

Further analysis of this data will occur, and lessons learned from this report will improve the future assessments. For example, further analysis should consider a smaller size for the large tree definition, particularly for the SBPS BEC zone. A future assessment of FREP stand-level biodiversity data should look at the density of CWD pieces retained on cutblocks that are both long and having a large diameter.

Use of the unadjusted and adjusted analysis for the tree indicators showed, in general that the impact of the somewhat unbalanced distribution of cutblocks among subzones compared with the baseline dataset was minimal. Of the three tree indicators and eight BEC zones (24 different tests), only two tests changed their conclusion regarding the null hypothesis with the adjustment to the data.

The paired versus unpaired presentation of CWD data produced similar results, which suggests that cutblock effects did not have a large influence on the CWD volume or density of long pieces of CWD.

The correction for the number of tree species found in RSM cutblocks increased the average number of retained tree species for 5 of the 8 BEC zones, while the average number of tree species in the baseline blocks increased with the correction only for the BWBS BEC zone. This observation is probably reflective of the generally larger number of plots per cublock in the baseline dataset. A larger number of plots is more likely to find more tree species; however, correction is often necessary only when comparing datasets that are not equal in their sampling intensity or spatial distribution. The Chao correction, however, can give extreme value under certain conditions.

A few ideas are presented above about potential reasons why the harvesting in a BEC zone may be showing particular biodiversity strengths or weaknesses. Section 4.1 of this document also briefly discusses other BEC zone strengths and weaknesses. It is important that such discussions be held between government and forest licensees to discuss various views of forest practices that impact biodiversity and identify site-specific means to continually improve practices for long-term economic and ecological stewardship.

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