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SOUTHERN INTERIOR FOREST REGION: ANALYSIS OF STAND-LEVEL BIODIVERSITY SAMPLING RESULTS IN SIX PREDOMINANT BIOGEOCLIMATIC SUBZONES

Prepared by:
Nancy Densmore, RPF

May 2011

BRITISH COLUMBIA

FREP
Forest & Range Evaluation Program

Sustainability of Forest and Range Resources Through Science and Stewardship

MINISTRY OF FORESTS, MINES AND LANDS
FOREST AND RANGE EVALUATION PROGRAM

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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 authors offer the following recommendations to those who develop and implement forest and range management policy, plans, and practices.

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EXECUTIVE SUMMARY

Over 650 harvested cutblocks were assessed for stand-level biodiversity attributes from 2006–2009 in the Southern Interior Forest Region of British Columbia. Quality and quantity of the tree retention and coarse woody debris was measured. Ninety-one percent of the cutblocks had retention (greater than 0.5% of the cutblock area). Overall retention was 16.6% of the gross area of the cutblocks.

The retained tree data from the samples in six predominant biogeoclimatic subzones (ESSFwc, ICHmw, IDFdk, MSdm, SBPSxc, and SBSdw) was compared against timber cruise data from the same subzones. This comparison gives an indication of the types of decisions being made for tree retention within those areas. For example, the FREP data collected in the MSdm and the SBPSxc showed consistently high biodiversity quality (i.e. equivalent or higher than baseline) for the three tree indicators presented, large dead trees (≥ 10 m tall and ≥ 30 cm diameter breast height (dbh)), large trees (live and dead ≥ 40 cm or 50 cm dbh), and number of tree species. These are important ecological attributes providing for wildlife tree dependent species. However, the ICHmw subzone consistently showed lower biodiversity quality for these indicators.

The volume of CWD left on the harvested areas of the cutblocks was similar or higher than that on the ground within retention patches for each of the six predominant subzones, a good indicator for maintenance of soil structure. However, the density of big pieces of CWD (≥ 20 cm diameter and ≥ 10 m long) is significantly lower for five of the six predominant subzones. Big pieces of CWD are important to maintain on sites for soil stability and wildlife habitat.

TABLE OF CONTENTS

List of Figures

1.0 INTRODUCTION

The purpose of this report is to improve understanding of a subset of stand-level biodiversity outcomes related to harvesting and retention forest practices in the Southern Interior Forest Region. The information presented here can facilitate discussions between natural resource professionals on biodiversity practices and highlight opportunities for continuous improvement of those practices.

Wildlife- trees and coarse woody debris (CWD) are components of the biodiversity value noted in the Forest Planning and Practices Regulation, under the *Forest and Range Practices Act* (FRPA). The Forest and Range Evaluation Program (FREP) is assessing how well these values are being maintained. Stand-level biodiversity, particularly the retention of live and dead standing trees and CWD within harvested cutblocks, is an important, (if not essential) component of wildlife habitat maintenance (for species dependent on mature and old-forest characteristics) (Seip and Parker 1997; Fenger et al. 2006), and vital for maintaining other ecological functions, such as hydrologic functioning, soil condition, and species dispersal (Chapman 1995; Winkler et al. 2008; Kremsater and Bunnell 2009).

2.0 BACKGROUND AND METHODOLOGY

Data, totalling 651 cutblocks, was collected by British Columbia Ministry of Forests and Range forest district staff in the Southern Interior Forest Region during the 2006-2009 field seasons. The cutblocks for sampling were chosen randomly from the full population of potential cutblocks (defined harvest date and 2 ha or larger), as documented in the RESULTS (Reporting Silviculture Updates and Landstatus Tracking System) corporate data system. The samples are from cutblocks harvested between 1997 and 2007 (Table 1). These cutblocks were therefore representative of the *Forest Practices Code of British Columbia Act* (FPC) era[1]

In brief, the field survey utilizes modified timber cruise plots to assess tree retention, and line transect plots for CWD. Both a tree and CWD assessment is done from every plot centre, which is randomly located, both within tree retention patches and in the harvested areas of cutblocks. Other collected information includes windthrow, invasive plants, and ecological anchors. The general retention patch information collected included patch location in relation to harvesting, size of patch, presence of riparian influence, and planned retention length (i.e. temporary retention is expected to be harvested prior to rotation end; and long-term retention is to be retained throughout the rotation).

A general overview of all sampled Southern Interior Forest Region cutblocks is presented below, followed by a summary of the predominant biogeoclimatic (BEC) subzone within six of the seven sampled zones. Only one cutblock in the Ponderosa Pine zone was sampled, and therefore no subzone summary is presented for that zone. In general, this report includes only the influence of long-term retention; however a shadow analysis was done to assess the effect of temporary retention and is briefly discussed for the predominant subzones. Further details on the survey methodology are found in the FREP stand-level biodiversity protocol (Province of British Columbia 2009).

The tree indicator data is compared against timber cruise data from major licensee and British Columbia Timber Sales (BCTS) cutblocks derived from the Electronic Commerce Appraisals System (ECAS) and the Official Notices Site (https://www23.for.gov.bc.ca/notices/init.do). A further description of the derivation of baseline data, plus BEC subzones for the FREP-sampled cutblocks is shown in Appendix 1.

Table 1. Samples by harvest completion year

Harvest year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Unknown	Total
% of samples	2.3	4.8	7.4	8.3	8.5	12.7	13.2	13.8	16.3	9.7	2.9	0.1	100

1 The effective date of the *Forest and Range Practices Act* (*FRPA*) was January 31, 2004; however, Forest Development Plans (FDP, an FPC plan governing harvest) were being created up until December 31, 2005, and could be extended up until March 31, 2007. Cutting permits (i.e. permit to harvest timber) originating from FPC FDP's extended beyond March 31, 2007. Analysis shows that very few cutblocks originating from Forest Stewardship Plans (FSP, an *FRPA* plan governing harvest) were showing up on the landscape until 2008 harvest year. None of the Southern Interior Forest Region 2007 harvest year cutblocks were from *FRPA*.

Cruise plots are not normally established in areas designated for wildlife tree retention. The comparison between FREP-sampled retention and cruise plots therefore indicates the biodiversity choices made on the sampled cutblocks. A difference in an indicator average between the cruise data and the FREP data for a BEC subzone likely indicates choices to establish retention areas that are to some extent different from harvested areas. Where dispersed retention is a common practice, the decisions of which single trees (or small groups of trees) to maintain can have an overall influence on the quality of retention. Retention choices are compared against the provincial wildlife tree management guidance (http://www.for.gov.bc.ca/ftp/hfp/external/!publish/web/wlt/policies/WT-Guidance-05-2006.pdf), which outlines good environmental choices for wildlife tree retention. For example, an overall average density of large trees that is higher than that found in the baseline supports the recommendation to bias retention towards areas with high-value wildlife trees.

A Kolmogorov-Smirnov two-sample test (K-S test) was used to assess the validity of the null hypothesis that the baseline and stand-level biodiversity retention data 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 further described in FREP Report No. 17 (B.C. Ministry of Forests and Range 2008a).

A baseline for CWD on a harvested cutblock may be considered in many ways such as the amount of wood on the ground soon after natural disturbance, prior to harvest, or in similar mature ecosystems. For FREP, the CWD indicators (total volume and density of big pieces) are compared in the retention patches (unharvested forest) versus the harvest area (affected by logging).

Long-term success for dead-wood management (both standing and downed wood) means retaining the amount and type of dead wood necessary to:

- sustain deadwood-dependent organisms (e.g. many fungi and invertebrates); and
- maintain ecological function driven by input of dead wood (B.C. Ministry of Forests and Range 2010).

The FREP monitoring results provide insight into the amount and quality of live and dead wood left on sites in the context of levels in unharvested areas.

2.1 *Indicators Assessed*

Many different indicators can be compiled from the data collected. A subset of potential indicators is presented in this report. The indicators chosen are important for ecological retention value. For example, the density of large trees is tracked as an indicator since size is a key attribute of high-value wildlife trees. Wildlife trees are habitat for over 80 British Columbia animal species, providing cover, nesting, denning, feeding, roosting and perching sites (Wildlife Tree Committee 2008). The most valuable wildlife tree is large, old, damaged or decayed. There is not enough time for a tree to develop these traits within a typical commercial harvest cycle, so it is important to maintain areas of old forest within harvested cutblocks (Fenger et al. 2006).

2.1.1 Retention patch size

Large retention patches (> 2 ha) provide closer to interior forest habitat conditions (considering wind, shade, and canopy interception) than small retention patches. Botting and deLong (2009) found that macrolichen and bryophyte species richness was not maintained in small retention patches compared to the surrounding forest, and suggested that larger patches (of 2 ha or more) would better maintain species diversity and allow for recolonization of the harvested area.

2.1.2 Retention patch location

A mixture of both internal and edge of harvest patch locations is suggested. Internal patches provide areas of cover within the harvest cutblock, potentially allowing more movement of small animals throughout the cutblock and easier recruitment of vegetation species. Edge patches have the potential of merging with forest cover outside of the cutblock, giving larger forested patches (even if temporarily) and often providing more linear retention from stream riparian reserves which can provide travel corridors. Although external, non-contiguous retention patches may provide biodiversity attributes, these patches do not provide direct benefits to the cutblock in terms of species or CWD recruitment and are therefore not recommended for provision of stand-level biodiversity

2.1.3 Large snags (dead trees ≥ 10 m tall and ≥ 30 cm dbh)

Large, dead trees (dead trees are also called “snags”) are important habitat for wildlife tree users. The BC Ministry of Forests and Range (2005) indicated that the minimum

size of a dead tree to be functional for bird reproduction is 20 cm dbh and 10 m tall. Observations of nesting use of stubs by birds in the southern interior of British Columbia indicated a preference for larger diameter (36–45 cm) trees (Harris 2001). The 30 cm diameter cut-off for this indicator was chosen because it met the functional dead tree description and was close to preferred diameters.

2.1.4 Large trees (live and dead; dbh ≥ 40 cm or ≥ 50 cm)

Large size is one of the main considerations for determining a high-value wildlife tree (BC Ministry of Forests and Range 2006). For this report, a 40 or 50 cm dbh or larger cutoff is used to define a large tree, depending on the baseline density of such large trees in the particular subzone.

2.1.5 Number of tree species

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

The cumulative distribution charts for tree species (see Section 4), shows the data in a more "stepwise" fashion than the density of various other tree indicators since the data has a smaller range of possible answers (e.g., about 0–15 possible tree species versus about zero to several hundred possible large trees per hectare). The number of species found onsite is highly dependent on the sampling effort, particularly in areas with rarely occurring species (B.C. Ministry of Forests and Range 2008). Due to the extensive area surveyed during a typical timber cruise, the number of plots in the baseline data will likely be higher than the number of plots in FREP stand-level biodiversity monitoring for any particular subzone. Because of this discrepancy, a slightly higher number of species is likely to be found in the baseline data.

Previous analysis (B.C. Ministry of Forests and Range 2008) utilized an estimate of number of species for the baseline and the FREP-sampled cutblocks with a "Chao2" biased correction. An anomaly of this correction is an occasional extreme range of species. The correction, used in the 2008 report on eight BEC zone assessments, showed no change in the difference between the average number of baseline tree species and the average number of FREP-sampled retention cutblocks for four of the eight zones. For three of the eight zones, there was an increase to the FREP-sampled retention of one tree species compared to the baseline. For one zone, there was an increase in the FREP-sampled retention average of two species compared to the baseline. Considering the potential discrepancy in the count of tree species from the bias correction, this assessment considers that a retention average must be lower than the baseline average by one or more tree species before considering there is a decrease.

2.1.6 Coarse woody debris volume and density of big pieces

The coarse woody debris (CWD) indicators are volume and number of big pieces (considering both diameter and length). Long pieces of CWD are more valuable than short pieces of similar diameter; long pieces last longer (Stone et al. 1998) before decaying into soil, and while decaying can better perform their habitat and slope stability functions compared with smaller pieces (Harmon et al. 1986). Big pieces of CWD, considering both length and diameter, are the most valuable ecological indicator. Big pieces decay slowest (higher volume of wood) and are most likely to provide long-term denning and feeding habitat opportunities. All pieces designated as big (10 m or longer and 20 cm diameter or bigger) are a minimum of 20 cm diameter at the point of transect crossing, meaning that the point of largest diameter on the log is also a minimum 20 cm, but likely larger.

3.0 REGIONAL SUMMARY

3.1 *General Description of Southern Interior Forest Region Sample Cutblocks*

- 651 cutblocks sampled
- 91% of cutblocks had retention (592 cutblocks), 9% of cutblocks had no retention (59 cutblocks)
  - 22% (13 of 59 cutblocks) of the no-retention cutblocks were less than or equal to 5 ha in gross size
  - 8% (5 of 59 cutblocks) of the no-retention cutblocks retained a few trees but the percentage rounded to 0
- 20 508.8 ha total gross area
- 10.5% (2154.4 ha) of patch (long-term) retention

- 6.1% (1260.4 ha) of dispersed retention (basal area equivalent[2])
- 16.6% average retention
- 44% of patch retention constrained[3] (938 ha of constrained retention)
- 77% of patches are less than or equal to 2 ha
- 23% of patches are greater than 2 ha
- Average of 2.9 ecological anchors[4] per hectare of retention, patch or dispersed (range: 0 – 90)
- Average of 7% windthrow in the cutblocks with retention measured[5]. Of these blocks, 63% were ≤ 5% and 23% ≥ 10%
- 35% of patches internal to cutblock boundary; 61% on the edge of the cutblock; and 4% external and non-contiguous to the cutblock
- Invasive species were found on 38% of the cutblocks

3.2 *Percent Retention*

The overall percent retention of 16.6% (shown above) is an average considering the total amounts of patch retention, dispersed retention (as basal area equivalent) and the total gross area sampled. This average increases to 20.1% when the temporary retention (retention on cutblock that is likely to be harvested before rotation end) is considered. Close to half of the additional 3.5% of temporary retention came from four blocks with very large temporary patches (totaling 334 hectares). There was 1.1% of dispersed temporary retention and the remainder of the temporary retention came from smaller patches scattered over 15 blocks.

2 Dispersed retention area is given as basal area equivalent area (i.e., a scaling down of the actual dispersed area). It can be thought of as converting dispersed retention to equivalent amount of patch area retention. For example, if a dispersed area contains 20% of the pre-harvest basal area, then reduce the actual area by 80%. Because pre-harvest data did not exist, for comparison purposes we used the basal area from retention patches in the same biogeoclimatic subzone. If no retention patches were available, we used the average basal area for all other retention patches in the same biogeoclimatic subzone.

3 Retention is considered constrained for one or more of the following reasons: wet area, riparian management zone, riparian reserve zone, rock outcrop, non-commercial brush, non-merchantable timber, sensitive terrain or soil, ungulate winter range, wildlife habitat area, old-growth management area, recreation feature, visuals, cultural heritage feature.

4 Ecological anchors include features such as large hollow trees, large witches broom, active wildlife trails, and active feeding on wildlife trees.

5 Windthrow is not measured in strata that have no standing trees remaining.

Table 2 below shows the percentage of cutblocks and percentage of gross harvested area by retention category. Work by the Centre for Applied Conservation Research at the University of British Columbia (Huggard and Bunnell 2007) links percentage of stand-level retention to forest bird response. The researchers concluded that many less sensitive (to harvesting) bird species decrease below the 15–20% retention levels. Some stands with greater than 40% retention, (or larger landscape reserves,) are needed by sensitive (to harvesting) bird species.

Table 2. Distribution of retention levels in FREP-sampled cutblocks

% retention levels	No. cutblocks	% cutblocks	Gross area (ha)	% total area
0	78	12.0	1524	7.4
1-4	78	12.0	1674	8.2
5-9	125	19.2	4102	20.0
10-14	112	17.2	4307	21.0
15-19	79	12.1	3000	14.6
20-24	49	7.5	1695	8.3
25-29	34	5.2	1288	6.3
30-34	25	3.8	711	3.5
35-39	20	3.1	983	4.8
≥ 40	51	7.8	1225	6.0
Total	651	100	20509	100

Over 56% of the FREP-sampled gross area is from cutblocks with less than 15% retention. Almost 11% comes from cutblocks with 35% or more retention. Twelve percent of the cutblocks, representing 7.4% of the total sampled area, had no retention. Almost 8% of the cutblocks representing 6% of the area had 40% or more retention.

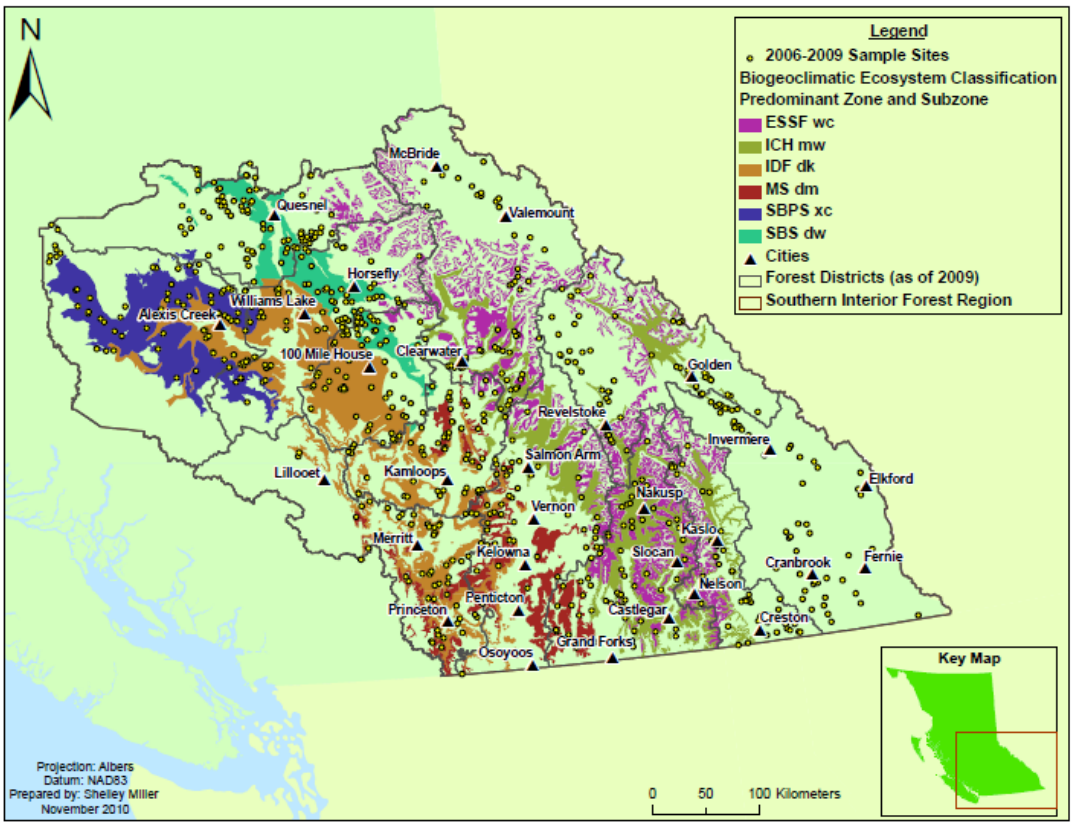

Figure 1. ***Southern Interior Forest Region stand-level biodiversity sample site locations 2006–2009 and predominant subzones. Data sources: Sample location data from FREP IMS and FREP staff; base mapping from the Land and Resource Data Warehouse***

4.0 DETAILED ASSESSMENT BY SUBZONE

4.1 *Interpreting the Cumulative Distribution Charts*

The following subsections show cumulative distribution charts comparing average cutblock indicators calculated from baseline data to the same indicators calculated from the sampled cutblocks. 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 resource stewardship monitoring sample data are presented separately (i.e., as two curves in each chart).

In general, a cumulative distribution retention curve equal to, or further to the right than the baseline curve, is good for biodiversity. If the retention curve is very similar to the baseline this may mean retention areas are being chosen that represent the pre-harvest condition for the indicator in question. If the retention curve is further to the right than the baseline, this may mean retention areas are being chosen that contain a higher density of the indicator in question than the pre-harvest condition. 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).

Results are presented separately for the predominant biogeoclimatic subzones with the most data, both sampled by FREP, and the cruise baseline). For subzone descriptions, please go to: http://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/subzones/index.html

4.2 *Biogeoclimatic Subzone Summary*

Table 3 gives an overall summary of key biodiversity indicators within the six predominant subzones. The tree and CWD indicators are given as a percentage of average from the full FREP-sampled dataset compared to the average from the baseline timber cruise data (for the tree indicators) or retention patch data (for the CWD indicators). A more comprehensive look at the subzones is given in sections 4.3 through 4.8.

Table 3. Summary of sampled biogeoclimatic subzones[a]

	Cutblock size (ha)		Retention (average)				Windthrow	Retention patch location in relation to harvest boundary (%)			Retention patches > 2 ha		Tree indicator average as percentage of average baseline			CWD average in harvest areas as % of average in retention patches	
Subzone (sample size)	Average	Maximum	Total (%)	Patch (%)	Dispersed (%)	% of cutblocks with retention[b]	Average (%)	Internal[c]	On edge[d]	External[e]	% of total number of retention patches	% of cutblocks with a > 2 ha patch	Large snags	Large trees	No. tree species	CWD volume per hectare	CWD large pieces per hectare
ESSFwc (32)	30	111	13.5	8.4	5.1	100	6.7	55	41	4	30	38	84.7	73.9	67.3	88.3	21.7
ICHmw (75)	25	174	11.3	9.7	1.6	77.4	6.5	43	55	2	25	25	66.4	72.4	57.8	91.5	45.0
IDFdk (89)	31	257	26.8	12.5	14.3	93.3	6.6	29	69	2	35	42	67.0	70.0	109.6	78.8	26.2
MSdm (40)	29	180	8.7	7	1.7	87.5	6.8	28	68	3	18	18	135.0	130.1	113.1	77.7	12.4
SBPSxc (35)	40	174	13.9	13	0.9	88.6	15.8	36	60	3	43	54	271.4	461.9[f]	135.8	101.0	4.4
SBSdw (44)	36	218	19.0	14.7	4.3	97.7	6.8	26	63	11	31	32	37.3	113.9	92.3	86.1	35.8

a For subzone descriptions please go to: http://www.for.gov.bc.ca/hre/becweb/resources/classificationreports/subzones/index.html

b Blocks with 0.5% or more retention

c The internal patches provide areas of cover within the harvest cutblock, potentially allowing more movement of small animals and easier recruitment of understory species throughout the cutblock.

d The edge patches may merge with forest cover outside of the cutblock, giving larger forested patches (even if temporarily); edge patches often supply more linear retention from riparian reserves, which can provide travel corridors.

e The external and non-contiguous retention patches are least preferred for stand-level biodiversity since there is little likelihood of providing direct ecologic benefits to the harvested area.

f A 40 cm dbh tree was the cut off for a large tree for the SBPS zone, however, note that this size of tree is fairly rare in this zone, showing up on only 25% of the cruise cutblocks, therefore the high percentage is actually only indicative of a high density of 40 cm trees on 25% of the FREP blocks

4.3 *Engelman Spruce-Subalpine Fir Wet Cold Subzone (ESSFwc)*

The ESSFwc data collected came predominantly from the Arrow-Boundary, Headwaters and Okanagan-Shuswap forest districts, representing the wc1, wc2 and wc4 variants. As noted in Table 3, retention was found in every cutblock and the average percent retention was 13.5%. This percent retention increases to 24.3% when the temporary retention (retention on block that is likely to be harvested prior to rotation end) is considered. However, the majority of the temporary retention comes from a single cutblock in the Headwaters forest district that had 79.2 hectares retained as temporary (of a total cutblock size of 111 hectares). Without this single large temporary patch, the percent retention would be 16.0%, with 0.5% coming from a single 4.5 ha temporary patch and 2% coming from two blocks with significant dispersed retention designated as temporary. Six plots were established in the temporary dispersed retention, but none in the patch retention. The addition of this temporary data resulted in a small increase in the density of large snags in the ESSF (average went from 85% to 86% of baseline average), but no change to the density of large trees or tree species.

4.3.1 Statistical analysis of ESSFwc indicators

Density of large dead trees (≥ 10 m tall and ≥ 30 cm dbh)

The average density of large snags found in the retention within the FREP-sampled cutblocks is 85% of that found in the cruise baseline. The main difference in these two populations, as seen in Figure 2, is the large percentage (50%) of the FREP-sampled cutblocks (retention) which had zero large snags found compared to about 12% of the cruise baseline cutblocks.

ESSFwc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	49	26.8	20.1	26.0	3.7
Retention	32	22.7	1.4	43.3	7.6

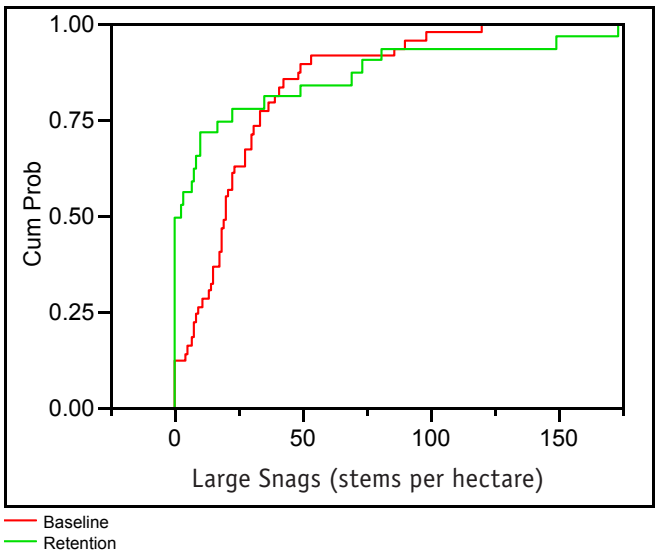

Figure 2. Cumulative probability for large snags in ESSFwc subzone.

K-S test: $D = 0.4401$ (maximum difference at 4 large snags per hectare), p-value = 0.001109. The p-value indicates a significant difference between these two curves. Compared to the cruise baseline, the FREP-sampled retention generally had a lower density of large snags.

Density of large trees (live and dead; ≥ 50 cm dbh)

The average density of large trees (50 cm or larger dbh, live and dead) found in the retention within the ESSFwc FREP-sampled cutblocks is 74% of that found in the cruise baseline. Figure 3 shows the largest difference in large tree density in the higher density range.

ESSFwc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	49	26.2	4.8	36.8	5.3
Retention	32	19.4	2.1	38.6	6.8

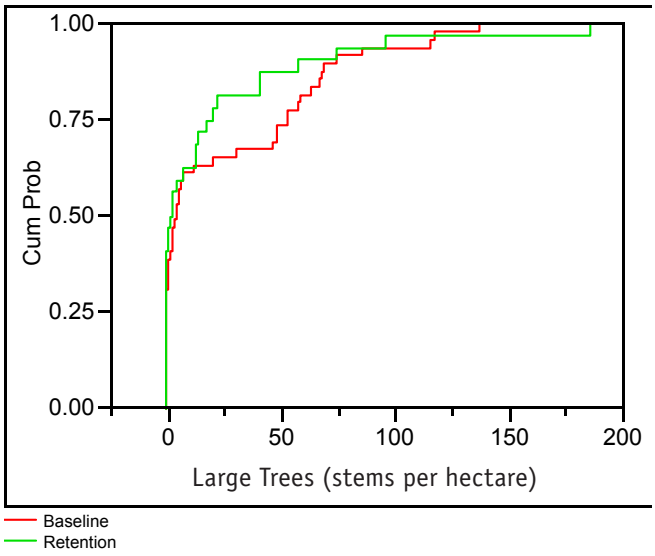

Figure 3. Cumulative probability for large tree density in the ESSFwc subzone.

K-S test: $D = 0.2015$ (maximum difference at 41 large trees per ha), p-value = 0.4114. The p-value indicates that there is not a significant difference between the two curves. Therefore, the FREP-sampled retention resembles the timber cruise in terms of density of large trees.

Number of tree species

The average number of tree species found in the retention within the ESSFwc FREP-sampled cutblocks is 67% of that found in the cruise baseline. Figure 4 shows that about 40% of the FREP-sampled cutblocks had three or more tree species found in the retention, compared to the cruise baseline which had about 85% of sampled cutblocks having three or more tree species found.

ESSFwc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	49	4.4	4.0	1.8	0.2
Retention	32	3.0	2.0	1.7	0.3

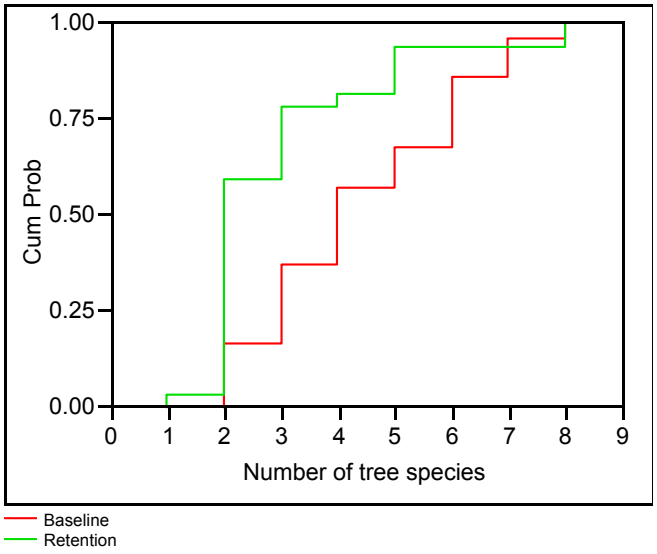

Figure 4. Cumulative probability for number of tree species in the ESSFwc subzone.

K-S test: $D = 0.4305$ (maximum difference at two tree species found per cutblock), p-value = 0.001531. The p-value indicates a significant difference between these two curves with the FREP-sampled retention having a lower density of tree species per cutblock compared to the cruise baseline.

Volume of CWD

The average volume per hectare of CWD found in the harvest areas within the ESSFwc FREP-sampled blocks is 88% of that found in the retention patches. Figure 5 shows the full dataset of ESSFwc blocks, with little difference in CWD volumes seen between the two curves.

ESSFwc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	27	163.0	145.8	110.8	21.3
Harvest	30	143.8	136.9	88.5	16.2

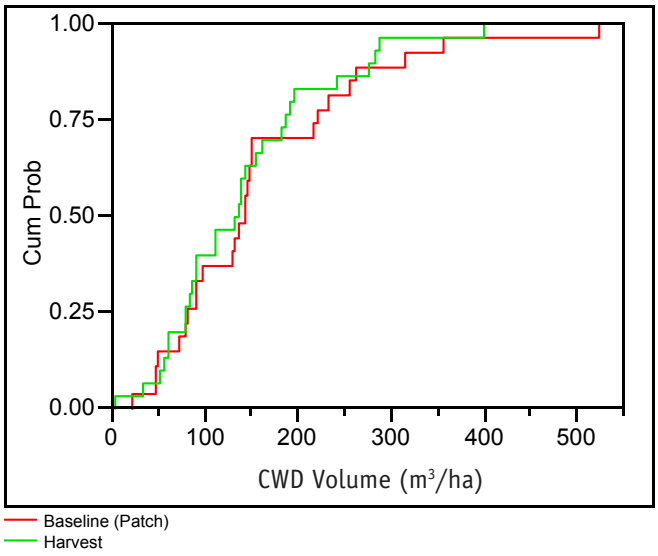

Figure 5. Cumulative probability for CWD volume in the ESSFwc subzone.

K-S test: D = 0.1519 (maximum difference at 144.4 m^3 per hectare of CWD volume), p-value = 0.8985. There is no significant difference between these two curves and the volume of CWD found on harvested sites is similar to the amount found within retention patches.

Density of big pieces of CWD (≥ 20cm diameter and ≥ 10 m long)

The average density per hectare of big CWD pieces found in the harvest areas within the ESSFwc FREP-sampled cutblocks is 22% of that found in the retention patches. Figure 6 shows about 55% of the harvest areas had no big pieces of CWD found compared to about 5% of the retention patches.

ESSFwc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	27	75.2	56.9	49.3	9.5
Harvest	30	16.3	0.0	30.1	5.5

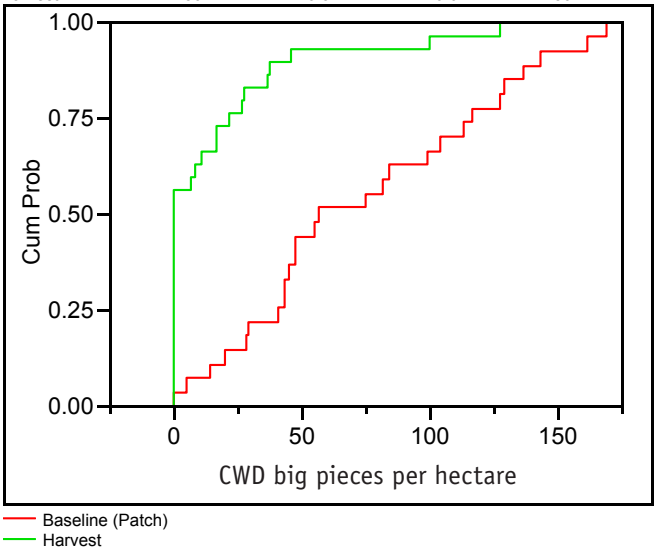

Figure 6. Cumulative probability for CWD big piece density in the ESSFwc subzone.

K-S test: D = 0.6852 (maximum value at 28 big pieces of CWD per ha), p-value=3.2×10^{-06}. There is a significant difference between these two curves with the density of large CWD pieces being lower in the harvested areas compared to within retention patches.

4.3.2 ESSFwc discussion

The ESSFwc subzone had retention within every cutblock. Average windthrow was 6.7%, and there was a good mixture of retention patch locations with about 54% of the retention patches internal to the harvest boundaries, 42% on the edge of the harvest boundary and 4% external and non-contiguous to the harvest boundary.

The average density of large snags was 85% of the timber cruise baseline average. This may be partly due to the 25% of FREP-sampled ESSFwc cutblocks which had less than 5% retention, potentially making it difficult to leave large retention areas capable of safely housing dangerous snags. The overall density of large trees in the FREP-sampled retention was not significantly different from that found in the baseline. The tree species diversity in the FREP-sampled retention was lower than the baseline with an average of 67% of that found in the baseline. About 60% of FREP-sampled cutblocks had only one or two tree species found, compared to just 15% of the baseline.

4.3.3 ESSFwc consideration

Continue practices of maintaining retention on every cutblock, having a good mix of retention patches location (internal to, and on the edge of, the harvest boundary), and, a good mix between patch retention and dispersed retention. Look for opportunities to retain more than two tree species on cutblocks. Increase the density of big CWD pieces left on cutblocks.

4.4 *Interior Cedar Hemlock Moist Warm Subzone (ICHmw)*

The ICHmw data collected came predominantly from the Arrow-Boundary, Headwaters, Kootenay Lake, Columbia and Okanagan-Shuswap forest districts, representing the mw1, mw2 and mw3 variants. As noted in Table 3, retention was found in 77% of the sampled cutblocks and the average percent retention was 11.3%. This percent retention increases to 19.6% when the temporary retention (retention on cutblock that is likely to be harvested before rotation end) is considered. However, the majority of the temporary retention comes from a single cutblock in the Okanagan-Shuswap forest district that had a 89.8 ha temporary patch, and a total cutblock size of 126 ha. Without this single large temporary patch, the percent retention would be 14.3%, with 0.5% coming from a single 4.5 ha temporary patch and 2% coming from two cutblocks with significant dispersed temporary retention. One plot was established in temporary dispersed retention and 8 plots were established in the temporary patch retention. The addition of this temporary retention data resulted in a small increase in the density of large snags (average went from 66 to 67% of the baseline average) and large trees (average went from 72 to 77% of the baseline average), but no change to the average number of tree species.

4.4.1 Statistical analysis of ICHmw indicators

Density of large dead trees (≥ 10 m tall and ≥ 30 cm dbh)

The average density of large snags found in the retention within the ICHmw FREP-sampled cutblocks is 66% of that found in the cruise baseline. The main difference in these two populations is the large percentage (40%) of the FREP-sampled cutblocks (retention) which had zero large snags found, compared to about 5% of the cruise baseline cutblocks. Figure 7 shows the 63 cutblocks of the total sampled 75 ICHmw cutblocks that contained retention.

ICHmw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	268	28.5	23.8	23.8	1.4
Retention	63	18.9	0.6	34.2	4.3

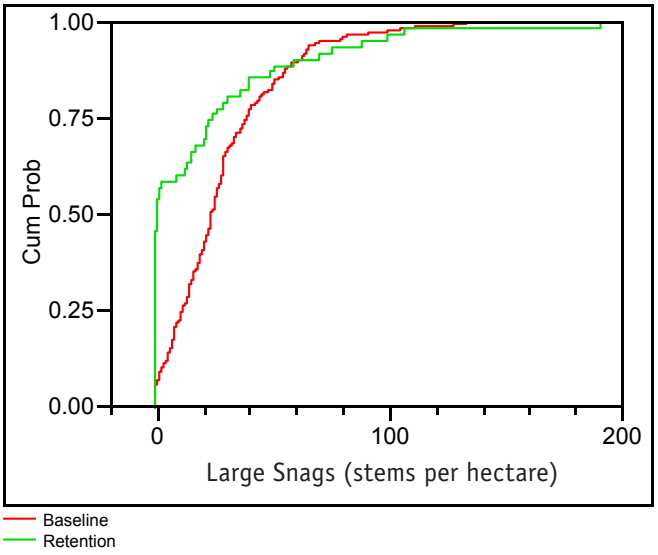

Figure 7. Cumulative probability for large snag density in the ICHmw subzone

K-S test: $D = 0.4893$ (maximum difference at one large snag per ha), p-value = 4.9×10^{-11}. There is a significant difference between these two curves with the FREP-sampled retention having an overall lower density of large snags compared to the cruise baseline.

Density of large trees (live and dead; ≥ 50 cm dbh)

The average density of large trees found in the retention within the ICHmw FREP sampled blocks is 72% of that found in the cruise baseline. Figure 8 shows the 63 cutblocks of the total sampled 75 ICHmw cutblocks that contained retention.

ICHmw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	268	28.2	17.6	33.1	2.0
Retention	63	20.4	6.1	32.1	4.0

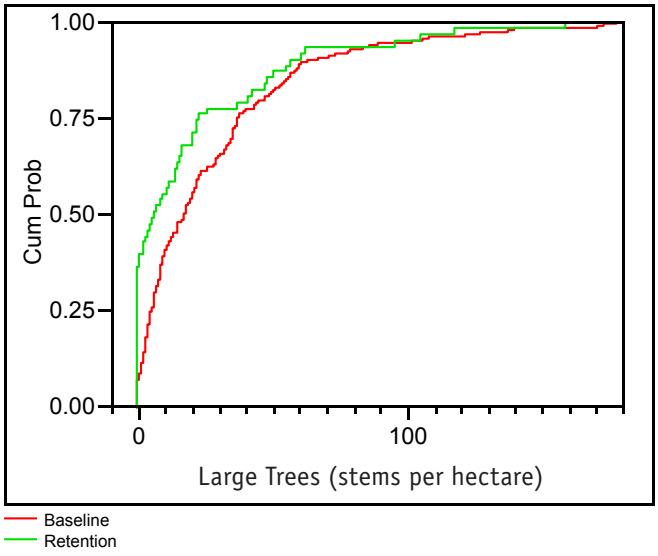

Figure 8. Cumulative probability for large tree density in the ICHmw subzone.

K-S test: D = 0.3138 (maximum difference at zero stems per ha of large trees), p-value = 8.7×10^{-05}. There is a significant difference between these two populations with the FREP-sampled retention having an overall lower density of large trees compared to the cruise baseline.

Number of tree species

The average number of tree species found in the retention within the ICHmw FREP-sampled cutblocks is 58% of that found in the cruise baseline. Figure 9 shows the complete data set with cutblocks with zero tree retention having zero number of species. Sixteen percent of the sampled ICHmw cutblocks contained no trees, accounting for the cutblocks with zero tree species in Figure 9.

ICHmw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	268	6.8	7.0	1.8	0.1
Retention	74	3.9	4.0	2.5	0.3

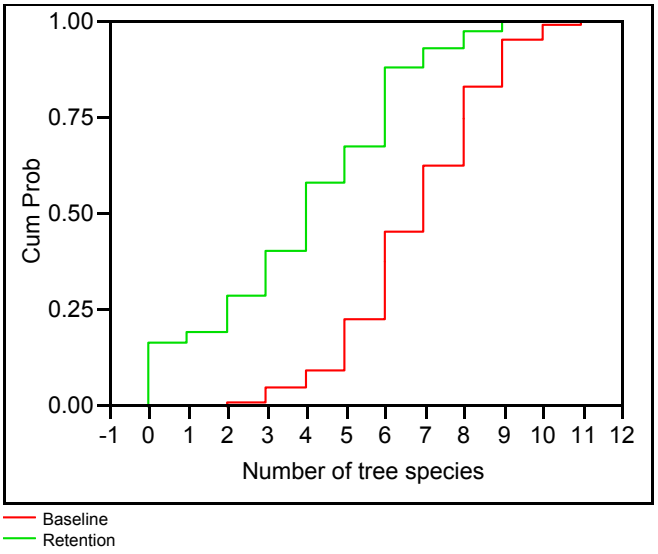

Figure 9. Cumulative probability for number of tree species in the ICHmw subzone.

K-S test: D = 0.4915 (maximum difference at four tree species found per block), p-value=1.4×10^{-12}. There is therefore a significant difference between these two curves with the FREP-sampled retention having fewer tree species compared to the cruise baseline.

Volume of CWD

The average volume per hectare of CWD found in the harvest areas within the ICHmw FREP-sampled cutblocks is 92% of that found in the retention patches. Forty-four of the 75 FREP-sampled cutblocks contained retention patches and therefore had data on CWD within patches. Figure 10 shows very similar curves from the two datasets.

Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	44	156.8	122.7	140.8	21.2
Harvest	75	143.5	136.2	85.0	9.8

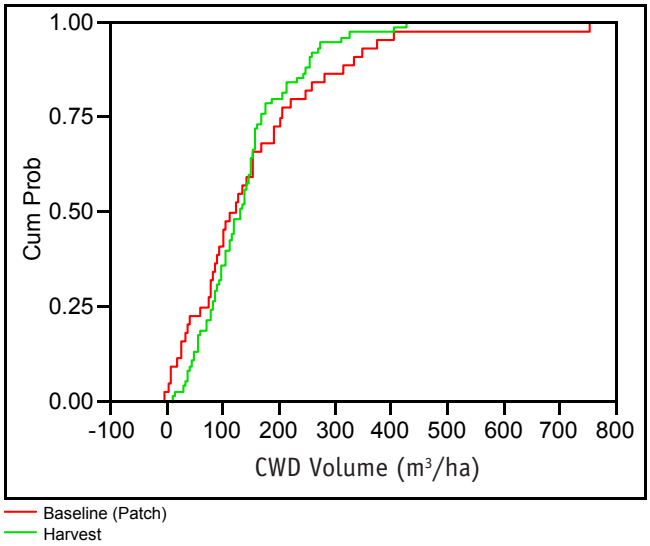

Figure 10. Cumulative probability for CWD volume in the ICHmw subzone

K-S test: $D = 0.1473$ (maximum difference at 44 m^3 per hectare of CWD volume), p-value = 0.5844. There is not a significant difference in the two data curves for this indicator.

Density of big pieces of CWD (≥ 20 cm diameter and ≥ 10 m long)

The average density per ha of big CWD pieces found in the harvest areas within the ICHmw FREP-sampled cutblocks is 45% of that found in the retention patches. Figure 11 shows a higher density of big CWD pieces in the retention patches compared to the harvest areas.

ICHmw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	44	53.8	45.2	53.4	8.0
Harvest	75	24.2	14.0	27.8	3.2

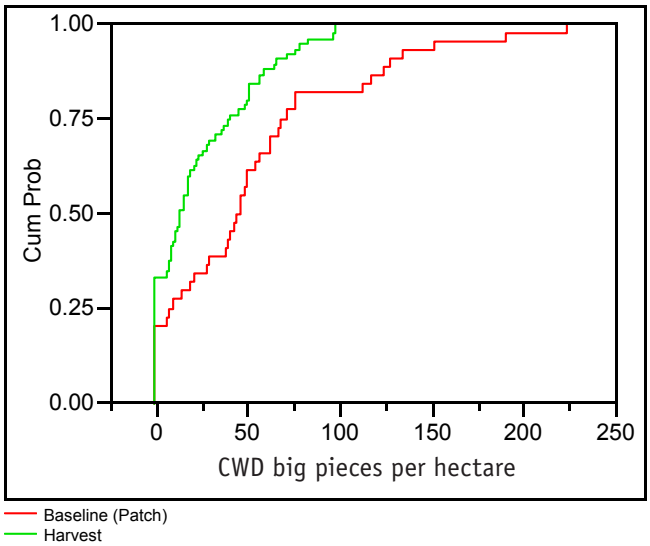

Figure 11. Cumulative probability for CWD big piece density in the ICHmw subzone.

K-S test: $D = 0.3391$ (maximum difference at 28 big pieces of CWD per ha), p-value = 0.0034. There is a significant difference between these two curves with the harvested areas overall having a lower density of big CWD pieces.

4.2.2 ICHmw discussion

The ICHmw subzone had retention on 77% of cutblocks. Therefore 23% of the FREP-sampled cutblocks and 21% of the total gross area of sampled cutblocks had minimal or no retention. Average windthrow was 6.5% of the area retained.

The average density of large snags was low, at 66% of the cruise baseline average. The average density of large trees decreased from that found in the baseline (72%). Overall, the tree species diversity is lower in the FREP-sampled retention compared to the cruise baseline. The density of big CWD pieces on the harvested ICHmw areas is 45% of what is found in the ICHmw retention patches. This, along with the 1.6% (on average) of dispersed retention (recruitment CWD), and the CWD volume, is the best contribution to the CWD quality indicator of any of the six Southern Interior Forest Region subzones reported here.

4.4.3 ICHmw consideration

Continue maintaining big CWD pieces on most cutblocks. Increase the percentage of harvested cutblocks with retention, retaining as wide a variety of tree species as possible.

4.5 *Interior Douglas-fir Dry Cool Subzone (IDFdk)*

The IDFdk data collected came predominantly from the Chilcotin, Cascades, Kamloops and 100 Mile forest districts, representing the dk1, dk2, dk3 and dk4 variants. As noted in Table 3, retention was found in 93% of the cutblocks and the average percent retention was 26.8%, with more than half of the retention coming from dispersed trees rather than patches. This percent retention increases to 28.0% when the temporary retention (retention on cutblock that is likely to be harvested prior to rotation end) is considered. This came from about 43 ha of dispersed temporary retention found in four cutblocks and, 5.5 ha of temporary retention patches over two cutblocks. There were 12 plots established in the dispersed temporary retention and one plot established in the temporary patch retention. The addition of this data resulted in no change to the average large snag density or average number of tree species, but a small increase in the density of large trees (average went from 70 to 75% of the average found in the baseline).

4.5.1 Statistical analysis of IDFdk

Density of large dead trees (≥ 10 m tall and ≥ 30 cm dbh)

The average density of large snags found in the retention within the IDFdk FREP-sampled cutblocks is 67% of that found in the cruise baseline. Figure 12 shows a higher percentage of the FREP-sampled cutblocks with no large snags found compared to the cruise baseline.

IDFdk: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	181	13.8	6.9	18.5	1.4
Retention	89	9.2	0.0	19.5	2.1

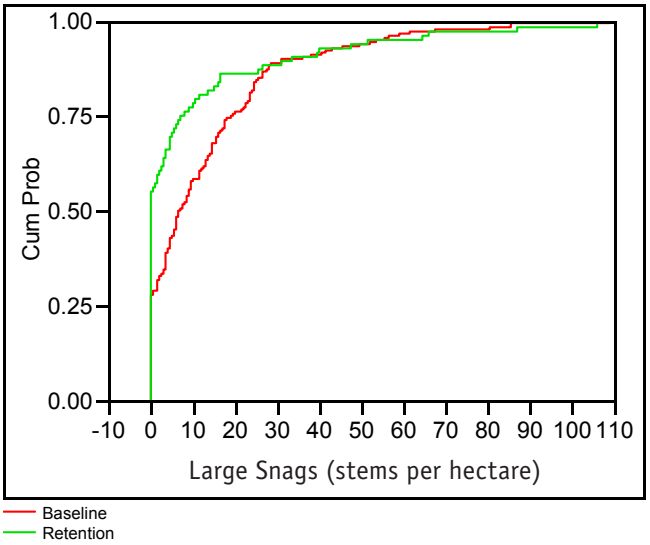

Figure 12. Cumulative probability for large snag diversity in the IDFdk subzone.

K-S test: D = 0.2924 (maximum difference at three large snags per hectare), p-value = 7.4×10^{-05}. There is a significant difference in these two curves with the FREP-sampled retention having an overall lower density of large snags.

Density of large trees (live and dead; ≥ 40 cm dbh)

The average density of big trees found in the retention within the IDFdk FREP-sampled cutblocks is 70% of that found in the cruise baseline. Figure 13 shows that for the first 75% of the data, in terms of increasing densities of large trees, the baseline curve and the FREP-sampled retention curve are nearly identical.

IDFdk: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	181	27.7	9.1	42.3	3.1
Retention	89	19.4	12.6	22.8	2.4

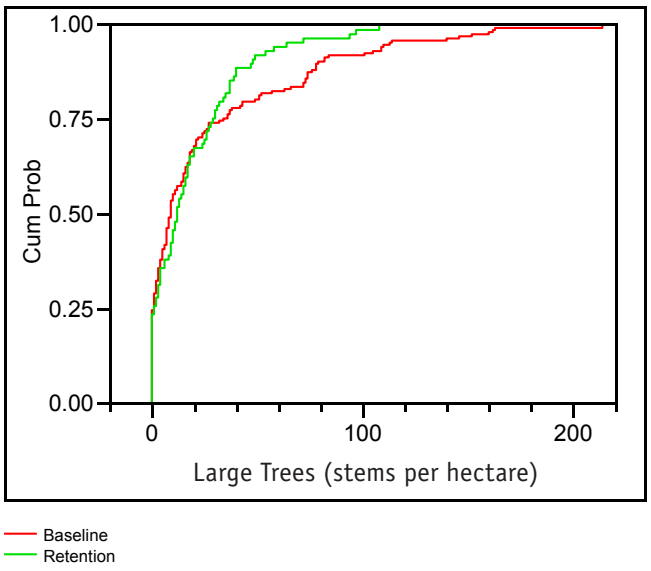

Figure 13. Cumulative probability for big tree density in the IDFdk subzone.

K-S test: $D = 0.1263$ (maximum difference at 64 large trees per hectare), p-value = 0.2969. There is not a significant difference between these two curves.

Number of tree species

The average number of tree species found in the retention within the IDFdk FREP-sampled cutblocks is 110% of that found in the cruise baseline. Figure 14 shows the complete data set with cutblocks with zero tree retention having zero number of species. Two percent of the FREP-sampled ICHmw cutblocks contained no trees, accounting for the cutblocks with zero tree species in Figure 14.

IDFdk: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	181	2.9	3.0	1.2	0.1
Retention	89	3.2	3.0	1.4	0.2

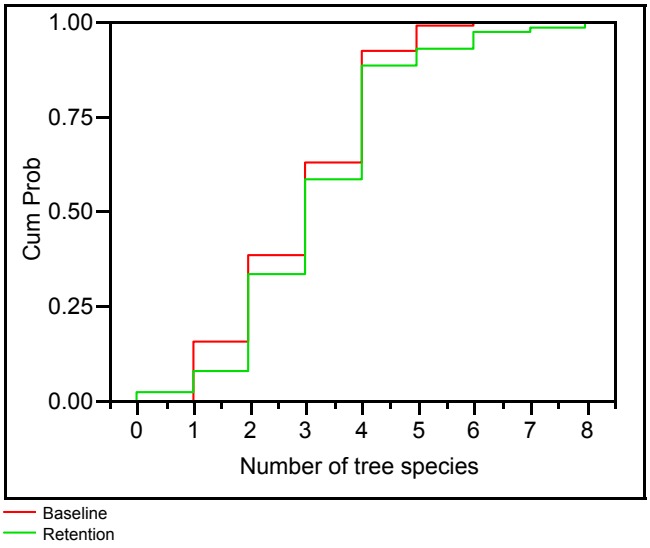

Figure 14. Cumulative probability for number of tree species in the IDFdk subzone.

K-S test: $D = 0.0816$ (maximum difference at one tree species found per cutblock), p-value = 0.8222. There is no significant difference between these two curves indicating that mature tree species diversity is being maintained in the retention areas.

Volume of CWD

The average volume per hectare of CWD found in the harvest areas within the IDFdk FREP-sampled cublocks is 79% of that found in the retention patches. Sixty of the FREP-sampled cutblocks contained retention patches and therefore had data on CWD within patches. CWD data in the harvest area was missing on four cutblocks. Figure 15 shows the CWD volume data very similar between the two datasets.

IDFdk: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	60	81.2	69.0	64.4	8.3
Harvest	85	64.0	57.7	36.8	4.0

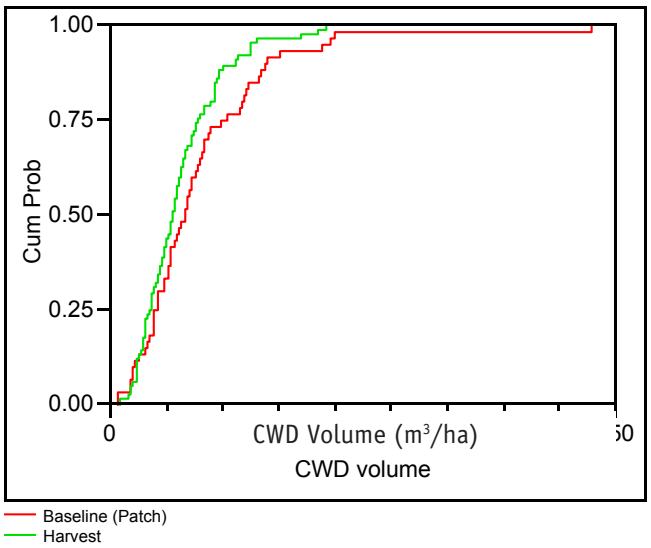

Figure 15. Cumulative probability for CWD volume in the IDFdk subzone.

K-S test: D = 0.1755 (maximum difference at 68.6 m^3 of CWD volume per ha), p-value = 0.2288. There is not a significant difference between these two curves. Comparable volume of CWD is being maintained on post-harvest sites compared to the CWD within retention patches.

Density of big pieces of CWD (≥ 20 cm diameter and ≥ 10 m long)

The average density per hectare of big CWD pieces found in the harvest areas within the IDFdk FREP-sampled cutblocks is 26% of that found in the retention patches. Figure 16 shows that about 60% of the harvest data had no big CWD found.

IDFdk: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	60	28.6	20.1	38.6	5.0
Harvest	85	7.5	0.0	12.4	1.4

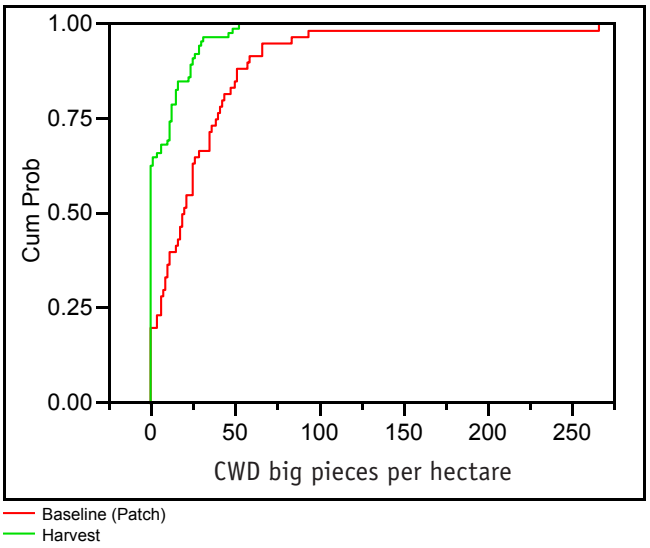

Figure 16. Cumulative probability for CWD big piece density in the IDFdk subzone.

K-S test: D = 0.4471 (maximum difference at two big pieces of CWD per hectare), p-value = 1.6×10^{-06}. There is a significant difference between these two curves, with a lower density of big CWD pieces found in the harvested areas compared to retention patches.

4.5.2 IDFdk discussion

Retention in the IDFdk (26.8%) is the highest of the six southern interior subzones presented in this report. This is largely due to the high amount of dispersed retention (14.3%). The IDFdk subzone had retention on 93% of cutblocks. Of the seven percent of FREP-sampled cutblocks that had zero retention, half of those had a small amount of retention maintained, but were rounded to zero. Average windthrow was 6.6%.

The average density of large snags was 67% of the baseline average. The overall density of large trees was not significantly different in the FREP-sampled retention compared to the baseline. The number of tree species found on average in the FREP-sampled retention is 110% of the cruise baseline, indicating comparable tree species diversity being maintained in retention patches compared to the timber cruise. The density of big CWD pieces on the harvested ICHmw areas is significantly lower at 26% of what is found in the IDFdk retention patches. However this 26% is supplemented with CWD recruitment coming from the high percentage of dispersed retention on the cutblock.

4.5.3 IDFdk consideration

Continue maintenance of the full diversity of tree species within retention areas, comparable densities of large trees and, retention on over 93% of the cutblocks. Look for opportunities to increase the densities of large snags in the retention areas. Increase density of big pieces of CWD in harvested areas.

4.6 *Montane Spruce Dry Mild Subzone (MSdm)*

The MSdm data collected came predominantly from the Cascades, Kamloops and Okanagan-Shuswap forest districts, representing the dm1 and dm2 variants. As noted in Table 3, retention was found in 88% of the cutblocks and the average percent retention was 8.7%. There was no temporary retention noted in the MSdm.

4.6.1 Statistical analysis of MSdm indicators

Density of large dead trees (≥ 10 m tall and ≥ 30 cm dbh)

The average density of large snags found in the retention within the MSdm FREP-sampled cutblocks is 135% of that found in the cruise baseline. Figure 17 shows the 38 cutblocks of the total sampled 40 MSdm cutblocks that contained retention.

MSdm: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	168	15.6	9.9	20.0	1.5
Retention	38	21.0	1.2	39.0	6.3

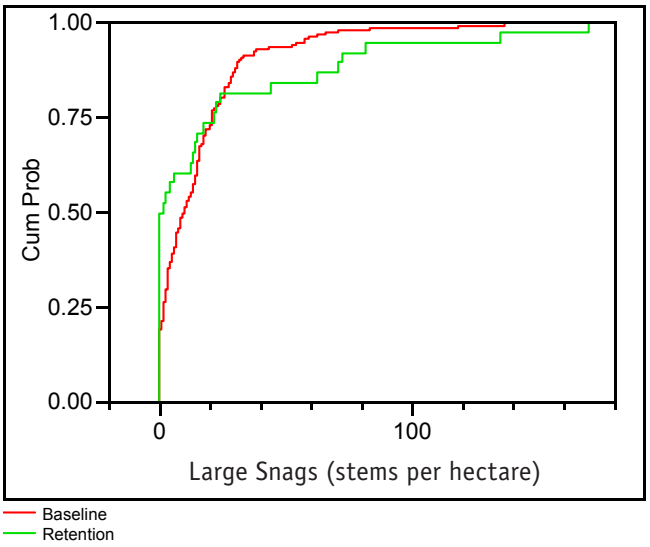

Figure 17. Cumulative probability for large snag density in the MSdm subzone.

K-S test: $D = 0.2917$ (maximum difference at 1 large snag per hectare), p-value = 0.01026. The p-value indicates a significant difference in these two curves, though it is split with 75% of the FREP-sampled retention having overall lower densities of large snags, and 25% having overall higher densities compared to the cruise baseline.

Density of large trees (live and dead; ≥ 40 cm dbh)

The average density of large trees found in the retention within the MSdm FREP-sampled cublocks is 130% of that found in the cruise baseline. The main difference in these two populations as seen in Figure 18 is in the upper quartile (top 25% considering density of large trees) of the two populations of large trees, where the FREP-sampled retention has a higher density. Figure 18 shows the 38 cutblocks of the total sampled 40 MSdm cutblocks that contained retention.

MSdm: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	168	29.3	17.4	39.5	3.0
Retention	38	38.1	8.5	66.9	10.8

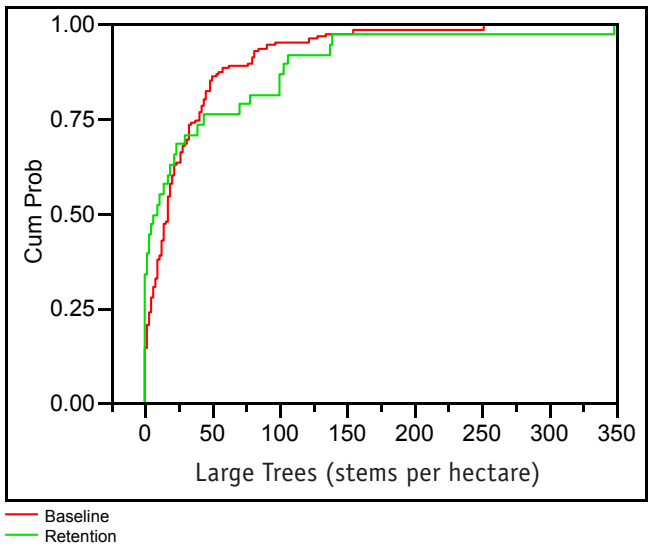

Figure 18. Cumulative probability for large tree density in the MSdm subzone.

K-S test: $D = 0.2281$ (maximum difference at two large trees per hectare), p-value = 0.07959. There is a marginally significant difference between these two curves, with an overall higher density of large trees in the FREP-sampled retention compared to the cruise baseline.

Number of tree species

The average number of tree species found in the retention within the MSdm FREP-sampled cutblocks is 113% of that found in the cruise baseline. Figure 19 shows the complete data set with cutblocks with zero tree retention having zero number of species. Five percent of the FREP-sampled MSdm cutblocks contained no trees, accounting for the cutblocks with zero tree species seen in Figure 19.

MSdm: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	168	3.6	4.0	1.2	0.1
Retention	40	4.1	4.0	2.1	0.3

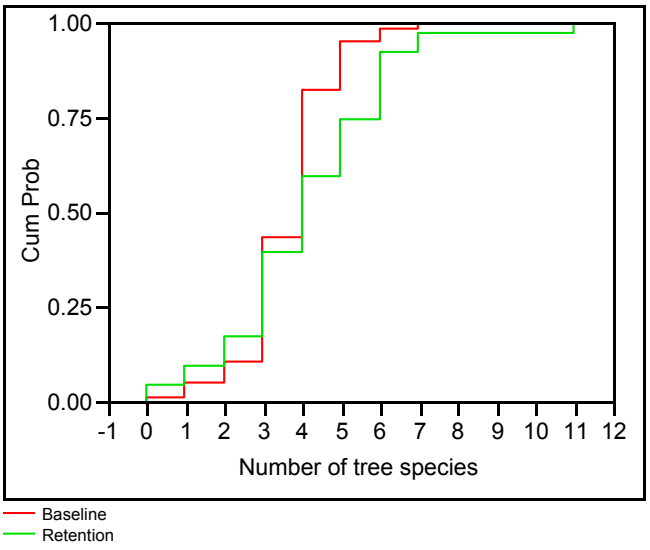

Figure 19. Cumulative probability for number of tree species in the MSdm subzone.

K-S test: $D = 0.2274$ (maximum difference at 4 species found per block), p-value = 0.07082. The p-value indicates a marginally significant difference between these two curves with an overall increase in the mature tree species diversity in the FREP-sampled retention compared to the baseline.

Volume of CWD

The average volume per hectare of CWD found in the harvest areas within the MSdm FREP-sampled cutblocks is 78% of that found in the retention patches. Twenty-eight of the 40 MSdm FREP-sampled cutblocks had retention patches and therefore data on CWD within the patches as seen in figure 20.

MSdm: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	28	147.5	127.3	118.5	22.4
Harvest	40	114.6	103.3	67.6	10.7

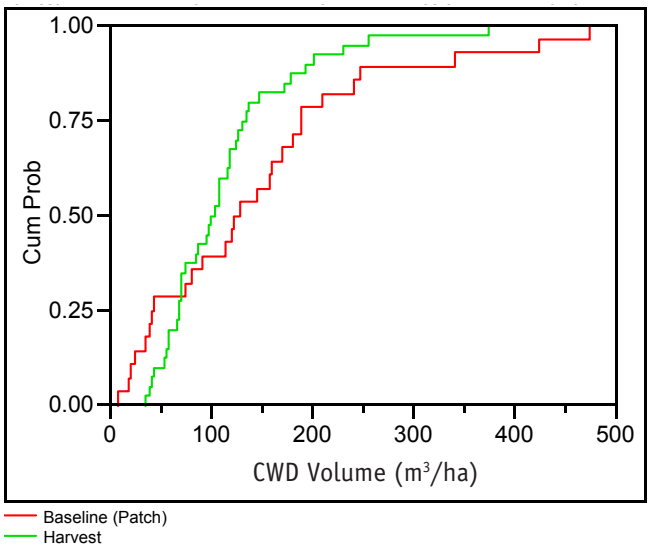

Figure 20. Cumulative probability for CWD volume in the MSdm subzone.

K-S test: $D = 0.2643$ (maximum difference at 139.3 m^3 of CWD per hectare), p-value = 0.2001. There is not a significant difference between these two curves.

Density of big pieces of CWD (≥ 20 cm diameter and ≥ 10 m long)

The average density per hectare of big CWD pieces found in the harvest areas within the MSdm FREP-sampled cutblocks is 12% of that found in the retention patches. Figure 21 shows the harvested areas overall have a much lower density of large CWD pieces than that found in the retention patches. In particular, the harvest data had no big CWD pieces found on about 60% of the cutblocks.

MSdm: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	28	68.6	53.2	71.6	13.5
Harvest	40	8.5	0.0	16.5	2.6

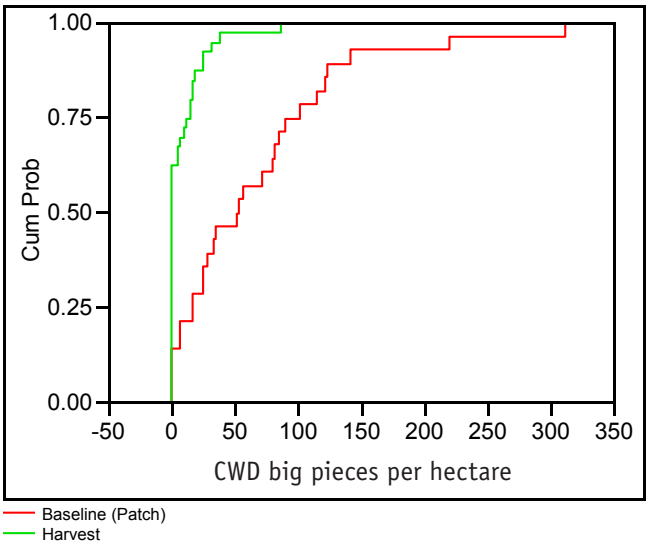

Figure 21. Cumulative probability for CWD big piece density in the MSdm subzone.

K-S test: $D = 0.5893$ (maximum difference at 20 big pieces of CWD per hectare), p-value = 2.2×10^{-05}. There is a significant difference in these two curves with the harvested areas having a lower density of big pieces of CWD compared to that found in retention patches.

4.6.2 MSdm discussion

Retention is lowest in the MSdm (8.7%) of the six predominant Southern Interior Forest Region subzones. This subzone also has the lowest percent of large (> 2 ha) retention patches. However, this is counteracted by high quality of the retention in terms of equivalent or slightly higher densities of large snags and large trees in the retention areas compared to the cruise baseline. The MSdm subzone had retention on 88% of cutblocks. Of the 12% of sampled cutblocks that had zero retention, more than half of those had a small amount of retention maintained, but were rounded to zero. Average windthrow was 6.8%.

The density of big CWD pieces on the harvested ICHmw areas is 12.4% of what is found in the ICHmw retention patches.

4.6.3 MSdm Consideration

Continue practice of maintaining retention areas with good densities of large snags, large trees and the full diversity of tree species. Continuous improvement opportunities include leaving some level of retention on every cutblock and where possible, leaving larger retention patches. Opportunities to increase the densities of big pieces of CWD within the harvest areas also exist.

4.7 *Sub-Boreal Pine Spruce Very Dry Cold Subzone (SBPSxc)*

Subzone description: The SBPSxc data collected came from the Central Caribou and the Chilcotin forest districts. As noted in Table 3, retention was found in 89% of the cutblocks and the average percent retention was 13.9%. There was no temporary retention noted in the SBPSxc subzone.

4.7.1 Statistical analysis of SBPSxc indicators

Density of large dead trees (≥ 10 metres tall and ≥ 30 cm dbh - SBPSxc)

The average density of large snags found in the retention within the SBPSxc FREP-sampled cutblocks is 271% of that found in the cruise baseline. Large snags are relatively rare in this ecosystem, showing up in only about 50% of the data (retention or baseline). Figure 22 shows the 32 cutblocks of the total sampled 35 SBPSxc cutblocks that contained retention.

SBPSxc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	136	5.7	0.0	9.3	0.8
Retention	32	15.4	0.0	35.9	6.3

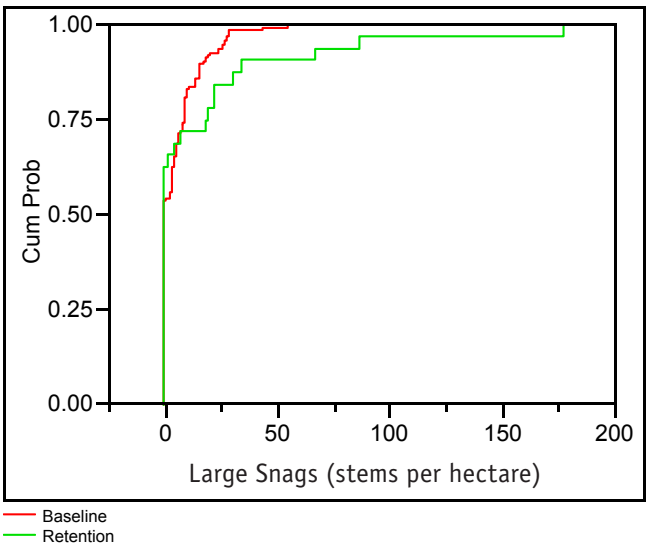

Figure 22. Cumulative probability for large snag density in the SBPSxc subzone.

K-S test: D = 0.1857 (maximum difference at 18 large snags per hectare), p-value = 0.3337. There is no significant difference between these two curves.

Density of large trees (live and dead; ≥ 40 cm dbh)

The average density of large trees found in the retention within the SBPSxc FREP-sampled cutblocks is 462% of that found in the cruise baseline. A 40 cm diameter tree is rare in both the cruise baseline cutblocks, and the FREP-sampled retention. This is seen in Figure 23 since both populations have approximately 75% of their sampled cutblocks with zero big trees found. Figure 23 shows the 32 blocks of the total sampled 35 SBPSxc cutblocks that contained retention.

SBPSxc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	136	1.1	0.0	2.7	0.2
Retention	32	5.3	0.0	14.8	2.6

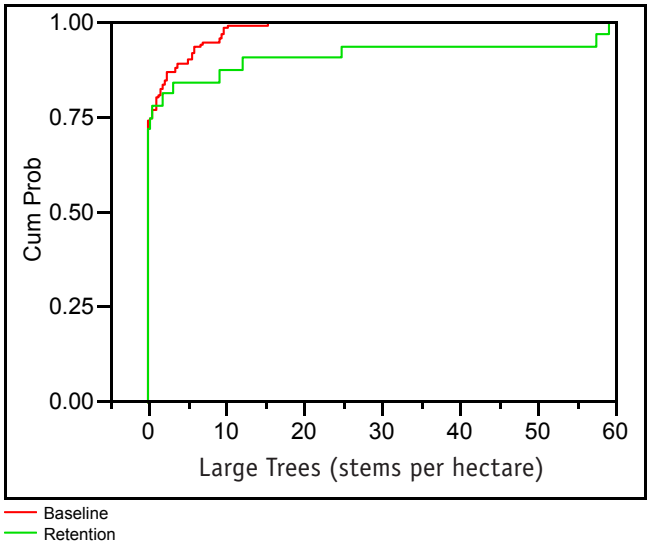

Figure 23. Cumulative probability for large tree density in the SBPSxc subzone.

K-S test: D = 0.1176 (maximum difference at 10 large trees per hectare), p-value = 0.8659.

There is no significant difference between these two curves.

Number of tree species

The average number of tree species found in the retention within the SBPSxc is 128% of that found in the baseline cruise. Figure 24 shows the complete data set with cutblocks with zero tree retention having zero number of species. Nine percent of the FREP-sampled SBPSxc cutblocks contained no trees, accounting for the cutblocks with zero tree species in the chart.

Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	136	1.4	1.0	0.5	0.0
Retention	35	1.8	2.0	1.0	0.2

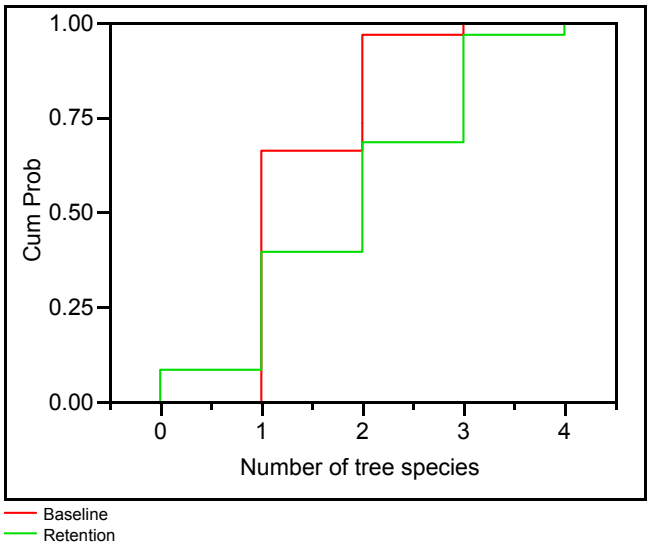

Figure 24. Cumulative probability for number of tree species in the SBPCxc subzone.

K-S test: D = 0.2849 (maximum difference at 2 tree species found per cutblock), p-value = 0.02182. There is a significant difference between these two curves with a higher tree species diversity found in the FREP-sampled retention compared to the cruise baseline.

Volume of CWD

The average volume per hectare of CWD found in the harvest areas within the SBPSxc FREP-sampled cutblocks is 101% of that found in the retention patches. Twenty-seven of the 35 FREP-sampled SBPSxc cutblocks contained patch retention and therefore had data on CWD within retention patches. Figure 25 shows very similar data between the two data curves.

SBPSxc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	27	51.5	41.0	56.5	10.9
Harvest	35	52.0	44.2	35.0	5.9

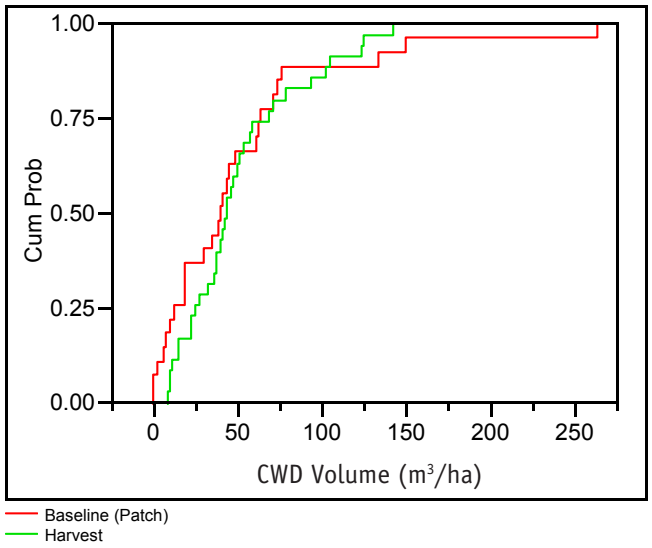

Figure 25. Cumulative probability for CWD volume in the SBPCxc subzone.

K-S test: D = 0.1989 (maximum difference at 19.6 m^3 per hectare of CWD volume), p-value = 0.5825 There is no significant difference between these two curves indicating CWD volume is being maintained in comparable amounts on the post-harvest sites as within the retention patches.

Density of big pieces of CWD (≥ 20 cm diameter and ≥ 10 m long)

The average density per hectare of big CWD pieces found in the harvest areas within the SBPSxc FREP-sampled cutblocks is 4% of that found in the retention patches. The harvested areas overall have a much lower density of large CWD pieces than the retention patches. In particular, figure 26 shows.that over 85% of the harvest data had no big pieces of CWD found.

SBPSxc: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	27	28.2	15.2	39.0	7.5
Harvest	35	1.2	0.0	4.0	0.7

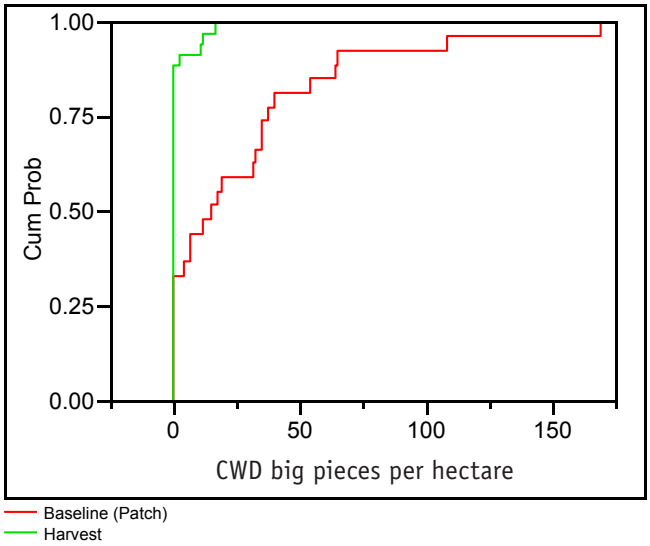

Figure 26. Cumulative probability for CWD big piece density in the SBPCxc subzone.

K-S test: D = 0.581 (maximum difference at 3 big pieces of CWD per hectare), p-value = 6.8×10^{-05}. There is a significant difference between these two curves with very little density of big CWD pieces found in the harvested areas compared to the retention patches.

4.7.2 SBPSxc discussion

Average retention in the SBPSxc is 13.9%, and retention is present on 88% of the FREP-sampled cutblocks. The large snag and big tree sizes used are undoubtedly a stretch for this subzone. Trees of 40 cm dbh are a rare element in this subzone, showing up on only 25% of the cruise cutblocks. However, the high densities of these found on the top 25% of the FREP-sampled cutblocks (in terms of density of the indicator) may indicate that there is a "bias" towards selecting retention areas of larger trees where these trees exist, though this data does not show up as significant in the statistical test. Tree species diversity is increased within the FREP-sampled retention compared to the cruise baseline. Average windthrow was 15.8%; a higher average than any of the other six predominant Southern Interior Forest Region subzones.

The CWD volume on the harvested areas is comparable to that found in the retention patches however, the density of big CWD pieces on the harvested SBPSxc areas is 4.4% of what is found in the ICHmw retention patches.

4.7.3 SBPSxc consideration

Continue practices of maintaining retention areas with comparable or somewhat higher densities of large snags and big trees (where they exist) and the full diversity of tree species. Continuous improvement opportunities are to increase the densities of big pieces of CWD within the harvest areas and to manage windthrow where possible.

4.8 *Sub-Boreal Spruce Dry Warm Subzone (SBSdw)*

The SBSdw data collected came predominantly from the Central Cariboo, 100 Mile, and Quesnel forest districts. As noted in Table 3, retention was found in 98% of the cutblocks and the average percent retention was 19.0%. This percent retention increases to 19.4% when the temporary retention (retention on cutblock that is likely to be harvested prior to rotation end) is considered. This temporary retention was found in two cutblocks with about 14 hectares of temporary dispersed retention between the two of them. There were 6 plots established in this temporary dispersed retention. The addition of this data resulted in a small increase in the average density of large snags (average went from 37 to 38% of the average from the baseline), and large trees (average went from 114 to 115% of the baseline average), but no change in the average number of tree species retained.

4.8.1 Statistical analysis of SBSdw indicators

Density of large dead trees (≥ 10 m tall and ≥ 30 cm dbh)

The average density of large snags found in the retention within the SBSdw FREP-sampled cutblocks is 37% of that found in the cruise baseline. The main difference in these two populations as seen in Figure 27 is the greater percentage (52%) of the FREP-sampled cutblocks (retention) which had zero large snags found, compared to about 8% of the cruise baseline cutblocks. Figure 27 shows all 44 cutblocks of the FREP-sampled in the SBSdw cutblocks which all contained some level of retention (2 cutblocks had <0.5% retention).

SBSdw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	291	42.5	33.0	38.3	2.2
Retention	44	15.8	0.0	29.5	4.4

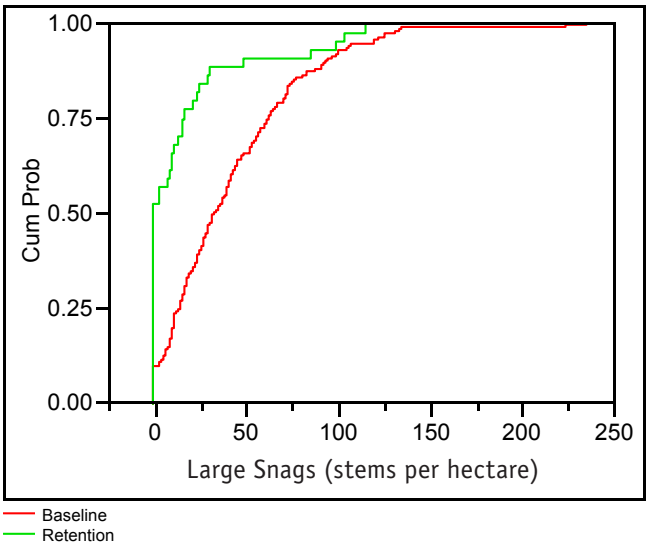

*Figure 27. **Cumulative probability for large snag density in the SBSdw subzone.***

K-S test: $D = 0.4634$ (maximum difference at 17 large snags per hectare), p-value = 1.5×10^{-07}. There is a significant difference in these two curves with the FREP-sampled retention having overall lower densities of large snags.

Density of large trees (live and dead ≥ 40 cm dbh)

The average density of large trees found in the retention within the SBSdw FREP-sampled cutblocks is 114% of that found in the cruise baseline. Figure 28 shows that all 44 FREP- sampled cutblocks in the SBSdw contained some level of retention (2 cutblocks had <0.5% retention).

SBSdw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	291	18.3	9.6	28.2	1.6
Retention	44	20.8	11.8	25.6	3.9

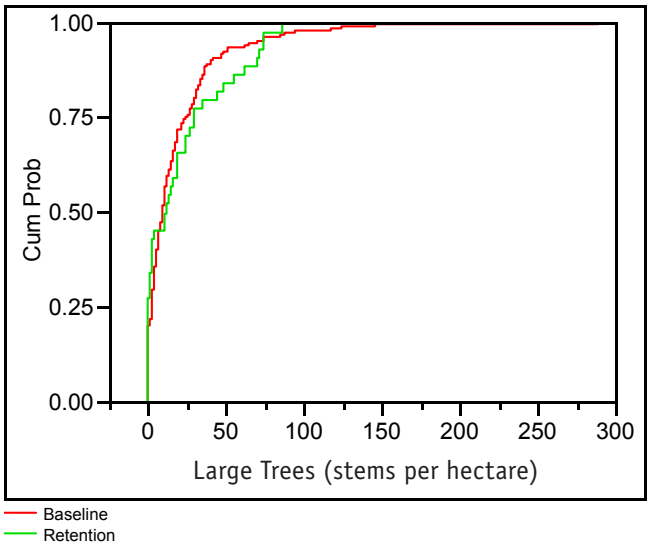

Figure 28. Cumulative probability for large tree density in the SBSdw subzone.

K-S test: D = 0.1313 (maximum difference at one large tree per hectare), p-value = 0.5253. There is not a significant difference between these two curves.

Number of tree species

The average number of tree species found in the retention within the SBSdw FREP-sampled cutblocks is 92% of that found in the cruise baseline. Figure 29 shows the complete data set with cutblocks with zero tree retention having zero number of species. All the SBSdw cutblocks contained some trees.

SBSdw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline	291	3.8	4.0	1.4	0.1
Retention	44	3.5	3.5	1.5	0.2

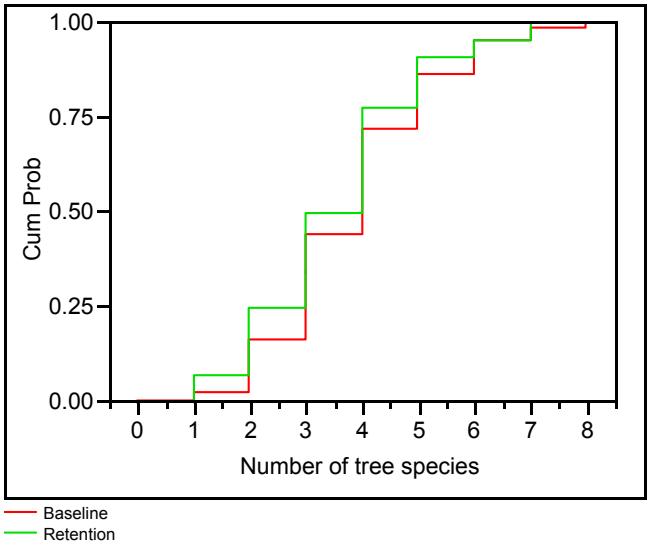

Figure 29. Cumulative probability for number of tree species in the SBSdw subzone.

K-S test: D = 0.0851 (maximum difference is at two tree species found per block), p-value = 0.945. There is not a significant difference between these two curves which indicates that mature tree species diversity is being maintained in the retained areas compared to the baseline.

Volume of CWD

The average volume per hectare of CWD found in the harvest areas retention within the SBSdw FREP-sampled cutblocks is 86% of that found in the retention patches. Figure 30 shows the 30 of the 42 FREP-sampled SBSdw cutblocks which contained patch retention and therefore had data on CWD within retention patches.

SBSdw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	30	120.6	81.1	111.0	20.3
Harvest	42	103.9	75.6	83.0	12.8

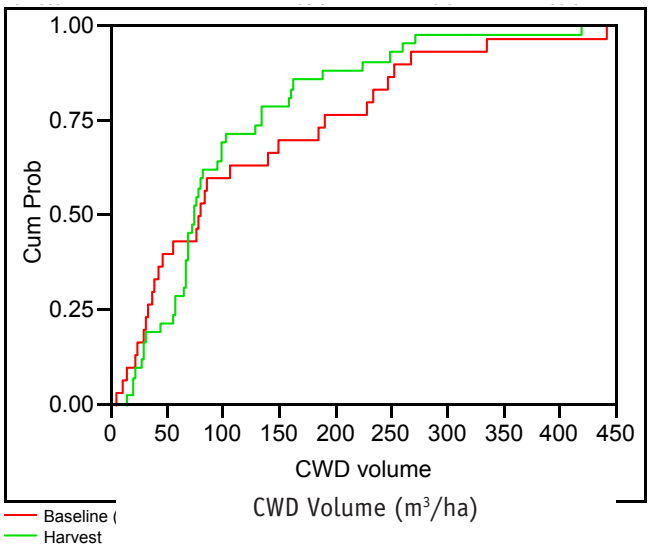

Figure 30. Cumulative probability for CWD volume in the SBSdw subzone.

K-S test: $D = 0.1952$ (maximum difference at 57.6 m^3 per hectare of CWD volume), p-value = 0.5172. There is no significant difference between these two curves.

Density of big pieces of CWD (≥ 20 cm diameter and ≥ 10 m long)

The average density per hectare of big CWD pieces found in the harvest areas within the SBSdw FREP-sampled cutblocks is 36% of that found in the retention patches. Figure 31 shows that the harvest areas had consistently lower densities of big CWD pieces compared to the retention patches.

SBSdw: Means and standard deviations

	N	Mean	Median	Std Dev	Std Err Mean
Baseline (Patch)	30	50.4	34.1	57.9	10.6
Harvest	42	18.0	0.0	29.8	4.6

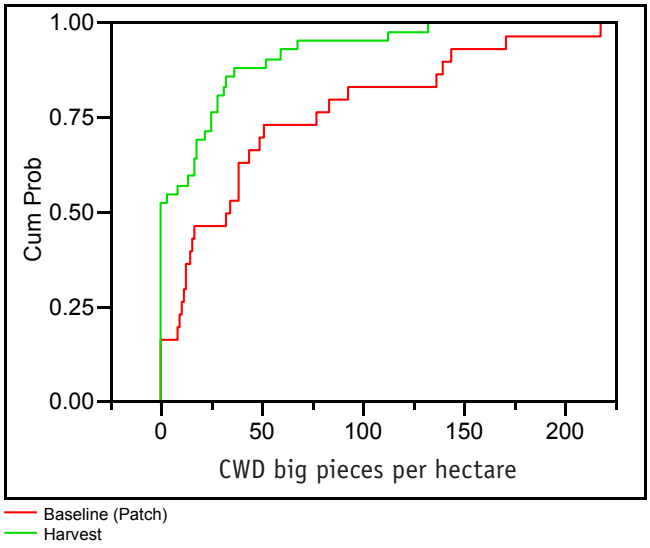

Figure 31. Cumulative probability for CWD big piece density in the SBSdw subzone.

K-S test: $D = 0.381$ (maximum difference at three big pieces of CWD per hectare), p-value = 0.01245. There is a significant difference between these two curves with the harvested areas having a lower density of big CWD pieces compared to the retention patches.

4.8.2 SBSdw discussion

Average retention in the SBSdw is 19% with 4.3% coming from dispersed retention and the remainder from patch retention. Ninety-eight percent of cutblocks had retention. Average density of large trees and tree species diversity were equivalent to that found in the cruise baseline. The SBSdw showed the lowest percentage of patches found internal to the harvest boundary, compared to the other predominant Southern Interior Forest Region Subzones. Average windthrow was 6.8%.

4.8.3 SBSdw consideration

Continue practices of maintaining areas of both dispersed retention and patch retention and having retention on essentially every cutblock. Continue maintaining good quality retention in terms of density of large trees and tree species diversity. Continuous improvement opportunities are to maintain more retention patches internal to the harvested boundary and to avoid the use of external (non-contiguous to harvest cutblock) retention patches.

5.0 WEIGHTING OF PERCENT RETENTION

A question coming out of this data is the difference in the retention of a small area of high quality biodiversity versus a larger area of lower-quality biodiversity. The question of whether these are equivalent is best answered by research, with a likely outcome of "it depends". It will depend on what biodiversity outcome you are looking at. Large areas of lower site quality retention may serve the purpose of providing a seed source for understory shrubs; however, without sufficient large dead trees, there will be decreased habitat value for primary cavity-nesting birds which depend on trees of sufficient size and decay to allow for nesthole construction (Fenger et al 2006). An exercise to weight the amount of retention by its quality is presented below. The table is an excerpt from Table 3 with the addition of quality weight and a weighted percent retention column. The quality weight is simply an average of the three tree indicator percentages (average value of the indicator from FREP retention data as a percentage of the baseline average). This weight is then applied to the % retention for the subzone so that high-quality retention will result in an "increase" in the percent retention, whereas low-quality retention will decrease it.

Table 6. Impact of quality weighting on average percent retention. Average tree indicators from FREP retention presented as % of the average cruise baseline value.

BEC Subzone	% retention	Large snags (%)	Large trees (%)	Tree species (%)	Quality weighting[b]	Weighted % retention
ESSFwc	13.5	84.7	100[a]	67.3	0.8	11.3
ICHmw	11.3	66.4	72.4	57.8	0.7	7.4
IDFdk	26.8	67	100	100	0.9	23.9
MSdm	8.7	135	130.1	113.1	1.3	11.0
SBPSxc	13.9	100	100	135.8	1.1	15.6
SBSdw	19	37.3	100	100	0.8	15.0

a If the K-S test indicates that the two curves (FREP retention data or baseline data) are not significantly different ($p \geq 0.1$) then the indicator is assumed to be 100%, or completely equivalent to the baseline.
b Quality weighting is the average of the three tree indicator percentages of baseline.

6.0 SUMMARY

Various harvesting and retention outcomes occur throughout the Southern Interior Forest Region. In the six predominant subzones reported on here, the average retention ranges from 8.7% in the MSdm to 26.8% in the IDFdk. The retention quality indicators also vary greatly. For example, the FREP data collected in the MSdm and the SBPSxc showed consistently high biodiversity quality (i.e. equivalent or higher than baseline) for the three tree indicators presented (large snags, large trees, and number of tree species). In comparison, the FREP data collected in the ICHmw subzone consistently showed lower biodiversity quality for these tree biodiversity indicators.

The question of whether the actual retention, is sufficient within a particular area or subzone can only be partially answered without knowledge of landscape-level retention levels and quality. However, to provide basic levels of stand-level retention for habitat needs of some less sensitive (to harvesting) forest dwelling birds a 15% stand-level retention has been suggested (Huggard and Bunnell 2007). When considering the impact of quality, (as seen in the weighting data in table 6), this average level is obtained in three of the six predominant subzones.

A consistent weakness in all subzones is the low density of big pieces of CWD (≥ 20 cm diameter and ≥ 10 m long). This is particularly an issue within the ESSFwc, MSdm, and SBPSxc. It is less of an issue in the ICHmw, IDFdk and SBSdw where a combination of higher densities of big CWD pieces (though significantly lower than found within retention patches) and dispersed retention potentially providing CWD recruitment, combine to give better CWD quality or potential quality.

APPENDIX

Appendix 1. Data Compilation

Number of cutblocks per BEC subzone in FREP samples and baseline cruise cutblocks.

Subzone	FREP samples	Cruise baseline BCTS[a] Official Notices Site	Cruise Baseline ECAS[a]
ESSFdc	15		
ESSFdk	5		
ESSFdm	1		
ESSFmm	4		
ESSFmw	1		
ESSFvc	5		
ESSFvv	1		
ESSFwc	32	32	17
ESSFwk	7		
ESSFwm	12		
ESSFxc	4		
ESSFxv	1		
ICHdk	2		
ICHdm	1		
ICHdw	18		
ICHmk	31		
ICHmm	6		
ICHmw	75	121	147
ICHvk	16		
ICHwk	25		
ICHxw	1		
IDFdk	89	82	99
IDFdm	18		
IDFmw	12		
IDFww	1		
IDFxh	2		
IDFxm	1		
MSdc	1		
MSdk	31		
MSdm	40	94	74
MSxk	27		
MSxv	10		
PPdh	1		
SBPSdc	6		
SBPSmc	4		
SBPSmk	32		
SBPSxc	35	60	76
SBSdh	6		
SBSdw	44	165	126
SBSmc	2		
SBSmm	2		
SBSmw	21		
SBSwk	3		

a Baseline used only for the predominant subzones; the description below is for the data acquisition of the full baseline data set.

The baseline used for tree data comes from timber cruise which is done by forest licensees to estimate the volume of timber to be harvested from a proposed cutblock. Timber cruise plot data is used (rather than summarized data). The plot data measures tree height, species, diameter, and tree class. The FREP tree data is taken from retention areas in harvested cutblocks, with the tree data being acquired using timber cruise survey methods.

All useable timber cruise data from the BCTS Official Notices Site were downloaded, without duplication, in 2006 (250 cutblocks), 2007 (670 cutblocks), and 2008 (1600 cutblocks). This BCTS site was the first source of electronic timber cruise raw data (tree information). In 2008, after the ECAS data system began including electronic timber cruise raw data, this system was also used to acquire timber cruise data, and 1940 cutblocks of timber cruise data were added to the database. The ECAS system allowed for major licensee data to be included in the baseline. As with the Official Notices Site downloads, all useable data was acquired without duplication. Useable data was electronic files showing the raw tree data from the timber cruise, in a .dat or .ccp format, where BEC information could be confirmed.

There is not a one-to-one comparison of FREP cutblocks and their cruise data, rather the full curve of data for FREP-sampled retention in a particular ecosystem is compared against the curve of data for timber cruised cutblocks from the same ecosystem. With the FREP data being chosen randomly from the full population of harvested cutblocks (≥ 2 hectares within defined harvest completion date range), and the cruise data representing as close as possible, the full population of cruised cutblocks, this allows an overall comparison of the trees maintained in retention versus the trees being harvested in the ecosystem.

The raw timber cruise data was compiled by Amanda Linell Nemec using the SAS software program. The compiled data shows for each cruised cutblock, the same tree indicators as derived from the FREP data.

The FREP data, both tree data and coarse woody debris data was compiled using a program written by BCStats. Equations for calculating CWD volume and piece density from the CWD line transect plots are from van Wagner 1982. Equations for calculating tree density are from the Cruise Compilation Manual, 2009. Previous data compilations of FREP data were done by Amanda Nemec using SAS, which allowed full comparison of data as compiled by the two programs, for quality-control purposes.

The statistics were calculated via the software “R”, and the cumulative distribution charts were done either with “R” or the software package JMP.

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