FREP

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FOREST AND RANGE EVALUATION PROGRAM

Stand-level Biodiversity Monitoring In 44 Large Cutblocks in The Central Interior of British Columbia

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Sustainability of Forest and Range Resources Through Science and Stewardship

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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Prepared by
Nancy Densmore, B.C. Ministry of Forests and Range, Forest Practices Branch
Data Analysis Consultation
Wendy Bergerud, B.C. Ministry of Forests and Range, Research Branch
Compilation
Amanda Linnell Nemec, International Statistics and Research Corp. Victoria, BC

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EXECUTIVE SUMMARY

This report presents monitoring results for 44 large cutblocks (≥ 100 ha) harvested between 1995 and 2005. In December 2005, British Columbia's Chief Forester issued guidance on biodiversity management pertinent to large cutblocks. Therefore, the results reported here represent a pre-guidance baseline of stand-level biodiversity on large cutblocks.

Cutblock retention ranged from 3 to 65% and average retention was 15.9%. This average compares favourably with the calculated target (based on the December 2005 guidance) of 15.3%. The lower amount of internal patch retention (completely surrounded by harvesting) observed compared to the amount of edge patch retention is a concern for biodiversity. Of the total retention observed in the 44 sampled cutblocks, 73.4% of the area came from edge patches, 20.5% came from internal patches, and 6.1% came from external patches (i.e., external to the harvest area). External patches do not provide direct biodiversity value to the cutblock.

To assess the quality of stand structure retention, several indicators in the 44 sampled cutblocks were compared to the same indicators derived from timber cruise data in similar unharvested timber types. These comparisons showed that the sampled retention:

- has similar numbers of tree species present – a good trend for biodiversity
- has greater density of large trees (≥ 50 cm diameter breast height) – a good trend for biodiversity
- has a higher density of large snags (≥ 30 cm diameter breast height and ≥ 10 m high) – potentially a good trend for biodiversity, although this needs further study

Coarse woody debris (CWD) indicators found in the harvested area were compared to the same indicators for CWD found in the retention patches. These comparisons showed that the sampled harvested areas:

- had similar volumes of CWD compared to CWD in patch retention – a good trend for biodiversity; but
- had lower density of long (≥ 10 m) CWD pieces compared to CWD in patch retention – a concern for biodiversity

Continued monitoring of large cutblocks will occur, although assessments of blocks harvested after issuance of the Chief Forester's guidance will not likely occur until the 2008 field season.

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Introduction

The Forest and Range Evaluation Program (FREP) was established in 2003 under the direction and guidance of British Columbia's Chief Forester. An objective of the FREP is to assess the effectiveness of the *Forest and Range Practices Act* (*FRPA*) in achieving stewardship of the eleven resource values identified under *FRPA*.

In December 2005, British Columbia's Chief Forester (Jim Snetsinger) issued guidance on landscape- and stand-level structural retention in large-scale mountain pine beetle salvage operations (Snetsinger 2005). Included were recommended levels of retention in salvage cutblocks of different sizes (Table 1).

Table 1. Recommended proportion of stand-level retention based on opening size

Opening size (ha)	Unharvested/retained (%)
< 50	10
50-250	10-15
250-1000	15-25
> 1000	> 25

This report presents FREP resource stewardship monitoring results for 44 large cutblocks harvested between 1995 and 2005. These data, therefore, represent a pre-guidance baseline of stand-level biodiversity on large cutblocks.

Methods

The sampled cutblocks, located in nine forest districts (Table 2), were 100 ha (gross area) or larger. The sampling design and field protocol for stand-level biodiversity (SLBD)[1] was used for the resource stewardship monitoring (RSM), and therefore all sampled cutblocks were chosen randomly from the distribution of potential cutblocks as derived from the RESULTS (Reporting Silviculture Updates and Landstatus Tracking System) database. In 2005, contractors Bill Golding and Doug Ellis sampled 16 cutblocks in a directed study (i.e., directed toward cutblocks ≥ 100 ha). In addition, eight large blocks were sampled during FREP's regular SLBD monitoring in the same year. In 2006, the Ministry of Environment's Geoff Price sampled 20 blocks in another directed large cutblock study (Price 2007). These sample sets therefore came from three different RESULTS extractions. The two targeted projects were specific to cutblocks with a gross area greater or equal to 100 hectares in a variety of central interior forest districts. The regular SLBD monitoring was not specific to large cutblocks. Data generated for all 44 sampled cutblocks has been pooled for this summary. Due to the three different sample sets, the data is not balanced between the central interior forest districts. It is more abundant in the Quesnel and Chilcotin Forest Districts and therefore the pooled data may not fully represent stand-level biodiversity in large blocks in all central interior forest districts. Further cutblock data was collected during the 2006 SLBD resource stewardship monitoring; however, this data was not ready for analysis when this report was drafted.

Table 2. Number of cutblocks sampled by forest district

Forest District	No. cutblocks sampled
Vanderhoof	4
Quesnel	15
Nadina	1
Mackenzie	2
100 Mile	5
Chilcotin	11
Central Cariboo	6

1 See FREP website for related protocols and indicators: http://www.for.gov.bc.ca/hfp/frep/indicators/table.htm

Results

Percent Retention

Sampled cutblocks were, on average, 158 ha in size (range: 100.7–357.7 ha). Total retention, inclusive of all patch and dispersed (single tree or small clumps of trees) retention associated with a cutblock, averaged 15.9% (range: 3–65%). According to Table 1, 15.3% would be the recommended retention for the sum of the 44 cutblocks.[2] This level was therefore about the same for the sampled cutblocks. If the cutblock with the highest level of retention is excluded, then the retention obtained dropped to 15%, a relatively minor change.

To roughly assess the amount of retention left in large cutblocks for areas harvested after issuance of the Chief Forester's guidance, the RESULTS database was queried using the following parameters:

- cutblock larger than 100 ha gross size
- harvest start date after January 1, 2006
- forest districts inclusive of Central Cariboo, Ft. St. James, 100 Mile House, Prince George, Quesnel, and Vanderhoof

A total of 156 cutblocks met these population parameters. The density of dispersed retention cannot be assessed from the RESULTS database without field surveys; therefore, this database query is only applicable to the amount of patch retention reported on these cutblocks. However, data for the 44 field surveyed large cutblocks that were harvested prior to issuance of the Chief Forester guidance shows that 3% of overall retention came from the basal area equivalency (BAE[3]) of dispersed retention.

The overall patch retention for these 156 cutblocks was 14.1%. If we applied the targets from the Chief Forester's guidance (see calculation method in footnote 2), then an overall retention of 16.9% would be expected. These blocks also contain an unknown amount of dispersed retention, the overall retention is most likely higher than 14.1%, and could reasonably be expected to be about 17.1% considering the 3% dispersed retention found from the FREP field surveys. This retention is well in line with the Chief Forester's recommendations.

2 Calculated by applying a 15% target retention to each cutblock of 100–250 ha, and 20% retention for the blocks > 250 ha, then calculating a weighted average.

Retention Patch Description

Each retention patch in the 44 sampled cutblocks fell into one of following three categories:

1. patch internal to the harvest area (i.e., completely surrounded by harvesting),
2. patch on the edge of the harvest area, or
3. patch external (non-contiguous) to the harvest area.

Because of the habitat benefits provided by internal patches (e.g., connectivity, recolonization sources, heterogeneity, diminished line of sight, and interspersion of mature attributes with developing early seral conditions), this category is considered the most valuable for stand-level biodiversity (Klenner 2006).

Twenty-nine percent of the sampled cutblocks lacked any internal patches and an additional 20% had only one internal patch. When considered in terms of total patch area, 73.4% was on the edge of harvested areas, 20.5% was internal, and 6.1% was external. Edge patches were often larger and more linear than internal patches. For example, data collected in 2006 (Price 2007) shows an average size for edge patches of 8.8 ha (total: 404 ha of edge patch in 20 cutblocks) and an average size for internal patches of 1.2 ha (total: 110 ha of internal patches in 20 cutblocks). Of the full sample of 44 large cutblocks, six blocks had external patches.

As large patches can have high biodiversity value, the size of each discreet retention patch was assessed. Depending on patch shape, patches larger than 7.5 ha potentially contain some forest interior habitat.[4] The average size of the largest patch found in each cutblock was 12.9 ha (range: 2.8–69.9 ha). The largest patch of 69.9 ha was found within a 112-ha cutblock and was left to protect two goshawk nests.

3 Dispersed retention area is given as basal area equivalent area (i.e., a scaling down of the actual dispersed area). Basal area equivalency converts dispersed retention to an equivalent amount of solid area retention. For example, if a dispersed area contains 20% of the pre-harvest basal area, the actual area is reduced by 80%.

4 Only if the retained patch is circular: a patch radius of 150 m gives a 100-m buffer around an interior circle with 50 m radius.

Comparison To Baseline Data

To assess the quality of stand structure retention, several indicators in the sampled RSM cutblocks were compared to the same indicators derived from timber cruise data in similar unharvested timber types. For this baseline comparison, timber cruise plot data was obtained for 290 British Columbia Timber Sales (BCTS) cutblocks through the BCTS Official Notices System. The cruise samples were from central interior areas with similar biogeoclimatic zones and subzones to the post-harvest RSM samples, and were all surveyed in 1997 or later, with most surveyed in 2003 or later. However, these samples are not from any of the RSM sampled cutblocks.

The following three indicators were calculated from the cruise plot data for each cruised cutblock:

1. number of tree species
2. functional snags – stems per hectare (dead trees ≥ 30 cm diameter breast height and ≥ 10 m high)
3. large trees – stems per hectare (dead and alive trees ≥ 50 cm diameter breast height)

These indicator values were compared to values of the same indicators in the retained areas of the sampled RSM cutblocks (i.e., both patch and dispersed wildlife tree retention, with dispersed wildlife tree retention calculated as a basal area equivalency[5]). The preliminary analysis appears below.

Work continues on the baseline dataset, including the collection of more available and useable[6] cruise plot data from the BCTS Official Notices System with expansion (if possible) into major licensee cruise data.

A Kolmogorov-Smirnov test (Conover 1980) was used to compare the baseline population to the sampled RSM population. This test measures the largest vertical difference between the two populations when graphed as cumulative distributions on the same chart. These distributions order data from the lowest to highest value of the particular indicator (with the sample count converted to a percentage).

Baseline data from unharvested stands was not available for the coarse woody debris (CWD) values. The best available comparison was between the CWD values found in the patch retention areas and the CWD values found in the harvest areas.

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5 Because no pre-harvest data was available, we used the basal area from wildlife tree patches on the same opening; or, if no patches were present, we used the average basal area for all other wildlife tree patches in the same biogeoclimatic subzone for comparison.

6 Not all cruise data on this site is in a useable format (e.g., some cruise cards are simply a PDF file; biogeoclimatic information is not always available and some files were corrupted).

Number of Tree Species by Block

Figure 1 shows a cumulative distribution of the number of tree species found in the unharvested (timber cruise data) and harvested (sampled retention in harvested blocks) distributions. Notice that the first 50% of the cruise blocks (ordered from lowest to highest density of number of tree species sampled) had three or fewer tree species and the first 50% of the RSM post-harvest blocks had four or fewer tree species present in the block retention. Basic statistics for the two distributions are summarized in Table 3. A Kolmogorov-Smirnov test compared the sample cumulative distributions for these two populations. If the null hypothesis (no difference between the two distributions) is correct, then there is a 52% chance that the observed data would depart this much (i.e., maximum 13% difference in cumulative distribution at about 3 stems per hectare for number of tree species found, as seen in Figure 1). In other words, there is no evidence for rejecting the null hypothesis. It seems from this data that the choice of retention areas is successful in capturing the full range of tree species.

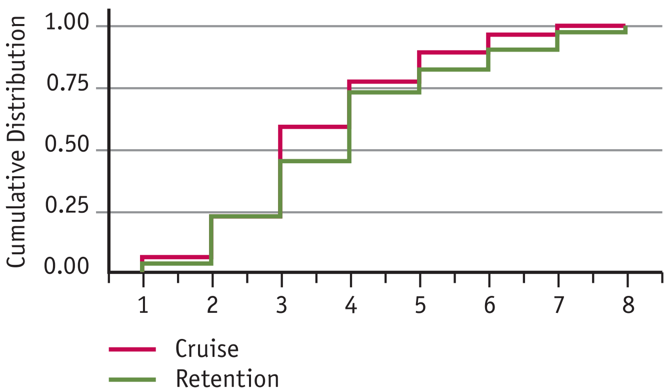

Figure 1. Cumulative distribution of number of tree species in two distributions of blocks: unharvested (timber cruise data) and harvested (sampled retention in harvested blocks).

Table 3. Comparison of number of tree species found in post-harvest retention versus cruise plot data

Comparison	Average # of tree species by block	Median	Min	Max	Conclusion
Retention Data	3.9	4	1	8	Good for Biodiversity
Cruise data	3.5	3	1	8	

Large Trees (stems per hectare dead and alive ≥ 50 cm dbh)

Figure 2 shows the cumulative distributions of the large trees found in the unharvested (timber cruise data) and harvested (sampled retention in harvested blocks) sample data. Basic statistics for the two groups are summarized in Table 4. A Kolmogorov-Smirnov test compared the sample cumulative distributions for these two populations. If the null hypothesis (no difference between the two populations) is correct, then there is a 5.7% chance that the observed data would depart this much (i.e., maximum 22% difference in cumulative distribution at about 3 stems per hectare for large trees, as seen in Figure 2). In other words, there is some weak evidence of a difference between these two populations with the retention areas containing a somewhat higher density of large trees.

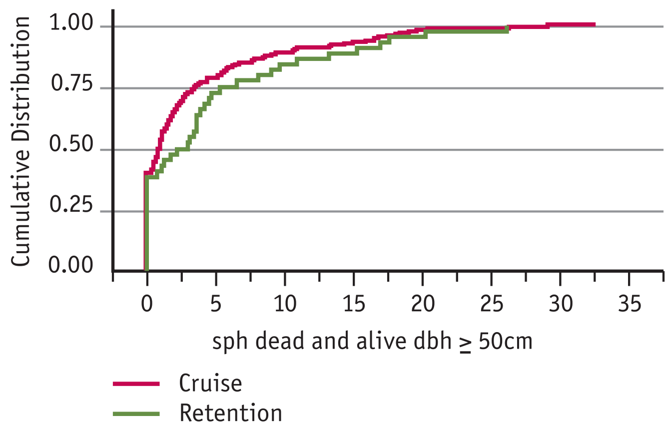

Figure 2. Sample cumulative distribution of density of trees 50 cm dbh or larger in the two groups of blocks: unharvested (cruise data) and harvested (sampled retention in harvested blocks).

Table 4. Comparison of density of large trees in post-harvest retention versus cruise plot data

Comparison	Average stems/ha large trees	Median	Min	Max	Conclusion
Retention Data	4.7	2.61	0	26.3	Good for Biodiversity
Cruise data	3.3	0.94	0	32.7	

Functional Snags (stems per hectare dead trees ≥ 30cm dbh and ≥ 10m high)

Figure 3 shows the cumulative distributions of the functional snags found in the unharvested (timber cruise data) and harvested (sampled retention in harvested blocks) groups. Basic statistics for the two groups are summarized in Table 5. A Kolmogorov-Smirnov test compared the sample cumulative distributions for these two populations. If the null hypothesis is correct (no difference between populations), then there is a 0.01% chance that the observed data would depart this much (i.e., maximum 39% difference in the cumulative distribution at about 25 stems per hectare, as seen in Figure 3). In other words, there is strong evidence for rejecting the null hypothesis.

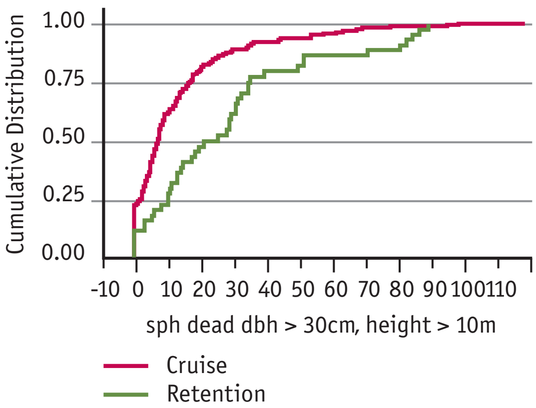

Figure 3. *Sample cumulative distribution of functional snags (≥ 30 cm dbh and ≥ 10 m high) found in two groups of blocks: unharvested (cruise data) and harvested (sampled retention in harvested blocks).*

The density of large snags is higher in the sampled retention areas compared to that found in the unharvested areas represented by the cruise data. The reason for this difference is not clear. The RSM cutblocks (harvested blocks) were sampled in 2005 or 2006, and the cruise data came from surveys conducted from 1997 to 2006; therefore, there may be a timing difference if more of the cruise block data was collected before beetle-induced pine mortality. This would be indicative of increasing mortality in the retained areas after harvest. Another possibility is that patch retention areas may be chosen with higher densities of dangerous (often dead) trees.

Table 5. *Comparison of density of functional snags in post-harvest retention versus cruise plot data*

Comparison	Average stems/ha functional snags	Median	Min	Max	Conclusion
Retention Data	28.6	23.4	0	89.1	Uncertain
Cruise data	13.3	7.27	0	118.8	

Coarse Woody Debris

CWD volume (m^3/ha) and density of long pieces (pieces/ha) was calculated separately for the patch retention and the harvest area (inclusive of clear-cut areas and areas with dispersed tree retention) of every block. The average block values found in the patch retention (considered close to natural levels) are compared against the average block harvest values.

CWD Volume

Figure 4 shows the cumulative distributions of CWD volume found in the unharvested (patch retention data) and harvested (sampled retention in harvested blocks) groups. Basic statistics for the CWD volume are summarized in Table 6. A Kolmogorov-Smirnov test compared the sample cumulative distributions for these two groups. If the null hypothesis is correct (no difference between the groups), then there is a 52.9% chance that the data would depart this much (i.e., maximum of 17.6% difference in the cumulative distribution at about 120 m^3/ha of CWD volume, as seen in Figure 4). In other words, there is no evidence for rejecting the null hypothesis.

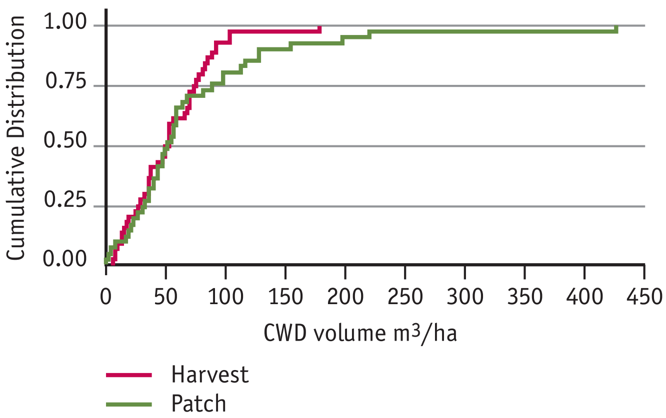

Figure 4. Sample cumulative distribution of CWD volume m^3/ha found in two groups: unharvested (patch retention data) and harvested.

The main difference in these sample cumulative distributions occurs in the upper 25% where the volumes of CWD in the patch retention areas deviate from that in the harvest areas. The highest volume of CWD is therefore found in the patch retention areas.

Table 6. Comparison of CWD volume in patch retention areas versus harvested areas

Comparison	Average CWD volume (m^3/ha)	Min	Max	Conclusion
Patch retention	74.0	3.3	427.8	Good for Biodiversity
Harvest area	55.6	8.1	180.1	

CWD Long (≥ 10 m) Pieces per Hectare

Figure 5 shows the cumulative distributions of the density of long pieces found in the unharvested (patch retention data) and harvested (sampled retention in harvested blocks) sample data. Basic statistics for density of long CWD pieces are summarized in Table 7. A Kolmogorov-Smirnov test compared the two sample cumulative distributions for these two groups. If the null hypothesis is correct (no difference between the groups), then there is a 0.01% chance that the observed data would depart this much (i.e., maximum 52.8% difference in the cumulative distribution at about 70 long pieces of CWD per hectare, as shown in Figure 5). In other words, there is strong evidence to reject the null hypothesis.

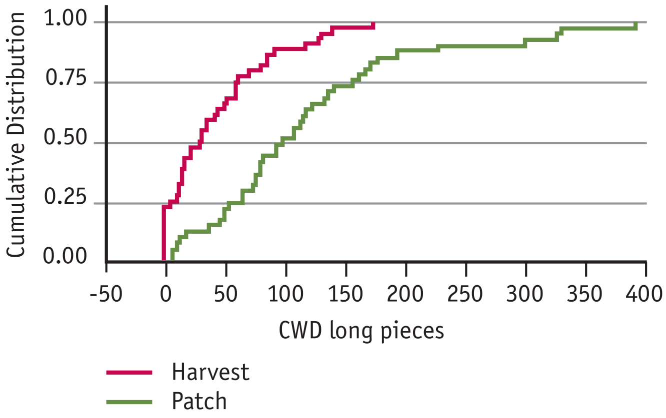

Figure 5. *Sample cumulative distribution of density of long CWD pieces (pieces per hectare ≥ 10 m long) found in two groups: unharvested (patch retention data) and harvested (harvested areas including clear-cut and dispersed retention areas).*

This comparison shows a much lower density of long CWD pieces in harvest areas compared to retained patches (representing mature unmanaged areas). Breakage and bucking, which shortens logs left on site, is a common occurrence on harvested sites. The lack of long CWD pieces means quicker decomposition of the CWD volume on site, and lower habitat value from the shorter pieces compared to the longer pieces (Harmon et al. 1986). Length has been chosen as a key indicator of CWD quality, though in reality it is both length and diameter that impact the longevity of a piece. CWD diameter is less impacted by harvest practices than is length.

Table 7. *Comparison of density of long CWD pieces in patch retention versus harvested areas*

Comparison	Average density of long pieces	Min	Max	Conclusion
Patch retention	119.4	7	394	Bad for Biodiversity
Harvest area	42.3	0	174	

SUMMARY

The percent of area retention in the sampled 44 large cutblocks, all harvested before December 2005, met (on average) the retention levels suggested by the Chief Forester (Snetsinger 2005). Retention patch size was well distributed, with a high number of large patches and a good range of patch sizes. One area of concern related to the 29% of cutblocks with no internal patches; overall, internal patches (patches completely surrounded by harvest areas) occupied less area than edge patches.

In comparisons of tree structure indicators for unharvested (timber cruise data) versus harvested (sampled retention in harvested blocks) areas, biodiversity values were positive for:

- numbers of tree species (equal or greater numbers of tree species found in retention areas vs. cruise data), and
- density of large trees (equal or higher density of large trees found in retention areas vs. cruise data).

The density of functional snags was higher in the retention areas versus the cruise data. Although snags were of functional size for wildlife, further work is necessary to assess whether retention is biased toward the dead component of the stand more than is appropriate.

The volume of coarse woody debris found in the harvest areas is fairly comparable to that found in the patch retention areas; however, the density of long CWD pieces is much lower in the harvest area compared to the patch area.

As the 44 sampled cutblocks were all harvested before the issuance of the Chief Forester's guidance on biodiversity management, the results reported here represent a performance "baseline" for large cutblocks in the central interior of British Columbia prior to December 2005. A check of large cutblocks harvested after January 2006 in the central interior (as reported in RESULTS) showed a comparable level of retention to that recommended by the Chief Forester (Snetsinger 2005).

Future assessment of large cutblocks for biodiversity is scheduled for the 2007 field season. Resource stewardship monitoring of large cutblocks planned and harvested after December 2005 will likely occur in the 2008 field season.

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FREP Forest&Range Evaluation Program

The FREP Mission:

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.

http://www.for.gov.bc.ca/hfp/frep/index.htm