Evaluation of Wildlife Tree Retention for Cutblocks Harvested Between 1996–2001 Under the Forest Practices Code

British Columbia

Ministry of Forests

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EVALUATION OF WILDLIFE TREE RETENTION FOR CUTBLOCKS HARVESTED BETWEEN 1996–2001 UNDER THE FOREST PRACTICES CODE

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PREFACE

This evaluation is the first part of a proposed two phase project. The following report, which comprises Phase I, covers various aspects of evaluating the implementation of wildlife tree retention policy in British Columbia. Phase I also briefly touches on aspects of evaluating the effectiveness of British Columbia's current wildlife tree retention policy in preparation for the proposed second phase of the project.

The plan for Phase II is to evaluate the effectiveness of current wildlife tree retention policy and practices to determine if policy direction and practices are resulting in the sustainability of key stand-level biodiversity attributes/indicators.

ABSTRACT

During the 2001 field season, 128 cutblocks from 12 forest districts, representing each of British Columbia's forest regions and seven of the province's 14 BEC zones, were evaluated for various aspects of wildlife tree retention using a standardized methodology.

The project had four main objectives:

- to assess how effectively current wildlife tree retention practices meet the ecological and administrative guiding principles specified in the *Provincial Wildlife Tree Policy and Management Recommendations* (Prov. of B.C. 2000)*;*
- to determine the timber supply impacts of current wildlife tree retention practices;
- to evaluate the structural and compositional changes of wildlife tree retention areas following harvest; and
- to identify wildlife tree retention practices that are achieving ecological objectives and minimizing costs.

Both pre- and post-harvest cutblocks were evaluated in the study. One hundred and eighteen (118) post-harvest cutblocks were randomly selected for sampling from a list generated by the Ministry of Forests' Integrated Silviculture Information System (ISIS). Ten (10) non-randomly selected pre-harvest cutblocks were also assessed in order to compare areas designated for wildlife tree retention in the silviculture prescriptions with available stand structure in the cutblocks. Sampling was conducted using prism plots, fixed-area plots, or complete counts.

Approximately 41.4% of the sampled cutblocks contained reserves rated as having high ecological value; 34.4 % were rated as having medium ecological value; and 14.8% were rated as having low ecological value (the other 9.4% had no reserves). Twenty-six percent (26%) of the sampled cutblocks contained four or more stems per hectare of high-value wildlife trees based on the total area under prescription (TAUP). Thirty-three percent (33%) of sampled cutblocks contained no high-value wildlife trees (includes 9.4% of cutblocks with no reserves).

High-value wildlife trees are being retained with both dispersed and patch retention; however, patches generally provide more high-value wildlife trees than dispersed retention. Dispersed retention accounted for approximately 20% of the total area of retention across the sampled cutblocks; patch retention accounted for the remaining 80%.

Of the 128 cutblocks surveyed, 12 (9.4%) had no retention. An additional 20 cutblocks (15.6%) contained retention with undefined objectives or reserves for purposes other than stand-level biodiversity. When combined, 25% of the sampled cutblocks either had no retention, contained retention with undefined objectives, or contained reserves for purposes other than stand-level biodiversity.

The estimated timber supply impacts due to wildlife tree retention weighted by the sample strata are 3.5% by volume and 4.3% by area. Mitigating factors, such as designating patches ≥2 hectares as old-growth management areas (OGMAs), moving the location of wildlife tree patches following each rotation, and allocating some large wildlife tree patches to more than one cutblock, have the potential to reduce the timber supply volume impacts associated with wildlife tree retention.

Windthrow, insects/disease, and salvage do not appear to have affected the ecological value of wildlife tree retention in the sampled cutblocks. Methods for achieving ecological objectives for wildlife tree retention, while minimizing costs include: anchoring reserve areas on high-value attributes and difficult operational sites, using larger versus smaller patch reserves, and ensuring effective communications between planners and logging crews.

From the results of the evaluation, it appears that wildlife tree retention is being widely implemented across British Columbia. However, there is room for improvement in the quality of wildlife tree habitat being retained. In addition, further work is required to accurately assess the contribution of current wildlife tree retention in meeting the habitat requirements of specific species in order to determine the actual ecological value of these reserves.

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The project management team is responsible for the final version of this document. They are: Peter Bradford and Nancy Densmore (MOF, Forest Practices Branch), Richard Thompson (Ministry of Water, Land and Air Protection), Atmo Prasad (MOF, Timber Supply Branch), Evelyn Hamilton and Wendy Bergerud (MOF, Research Branch), and Bill I'Anson (technical writer).

Contents

INTRODUCTION

For over a decade, forest managers in British Columbia have been working on strategies to manage stand-level biodiversity. In 1995, retention of wildlife trees and riparian management areas became a legal requirement under the *Forest Practices Code of British Columbia Act*. These types of reserves retain stand structure that provides habitat for a wide variety of flora and fauna.

In British Columbia, over 80 vertebrate species of wildlife are dependent on wildlife trees for some aspect of their habitat needs (Steeger and Machmer 1995). In addition to valuable habitat, wildlife tree retention and riparian management areas also provide aesthetic breaks, future sources of coarse woody debris and organic material, and refuges for fungi and other micro-organisms that contribute to long-term forest productivity. Riparian management areas also help protect aquatic habitats and water quality, and can function as connectivity corridors.

The Forest Practices Code *Biodiversity Guidebook* (Prov. of B.C. 1995) provides suggested levels of retention for wildlife trees, based on a biogeoclimatic (see Meidinger and Pojar 1991) subzone analysis of total area available for harvest and the amount of area previously harvested without wildlife tree retention. In the absence of legal landscape-unit objectives, many forest districts rely on some form of district manager policy to help guide implementation of wildlife tree retention.

In the spring of 2000, the British Columbia government released two significant wildlife tree related documents: the *Landscape Unit Planning Guide* (Prov. of B.C. 1999) and the *Provincial Wildlife Tree Policy and Management Recommendations* (Prov. of B.C. 2000). The *Landscape Unit Planning Guide* contains the suggested levels of wildlife tree retention as presented in the *Biodiversity Guidebook*, and includes the *Provincial Wildlife Tree Policy and Management Recommendations*. It also restates the timber supply modelling assumptions presented in the *Forest Practices Code Timber Supply Analysis* (Prov. of B.C. 1996), which indicates that a portion of wildlife tree retention should come from constrained areas within the cutblock, such as riparian reserves.

The *Provincial Wildlife Tree Policy and Management Recommendations* provides ecological and administrative guidance on the selection of appropriate wildlife trees and wildlife tree patches. It also suggests best management practices for implementing wildlife tree policy.

This evaluation project was undertaken to answer the following questions:

1. How effectively do current wildlife tree retention (WTR) practices meet the ecological and administrative guiding principles specified in the *Provincial Wildlife Tree Policy and Management Recommendations?*
2. What are the timber supply impacts of current WTR practices? How much WTR is within the timber harvesting land base (THLB), and how much is within non-contributing or constrained areas (e.g., riparian reserves, operational constraints)?
3. What structural and compositional changes are occurring in WTR areas following harvest? Have these changes affected the ecological value of the retention areas?

4. Are there identifiable WTR practices currently being used that achieve ecological objectives and minimize costs?

Some additional benefits/outcomes of this evaluation include:

- providing a “snap shot” of the current state of stand-level biodiversity and related forest practices to facilitate improving existing WTR policy;
- establishing a benchmark for measuring the effectiveness of future WTR policy and best management practices;
- guiding the development of a proposed Phase II effectiveness evaluation of WTR; and
- providing a basis for establishing effective methodologies for conducting other evaluation projects.

Cedar with heart rot and active wildlife use.

PROJECT DESIGN

Overview of Project Design Process

A project design team consisting of staff from the Ministry of Forests (Research, Forest Practices, and Timber Supply Branches), the Ministry of Water, Land and Air Protection (Biodiversity Branch), and the Ministry of Sustainable Resource Management, with support from the Workers' Compensation Board and the consulting community, was formed to develop the evaluation methodology. A representative from the forest industry was also involved in the initial stages of the evaluation.

The design team considered a number of methods/options for evaluating the objectives of the study. The two most discussed options were: 1) a paper exercise with no field verification (e.g., office review of the Integrated Silviculture Information System (ISIS) data base, forest cover maps, and silviculture prescriptions); and 2) a field-based sampling of pre- and post-harvest cutblocks from around the province.

Option one would have provided a determination of how much area had been left in wildlife tree retention, but would have given no indication of the quality of the habitat retained or the accuracy of the ISIS data base and/or silviculture prescriptions. Option #2 was selected as the preferred option, and 128 cutblocks (10 pre-harvest and 118 post-harvest) were surveyed during the 2001 field season.

Six consulting firms, one per forest region, were retained to do the field sampling. To help ensure consistency of data collection, each firm had at least one current instructor for the *Wildlife/Dangerous Tree Assessor's Course* (Prov. of B.C. 2002). All consultants involved in the project were very familiar with wildlife tree management in British Columbia.

Field survey methodologies and associated field data collection forms were drafted and tested by the project team (see Appendices I–III). Field-based training sessions for the field assessors were held near Kamloops and on Vancouver Island. The objectives of the training sessions were twofold: 1) to ensure data collection consistency by reviewing and testing the methodology, and 2) to allow the field assessors to view the procedures in the field and suggest any "fine tuning" prior to implementation. The field-based training sessions were followed-up with field visits by the project team to at least two cutblocks per forest region to ensure/confirm consistent data collection, interpretation and quality control.

Requirements for office data collection were also developed, along with a questionnaire concerning district-level guidance for wildlife tree retention (see Appendix IV). The District Questionnaire was sent to each forest district participating in the evaluation prior to data collection. The purpose of the questionnaire was to collect background information from the district perspective to help provide context for the evaluation. This information was very useful for interpreting and discussing data and results in other sections of this report, particularly the Ecological and Administrative Guiding Principles, and the Timber Supply Impacts sections. The results of the District Questionnaire are summarized in Appendix V.

Post-harvest cutblocks were selected for sampling from a list generated by ISIS of all cutblocks greater than five hectares in size harvested between 1996 and 2001. It was assumed that cutblocks from this period would have been harvested under Forest Practices Code regulations. Two districts in each of the six forest regions[1] were sampled. The districts were selected on a non-random basis to represent the broad spectrum of geographic areas and biogeoclimatic (BEC) zones across the province. The population of cutblocks within the two largest BEC zones per district (or single BEC zone if only one was present) was used to generate the potential sample cutblocks from the ISIS list. This identified a total of 22 strata – each defined by district and BEC zone (see Table 1). Cutblocks to be sampled were randomly selected with equal probability from within each stratum.

The field assessor for each district was provided with information on 17 cutblocks – 15 post-harvest cutblocks listed in random order and, if possible, two pre-harvest cutblocks. Pre-harvest cutblocks were included in the evaluation to provide field assessors with an opportunity to observe the stands prior to harvest and compare areas designated for wildlife tree retention with the available habitat within the cutblock. The criteria for the pre-harvest cutblocks were that they had to have an approved silviculture prescription and timber cruise data. District staff selected the pre-harvest cutblocks for the evaluation from within the same sample BEC zones as the post-harvest cutblocks. The number of pre-harvest cutblocks that met these criteria and were readily accessible for the field assessors was quite low.

Field assessors sampled each of the cutblocks in the order provided, unless the cutblock was inaccessible, in which case the assessors proceeded to the next cutblock on the list. The number of cutblocks sampled per district varied as a result of accessibility, the size and complexity of the cutblocks, and the limited budget available for sampling within each region.

Due to the difficulty in obtaining individual plot data and cruise plot maps, pre-harvest cruise summaries were used to provide pre-harvest comparison information for the analyses.

Table 1 lists the number of cutblocks sampled by forest region, district and BEC zone. The bracketed numbers in Table 1 are the total number of cutblocks harvested in those strata from 1996 through 2001, as obtained from ISIS, representing the population of post-harvest cutblocks from which the random sample was taken. The ratio of sampled cutblocks to the total number of cutblocks harvested was used as the selection probability. Table 1a shows the number of pre-harvest and post-harvest cutblocks sampled by BEC zone.

1 The Ministry of Forests regions and districts sampled during the evaluation reflect the administrative structure of the ministry at the time of the study.

Table 1. Number of sampled cutblocks by region, forest district and BEC zone, with the total number of post-harvest cutblocks (in brackets)

Forest Region	Forest District	BEC zone[a]							
		BWBS	CWH	ESSF	ICH	IDF	SBPS	SBS	Total
Cariboo	Chilcotin					6 (144)	5 (1411)		11 (1555)
	Quesnel						1 (492)	4 (887)	5 (1379)
Kamloops	Clearwater			7 (276)	7 (413)				14 (689)
	Kamloops				7 (187)	8[b] (516)			15 (703)
Nelson	Arrow			5 (250)	5 (650)				10 (900)
	Kootenay Lake			9 (185)	3 (387)				12 (572)
Prince George	Fort St. John	8 (406)		2 (27)					10 (433)
	Prince George			4 (115)				5 (1698)	9 (1813)
Prince Rupert	Kispiox		6 (40)		8 (258)				14 (298)
	North Coast		10 (182)						10 (182)
Vancouver	Chilliwack		8 (423)	3 (42)					11 (465)
	South Island		7 (699)						7 (699)
Total Sample		8 (406)	31 (1344)	30 (895)	30 (1895)	14 (660)	6 (1903)	9 (2585)	128 (9688)

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

[b] No cruise data was found for one IDF cutblock in the Kamloops Forest District – data for this cutblock was used for ecological and administrative assessments, but not to assess volume or area impact.

Note: The BWBS, SBPS and SBS zones contained lower numbers of sampled cutblocks (smaller sample size), and evaluation results for these zones are less reliable.

Table 1a. Number of pre- and post-harvest cutblocks sampled by BEC zone

BEC zone[a]	Number of cutblocks surveyed pre-harvest	Number of cutblocks surveyed post-harvest	Total number of cutblocks surveyed
BWBS	1	7	8
CWH	4	27	31
ESSF	3	27	30
ICH	0	30	30
IDF	1	13	14
SBPS	0	6	6
SBS	1	8	9
Total	10	118	128

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

Silviculture prescriptions described many different objectives for the reserves left within cutblocks. These objectives included wildlife tree retention, riparian reserves and management zones, temporary reserves, reserves associated with the retention silvicultural system, and visual reserves. In some instances, there were no objectives described in the silviculture prescription for reserves left on site.

Reserves retained for reasons other than wildlife tree or riparian retention were considered to contribute to ecological value. However, due to their unknown longevity, it is difficult to estimate the long-term contribution of these reserves to stand-level biodiversity. These types of reserves were not included in the timber supply impact analysis.

Table 1b describes the different types of reserves sampled in the evaluation, and provides a code and description for each reserve type. These codes are used throughout this report.

Table 1b. Types of reserves found in the evaluation

Reserve type[a]	Code used in report	Description of reserve type
Alternative Wildlife Tree Reserve (pre-harvest cutblocks only)	AW	These were potential reserve areas identified by the field assessors that provided, in the opinion of the assessors, better wildlife tree habitat than the reserves identified in the silviculture prescription (SP).
Dispersed Riparian	DR	Riparian management zones with partial retention.
Dispersed Temporary	DT	A dispersed reserve where the SP indicated the reserve was temporary.
Dispersed Retention Silvicultural System	DS	A dispersed reserve where the SP described the silvicultural system (and the trees retained) as variable retention.
Dispersed Undefined	DU	A dispersed reserve where the SP did not describe the retention of reserves or where the SP did not describe the objective or longevity of the reserve.
Dispersed Visual	DV	A dispersed reserve where the SP described the reserve objective as "visual."
Dispersed Wildlife	DW	A dispersed reserve where the SP described the reserve objectives as wildlife, wildlife tree retention, and/or biodiversity.
Patch Riparian	PR	Includes patch areas within riparian reserves or riparian management zones.
Patch Retention Silvicultural System	PS	A patch reserve where the SP described the silvicultural system (and the trees retained) as variable retention.
Patch Temporary	PT	A patch reserve where the SP indicated the reserve was temporary.
Patch Undefined	PU	A patch reserve where the SP did not describe the retention of reserves or where the SP did not describe the objective or longevity of the reserve.
Patch Wildlife	PW	A patch reserve where the SP described the reserve objectives as wildlife, wildlife tree retention, and/or biodiversity.

[a] Dispersed reserve – trees retained individually as opposed to a patch or group.
Patch reserve – discrete area or group of trees with no harvesting.

Field Sampling Procedures

All 128 cutblocks in the study were surveyed between August and November 2001. Plots were established in reserves within or adjacent to the harvest area boundaries. Where the silvicultural system was some form of partial cutting, reserve trees/areas that were not likely to be harvested were also sampled (e.g., a shelterwood system where the silviculture prescription specified the trees were to be retained for biodiversity). Short-term retention areas, such as temporarily deferred areas and seed trees designated for future harvest, were not required to be sampled.

While cutblocks were the primary sampling units, overall cutblock estimates were obtained by sampling and summing the individual reserves within each cutblock. Data collection methods were different for the two general types of reserves: 1) patches and 2) dispersed. This was necessary since patches were usually somewhat dense, while dispersed areas usually had trees thinly spread out over a large area. The overall cutblock estimate was obtained by weighting the separate patch and dispersed estimates by area and summing or averaging, as the case may be.

Reserve patches were generally sampled using prism plots, with a sampling intensity of one plot per hectare of reserve. In very small patches (less than 20 trees) all trees were measured. The plots were randomly chosen from a grid of potential plot locations overlaid on the retention polygon. A maximum of 10 plots was established per patch reserve area. A minimum basal area factor of four was used. For plots located on the edge of the reserve polygon, the mirage correction procedure was used rather than establishing ½ or ¼ plots (see Appendix VI).

Wildlife tree patch anchored around large Douglas-fir vets near Quesnel.

Areas of dispersed (single tree) reserves were either measured with a complete count of all reserve trees, or, if this was not practical, using prism sampling. Fixed area plots were also used in some cases for larger areas of dispersed reserves where the density was not sufficient to utilize prism plots and it was not practical to do a full count of all retained trees. The choice of which type of plot to use depended on the density of retained trees and the discretion of the field assessors, provided a minimum of 30 trees were sampled per dispersed reserve. A minimum of 30 trees were selected based on operational feasibility and statistical considerations (i.e., means are often normally distributed with a sample size of 30 or more).

The potential to use two data collection methods for patches and three methods for dispersed reserves provided a degree of flexibility and facilitated efficient data collection, given the broad stand structure and geographic variation in the study area. Standard timber cruising methodology was used for the collection of individual tree data (see http://www.for.gov.bc.ca/revenue/manuals/cruising/). Additional data associated with the wildlife tree policy ecological guiding principles were also collected (see Appendix I).

Data collected from each sampled reserve included tree species, height, diameter, tree class, and damage codes. Sampled trees included standing dead and down. The minimum size for sampled trees was 12.5 centimetres diameter at breast height (dbh). Additional information, such as wildlife tree rating, and presence of dangerous and hollow trees, was also collected to help determine the value of the patch in terms of wildlife tree retention. Field cards, and descriptions of all data elements collected, are provided in the Appendices.

Each reserve area was summarized by answering a series of questions (see Appendix II), and several representative photographs were taken for each cutblock. Cutblocks were assessed for how well the reserves met the ecological and administrative guiding principles specified in the *Provincial Wildlife Tree Policy and Management Recommendations.*

Sampling Pre-harvest Cutblocks

Ten of the 128 cutblocks evaluated were pre-harvest cutblocks (see Table 1a). Field assessors surveyed the proposed reserve areas identified in the silviculture prescriptions using the same procedures described above. In addition, the assessors also searched for "alternative" reserves that would have provided "better" ecological wildlife tree values than the designated reserve areas in the silviculture prescriptions. This exercise was based on a review of aerial photos and the professional opinion of the field assessors following a walk through of the proposed cutblocks. The "alternative" reserves were surveyed and compared to the proposed reserves identified in the silviculture prescription. The area outside the prescribed and "alternative" reserve areas (i.e., non-reserve area) was not directly sampled.

Analysis Methods

Most variables for the 128 sampled cutblocks were summarized by BEC zone. This involved several steps. First, a summary or count, depending on the variable, was determined for each reserve, which was then summarized for each reserve type within the cutblock. Most variables were weighted by the area of the reserve type within the cutblock. These cutblock values were then used to develop BEC zone summaries. Analysis of the majority of variables was only for the 128 cutblocks surveyed. Volume and area timber supply impacts were estimated for the BEC zones in the study by using the selection probabilities. Analysis methods are described more precisely under individual sections of the report.

Depending on the question being asked, dispersed retention was analyzed either as actual area (often equivalent to the net area to be reforested (NAR) if the dispersed trees were distributed over the entire cutblock), or as a volume equivalency area. Volume equivalency area is determined by comparing pre-harvest volumes from cruise data and post-harvest volumes as calculated from project data. For example, if a dispersed retention area contained 5% of the pre-harvest volume, its volume equivalency area would be calculated as 5% of the total area of dispersed retention.

The information collected from all surveyed reserves, including temporary, visual, and reserves with undefined objectives, was utilized in the ecological analysis of wildlife tree retention. This was done to see if wildlife tree habitat values were being retained regardless of the intention of the reserve.

In the timber supply section, only reserves classified and designated as wildlife tree retention were used to determine timber supply impacts. While riparian reserves were included in the ecological analysis, they are not pertinent to the timber supply analysis as riparian reserves are removed from the timber harvesting land base.

Small area of trees in gully not identified as a reserve, adjacent to a cutblock near Chilliwack.

Results

Ecological and Administrative Guiding Principles

A major component of this evaluation was to assess how effectively current wildlife tree retention met the recommendations and suggested practices outlined in the ecological and administrative guiding principles of the *Provincial Wildlife Tree Policy and Management Recommendations.* The results are as follows.

Ecological Guiding Principle1 (EGP 1)

Wildlife tree retention should, as a first priority, protect trees with valuable wildlife tree attributes. Where there are few trees with valuable attributes, wildlife tree retention should be located in areas most suitable for long-term wildlife tree recruitment. Where neither of these objectives are attainable, wildlife tree retention should be reflective of the pre-harvest stand.

EGP 1 – Evaluation Results

To evaluate EGP 1, we asked four questions.

Question #1. What is the ecological value rating of the reserves being retained?

Ecological value ratings were assigned to each reserve area by the field assessors based on a synthesis of the data collected in the reserve, knowledge of the surrounding stand type, and professional judgement. Ratings were determined by considering the question, "Is the reserve ecologically appropriate when compared to other available habitat within the TAUP?" Ratings used to describe ecological value were high, medium or low (see Appendix VII).

It is important to bear in mind that the ecological value ratings are relative, and largely related to the available attributes that could have been retained in the cutblock. For example, in zones with few large dead trees, such as the SBS, retaining large trees with the potential to become good wildlife trees would likely yield a high rating. Whereas in the CWH or ICH, where large dead trees are more common, high-value wildlife trees must have been retained in order to warrant a high rating.

A single ecological value rating was determined for each sampled cutblock by weighting the field assessors' ratings for each reserve within the cutblock based on the relative size of the reserve. No attempt was made to determine the actual ecological value of the cutblocks in terms of maintaining habitat for any particular species.

Table 2 presents the average ecological value rating for the sampled cutblocks by BEC zone. Figure 1 illustrates the percentage of cutblocks in each ecological value rating category.

Table 2. Average ecological value rating of sampled cutblocks, by BEC zone

BEC[a] zone	# of cutblocks	Number of cutblocks per category				Percent of cutblocks per category			
		High	Medium	Low	No reserves	High	Medium	Low	No reserves
BWBS	8	1	6	1	0	12.5	75	12.5	0
CWH	31	22	7	0	2	71.0	22.6	0.0	6.5
ESSF	30	4	10	11	5	13.3	33.3	36.7	16.7
ICH	30	16	10	3	1	53.3	33.3	10.0	3.3
IDF	14	7	5	1	1	50.0	35.7	7.1	7.1
SBPS	6	0	3	1	2	0.0	50.0	16.7	33.3
SBS	9	3	3	2	1	33.3	33.3	22.2	11.1
Total	128	53	44	19	12	41.4	34.4	14.8	9.4

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

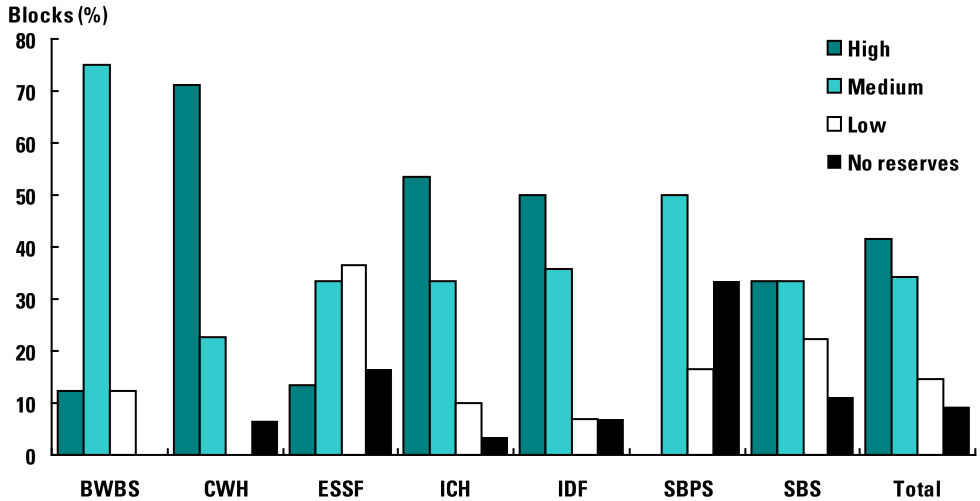


Figure 1. Percentage of cutblocks in each ecological value rating, by BEC zone.

Overall, the percent of sampled cutblocks rated as having high ecological value was 41.4%, with 34.4 % having medium value, 14.8% having low value, and 9.4% having no reserves. When averaged over all BEC zones, almost 76% of the cutblocks were rated as having either high or medium ecological value.

The percentage of cutblocks with high ecological value ranged from 0% in the SBPS to 71% in the CWH. Ranking from the greatest percentage of high-value cutblocks to the lowest percentage was CWH, ICH, IDF, SBS, ESSF, BWBS and SBPS.

The ESSF had the most cutblocks rated as having low ecological value (36.7%), followed by the SBS (22.2%), and the SBPS (16.7%). None of the CWH cutblocks were rated as having low ecological value. In the SBPS, 33.3% of cutblocks had no reserves.

BEC zones that experience frequent stand-destroying fires tend to have younger forests (e.g., SBPS, BWBS, SBS). These zones with younger forests generally had fewer cutblocks rated as having high ecological value compared to zones where the forests tend to be older (e.g., CWH and ICH). Zones with older forests generally experience fewer fires, and had more high-value stand attributes available for retention (e.g., large live and dead standing trees). In the IDF, larger Douglas-fir trees often survive fires to provide a source of high-value stems for retention.

The observations provided by the field assessors were used to develop Table 3. This table shows the attributes that were considered to represent high, medium and low ecological value cutblocks in the different BEC zones.

Table 3. Description of ecological value ratings as determined by the field assessors, by BEC zone

BEC zone[a]	High	Medium	Low
BWBS	large Sx,[b] Ac	smaller trees, windthrow damage, live rather than dead trees	no variation in stand structure, only scattered stubs
CWH	stand diversity, good range of tree sizes, large dead and live trees, streams and wetlands, good range of ecotypes	often in second growth, smaller trees, deciduous, retained stems with potential	no low-value cutblocks
ESSF	dead and diseased trees, large sized Sx, Fd, Bl, wetlands	few vets, smaller and younger trees	few small trees
ICH	large trees, dead trees, diseased trees, mix of species, range of ecotypes, wetlands, shrubby grizzly bear habitat	mostly large trees	no large trees
IDF	large Fd, Py, dead trees, trees with decay, presence of At	some Fd	little structure retained
SBPS	no high-value cutblocks	some At and/or Sx	little or no retention (some small At and/or Sx)
SBS	trees with potential to become good wildlife trees	presence of Pl, At, Ac	little structure retained

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

[b] Sx = spruce hybrid; Ac = cottonwood; Fd = Douglas-fir; Bl = subalpine fir; Py = yellow pine; Pl = lodgepole pine; At = aspen.

Question #2. How abundant are high-value wildlife trees?

The number of high-value wildlife trees per cutblock was derived by totalling the number of high-value wildlife trees in all reserves (excluding AW – alternate reserves) on each cutblock and dividing by the total cutblock area (TAUP). See Table 4. (For a definition of high-value wildlife trees, see Appendix VII).

Table 4. Number of sampled cutblocks by high-value wildlife tree density class (sph), by BEC zone (all reserves)

Density of high-value wildlife trees (based on TAUP)	BEC zone[a]							Total
	BWBS	CWH	ESSF	ICH	IDF	SBPS	SBS	
≥10 sph	2	4	2	5	0	0	0	13 (10%)
4.0–<10 sph	1	10	4	3	0	0	2	20 (16%)
>0–<4.0 sph	2	13	6	16	8	2	5	52 (41%)
0	3	4	18	6	6	4	2	43 (33%)
Total	8	31	30	30	14	6	9	128

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

Twenty-six percent of the cutblocks (16%+10%) had four or more stems per hectare (sph) of high-value wildlife trees based on TAUP. Thirty-three percent of cutblocks had no high-value wildlife trees. Of the 13 cutblocks with ≥10 sph of high-value wildlife trees, one ICH cutblock had 60 sph, one BWBS cutblock had 42 sph, and the remaining cutblocks ranged from 11–23 sph.

Table 4a shows the number of sampled cutblocks with high-value wildlife trees by dispersed and patch reserve types. Of the 128 sampled cutblocks, 71 contained dispersed retention and 79 contained patch retention. Many of the cutblocks contained both dispersed and patch retention (see Table 9), and are therefore represented in both categories. The purpose of Table 4a is to compare the density of high-value wildlife trees using dispersed versus patch retention.

Table 4a. Number of sampled cutblocks by high-value wildlife tree density class (sph), by BEC zone (separated by patch-P and dispersed-D reserves)

Density of high-value wildlife trees (by reserve)	BEC zone[a]														All	
	BWBS		CWH		ESSF		ICH		IDF		SBPS		SBS			
	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P
≥10 sph	1	1		4		2	1	3							2 (3%)	10 (13%)
4.0–<10 sph	1			10	1	3	2	3					1	1	5 (7%)	17 (21%)
>0–<4.0 sph	2	1	6	11	4	3	12	7	6	2	2	1	4	1	36 (51%)	26 (33%)
0	2	3	3	2	13	9	4	4	3	5	2		1	3	28 (39%)	26 (33%)
Total	6	5	9	27	18	17	19	17	9	7	4	1	6	5	71	79

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

Table 4a shows that there was a higher percentage of sampled cutblocks with patch retention containing four or more stems per hectare of high-value wildlife trees (34%), compared to cutblocks with dispersed retention (10%). The percentage of cutblocks with no high-value wildlife trees per hectare was similar between dispersed and patch retention (39% versus 33%). Overall, current practices, as observed on the 128 sampled cutblocks, suggest that high-value wildlife trees are being retained with both dispersed and patch retention techniques. However, in the CWH, higher densities of high-value wildlife trees are more likely to be found with patch retention. This is probably due to safety considerations.

The percent occurrence of high-value wildlife trees was determined for each reserve. An average of these percentages was determined for all the reserves within each reserve type. This information is presented in Table 5.

Table 5. High-value wildlife trees as a percent of total tree population, by reserve type

	Reserve type[a]										
	AW	**DR**	**DT**	**DU**	**DV**	**DW**	**PR**	**PS**	**PT**	**PU**	**PW**
Average % of trees rated as high-value wildlife trees	6.7	2.9	13.1	2.7	5.9	3.5	4.9	9.0	5.8	3.7	4.8

[a] AW= Alternative Wildlife Tree Reserve; DR=Dispersed Riparian; DT=Dispersed Temporary; DU=Dispersed Undefined; DV=Dispersed Visual; DW=Dispersed Wildlife; PR=Patch Riparian; PS=Patch Retention Silvicultural System; PT=Patch Temporary; PU=Patch Undefined; PW=Patch Wildlife.

The highest average percentage of high-value wildlife trees occurs in the four DT reserves (13.1%). In particular, one SBS DT had 23.4% of stems as high-value wildlife trees; however, this reserve was expected to be harvested within 20 years, so these high-value wildlife trees are only short term. The three PS reserves (found only in the CWH on the South Coast) also had a high percentage of high-value wildlife trees (9.0%).

- The average percentage of high-value wildlife trees for all dispersed reserves was 3.5%.
- The average percentage of high-value wildlife trees for all patch reserves was 4.9%.
- The average percentage of high-value wildlife trees for DW and DR reserves was 2.9%.
- The average percentage of high-value wildlife trees for PW and PR reserves was 4.8%.

The average percentage of high value wildlife trees for all dispersed reserves (3.5%) is lower than the average for all patch reserves (4.9%). When only stand-level biodiversity reserves (wildlife and riparian) are considered, the average percentage of high value wildlife trees for dispersed reserves is 2.9% versus 4.8% for patch reserves.

Question #3. How did pre- and post-harvest species composition compare?

Table 6 illustrates the shift in species composition after harvesting. Pre-harvest species composition was derived from the pre-harvest cruise compilation data. A percentage of total net volume by species groupings was determined by summing the data from all cutblocks in each BEC zone. This was done for the pre-harvest cruise data and the post-harvest reserve area data for the sampled cutblocks. The species groupings are fairly broad, and the opportunity exists to do a more refined analysis (e.g., separate out the different pine species).

Table 6. Percent species by volume per BEC zone – pre- and post-harvest

Species	BEC zone[a]														Total	
	BWBS		CWH		ESSF		ICH		IDF[b]		SBPS		SBS			
	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post	pre	post
Fir/Larch			31	16	1	5	24	18	38	74			21	10	20	16
Pine	55	16			19	29	13	6	53	12	81	51	56	46	22	9
Spruce	33	44	5	28	44	30	17	24	6	6	16	17	13	31	18	27
Balsam			13	16	34	31	9	11		1			2	5	13	13
Hemlock			31	27	1	2	16	19					5	4	15	18
Cedar			16	10		3	19	21		2					10	11
Aspen	10	36					1		1	2	3	32	1	4	1	3
Cotton-wood	3	4													0	0
Birch			1				1	1	1	2			1		1	0
Other Decid.			1	3											0	1

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

[b] No cruise data was found for one IDF cutblock in the Kamloops Forest District – this cutblock was not included in Table 6.

Major shifts in species composition occurred in:

- BWBS – decrease in pine (55% to 16%; increase in aspen (10% to 36%)
- CWH – decrease in fir/larch (31% to 16%); increase in spruce (5% to 28%)
- ESSF – increase in pine (19% to 29%); decrease in spruce (44% to 30%)
- IDF – increase in fir/larch (38% to 74%); decrease in pine (53% to 12%)
- SBPS – decrease in pine (81% to 51%); increase in aspen (3% to 32%)
- SBS – decrease in fir/larch and pine (21% to 10%); increase in spruce (13% to 31%).

The decrease in pine composition in the IDF, SBPS and SBS may be partly a result of the ongoing bark beetle epidemic in those BEC zones (Tim Ebata, pers. comm.) due to preferential retention of other species to reduce future mountain pine beetle risk and/or to the removal of trees that have been attacked by the beetle. The large increase in aspen in the BWBS and SBPS is due to the high level of retention of aspen in dispersed retention areas. The increase in spruce in the CWH was entirely due to the variable retention silvicultural system (PS). Species shifts within the ICH were relatively minor.

Species shifts are generally more notable in coniferous species when all BEC zones are totalled. The volume contributed by pine, when averaged across all BEC zones, dropped from 22% at pre-harvest to 9% post-harvest. Lodgepole pine is not generally considered a valuable or preferred wildlife tree, and commonly represents a high proportion of stand volume. This decrease may indicate a deliberate selection of trees considered valuable for wildlife tree retention, where rarer and/or more valuable wildlife trees are retained on the cutblock. The percentage of spruce increased from 18% to 27% in the reserves. In the Interior, this increase in spruce was generally attributed to the retention of small diameter understorey trees, which have little current wildlife tree value.

Question #4. How did pre- and post-harvest diameter and height by species compare?

Table 7 shows the average pre- and post-harvest diameter and height by species for the cutblocks sampled in each BEC zone. The pre-harvest data was derived from the cruise compilation summaries. Stems classified in the cruise data as "dead useless" were not included. Data for any particular species in a cutblock was used only when that species occurred both pre- and post-harvest.

Table 7. Average pre- and post-harvest tree diameter and height by species for the cutblocks sampled in each BEC zone

BEC zone[a]	Species[b]	DBH (cm)					Height (m)				
		# of blocks	Pre-harv mean	Post-harv mean	Post/pre ratio	Significant[c]	# of blocks	Pre-harv mean	Post-harv mean	Post/pre ratio	Significant[c]
BWBS	Cotton-wood	2	43.2	53.2	1.23		2	27.4	26.9	0.98	
BWBS	Aspen	7	27.0	30.9	1.15		7	22.4	23.6	1.05	
BWBS	Lodgepole pine	5	23.7	27.4	1.16		5	21.5	19.1	0.89	
BWBS	Spruce	7	27.5	26.2	0.96		7	23.1	18.3	0.79	
CWH	Balsam	13	47.9	41.8	0.87		11	34.3	25.9	0.75	Y
CWH	Cedar	24	49.6	52.5	1.06		24	30.0	23.7	0.79	Y
CWH	Alder	3	27.3	31.8	1.16	Y	3	27.5	26.5	0.97	
CWH	Birch	1	21.5	21.6	1.00		1	18.1	17.5	0.97	
CWH	Douglas-fir	12	43.9	42.2	0.96		11	35.3	29.9	0.85	Y
CWH	Hemlock	28	37.6	40.0	1.06		28	30.8	23.2	0.75	Y
CWH	Big leaf maple	2	28.4	32.0	1.13		2	34.7	28.9	0.83	
CWH	Lodgepole pine	1	28.8	20.4	0.71		1	25.8	17.0	0.66	
CWH	Spruce	6	68.7	78.6	1.15		6	42.2	37.5	0.89	
ESSF	Aspen	1	26.4	22.4	0.85		1	22.0	20.0	0.91	
ESSF	Balsam	20	28.4	23.0	0.81	Y	20	23.2	12.8	0.55	Y
ESSF	Cedar	1	54.4	34.2	0.63		1	26.2	14.2	0.54	
ESSF	Douglas-fir	4	38.1	36.6	0.96		4	25.7	23.5	0.91	
ESSF	Hemlock	3	30.6	26.4	0.86		3	21.2	12.5	0.59	
ESSF	Larch	3	32.6	44.2	1.35		3	29.3	25.7	0.88	
ESSF	Lodgepole pine	11	23.4	23.6	1.01		11	21.1	17.1	0.81	Y
ESSF	White pine	2	42.6	36.2	0.85		1	25.4	23.4	0.92	
ESSF	Spruce	23	34.6	27.4	0.79	Y	23	26.1	16.2	0.62	Y

BEC zone[a]	Species[b]	DBH (cm)					Height (m)				
		# of blocks	Pre-harv mean	Post-harv mean	Post/pre ratio	Significant[c]	# of blocks	Pre-harv mean	Post-harv mean	Post/pre ratio	Significant[c]
ICH	Cotton-wood	3	67.5	77.3	1.14		3	34.6	30.0	0.87	
ICH	Aspen	5	31.4	25.8	0.82	Y	5	26.9	20.6	0.77	Y
ICH	Balsam	18	30.5	27.3	0.90		15	25.8	17.0	0.66	Y
ICH	Cedar	18	36.3	27.6	0.76	Y	18	25.6	15.6	0.61	Y
ICH	Birch	6	25.2	25.8	1.03		5	22.7	19.6	0.87	
ICH	Douglas-fir	15	41.1	46.3	1.13		14	32.1	25.7	0.80	Y
ICH	Hemlock	15	32.6	32.8	1.01		15	26.3	19.5	0.74	Y
ICH	Larch	2	49.6	40.8	0.82		2	30.5	30.5	1.00	
ICH	Lodgepole pine	7	27.2	25.3	0.93		7	24.5	17.6	0.72	Y
ICH	White pine	6	32.7	27.4	0.84		5	27.4	14.6	0.53	Y
ICH	Spruce	20	39.2	34.2	0.87		20	31.9	21.7	0.68	Y
IDF[d]	Aspen	3	22.4	22.2	0.99		2	17.4	19.3	1.11	
IDF	Cedar	1	36.4	21.5	0.59		1	21.0	12.1	0.58	
IDF	Birch	2	23.9	24.5	1.03		2	27.8	20.5	0.74	
IDF	Douglas-fir	11	41.6	39.6	0.95		9	23.7	20.7	0.87	
IDF	Lodgepole pine	8	19.1	23.1	1.21	Y	8	17.9	17.0	0.95	
IDF	Yellow pine	1	39.0	39.2	1.01		1	17.8	18.6	1.04	
IDF	Spruce	3	28.9	24.0	0.83		3	24.9	16.1	0.65	
SBPS	Aspen	2	23.5	20.8	0.89		2	18.2	14.1	0.77	
SBPS	Lodgepole pine	1	22.2	21.7	0.98		1	22.1	18.2	0.82	
SBPS	Spruce	1	31.2	22.3	0.71		1	26.6	15.6	0.59	
SBS	Cotton-wood	3	37.1	34.5	0.93		3	24.5	22.7	0.93	
SBS	Aspen	5	32.8	39.4	1.20		5	27.7	22.3	0.81	
SBS	Balsam	4	27.7	19.4	0.70		3	26.3	13.6	0.52	Y
SBS	Birch	2	23.0	25.7	1.12		2	23.2	20.7	0.89	
SBS	Douglas-fir	6	46.8	52.8	1.13		5	29.0	28.8	0.99	
SBS	Hemlock	1	34.7	20.7	0.60		1	26.5	12.5	0.47	
SBS	Lodgepole pine	4	28.7	27.7	0.97		4	27.0	23.5	0.87	Y
SBS	Spruce	7	31.2	29.8	0.95		6	25.3	19.1	0.75	Y
Tally of blocks with significant size difference						6					18

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

[b] Spruce includes: black, Englemann, Sitka, white and hybrid (Sb, Se, Ss, Sw and Sx).
Balsam includes: amabalis, grand and subalpine (Ba, Bg and Bl).
Hemlock includes: mountain and western (Hm and Hw).
Cedar includes: western red and yellow (Cw and Cy).

[c] Y in significant column indicates that the 95% confidence limit for the ratio does not include the null hypothesis of 1.0.

[d] No cruise data was found for one IDF cutblock in the Kamloops Forest District – this cutblock was not included in Table 7.

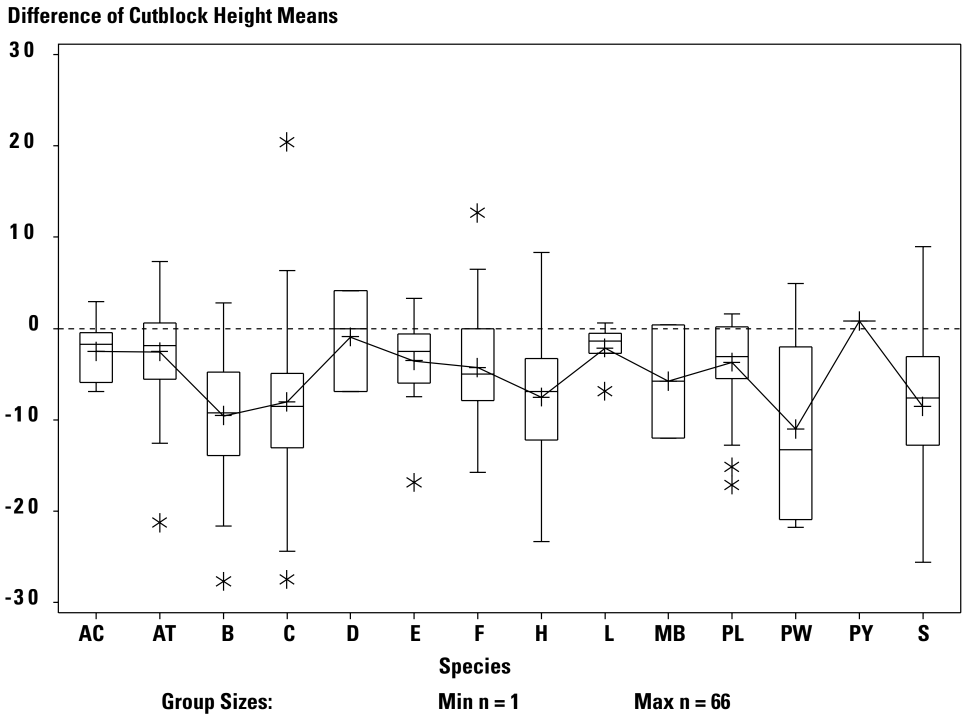
The data from Table 7 shows that there is a trend towards smaller average heights and diameters in reserve trees compared to average pre-harvest heights and diameters. Of the 51 zone/species combinations, 48 (94%) showed reductions in average height, 18 of these height reductions were statistically significant. Three of the zone/species combinations (6%) showed increases in average height, none of which were statistically significant. Thirty of the 51 zone/species combinations (59%) showed decreases in average diameter, four of which were statistically significant. Twenty of the zone/species combinations (39%) showed increases in average diameter, two of which were statistically significant.

The changes in pre- and post-harvest height and diameter by tree species are presented in the boxplots in Figure 2. The further the middle of the box is from the zero line, the stronger the evidence of decreased post-harvest heights or diameters (if below the zero line) or increased post-harvest heights or diameters (if above the zero line). The lower and upper ends of the boxes are defined by the lower and upper quartiles of the data (one-quarter of the data points are smaller than the lower quartile while three-quarters of the data points are smaller than the upper quartile). The middle line is the median (half of the data points are smaller than this value), while the cross is the mean of the data. The jointed line between the boxes connects the means. The whiskers attached to the boxes extend either to the minimum or maximum value of the data up to 1.5 times the length of the box. Data points beyond this are plotted individually.

From the data, it is difficult to determine with certainty the reason for the decrease in average height and diameter in post-harvest reserve trees. Selection of lower site quality locations for wildlife tree retention areas (e.g., wet sites, seepage areas, ridges) may explain the lower averages for some heights and diameters. Selection of marginally merchantable/economic trees, understorey trees, and large advanced regeneration (see interior spruce in Table 6) could also account for the height/diameter decreases in wildlife tree retention areas. Selection of lower height/diameter trees to reduce windthrow risk could also be a factor.

The trend towards smaller average heights and diameters in reserve trees is a concern. Taller wildlife trees generally provide larger diameters at higher distances above the ground, providing more habitat values for wildlife tree users (Bevis and Martin 1999) (Bunnell et al. 1999). Nest predation is known to decrease with increased nest height (Li and Martin 1991).

a) Height



b) Diameter

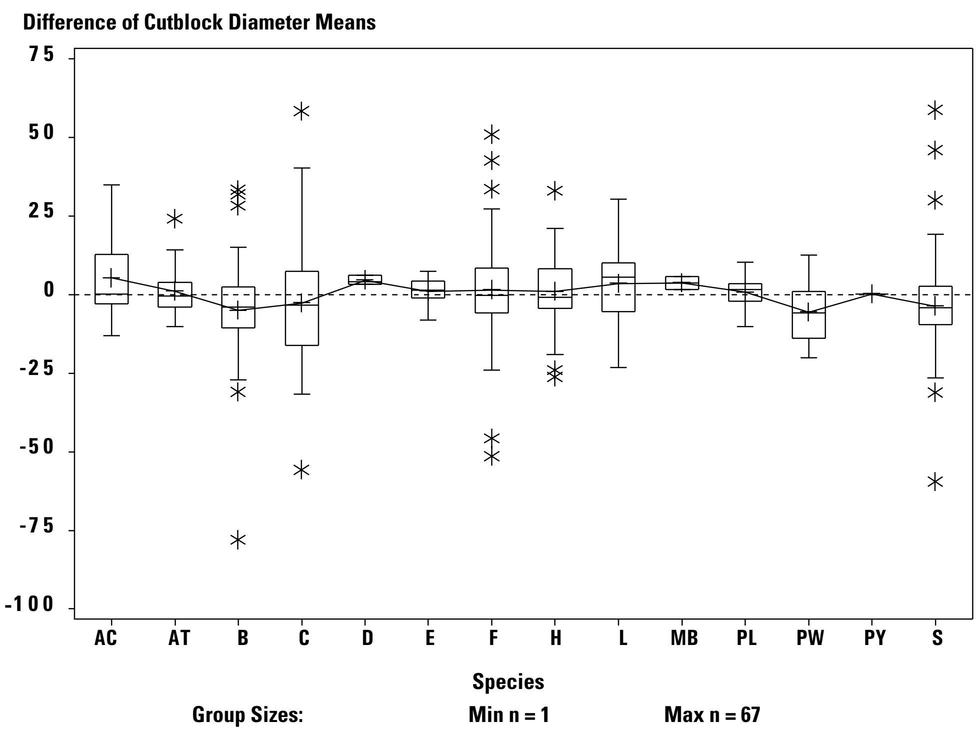


Figure 2. Average pre- and post-harvest heights (m) and diameters (dbh in cm) by tree species.[a]

[a] AC=cottonwood; AT=aspen; B=balsam; C=cedar; D=alder; E=birch; F=Douglas-fir; H=hemlock; L=larch; MB=big leaf maple; PL=lodgepole pine; PW=white pine; PY=yellow pine; S=spruce.

Ecological Guiding Principle 2 (EGP 2)

A diversity of wildlife tree retention strategies is recommended, for example, a range of wildlife tree patch sizes, combined with dispersed trees (there will be ecosystem-dependent variances to this recommendation). However, larger patches containing trees with valuable wildlife habitat attributes generally serve a greater number of ecological functions.

EGP 2 – Evaluation Results:

To evaluate EGP 2, we asked three questions.

Question #1. Have a variety of retention strategies been used (e.g., patches versus dispersed)?

Wildlife tree retention within a cutblock can be dispersed or in patches. Table 8 shows how frequently these two types of retention were used in the sampled cutblocks, either alone or in combination.

Table 8. Percentage of cutblocks within each BEC zone that contain patch, dispersed, both, or no retention

BEC zone[a]	# of cutblocks sampled	Patch reserves only		Dispersed reserves only		Dispersed & patch reserves		No retention	
		#	%	#	%	#	%	#	%
BWBS	8	2	25	3	38	3	38	0	0
CWH	31	20	65	2	6	7	23	2	6
ESSF	30	7	23	8	27	10	33	5	17
ICH	30	10	33	12	40	7	23	1	3
IDF	14	4	29	6	43	3	21	1	7
SBPS	6	0	0	3	50	1	17	2	33
SBS	9	2	22	3	33	3	33	1	11
Total/Ave	128	45	35	37	30	34	27	12	9

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

The majority of CWH cutblocks (65%) had patch retention only. Very few CWH cutblocks (6%) had only dispersed retention. All other zones showed a higher percentage of cutblocks with only dispersed retention (27–50%). The SBPS zone had no cutblocks with only patch retention. When reserves types are averaged for all sampled cutblocks, there is a fairly even distribution between dispersed, patch, and a combination of the two.

The intent of provincial wildlife tree policy is to have some retention in every cutblock. However, 12 of 128 sampled cutblocks had no retention. Furthermore, an additional 20 cutblocks contained retention with undefined objectives (18 cutblocks) or reserves for purposes other than stand-level biodiversity (2 cutblocks). The longevity of these 20 reserves is unclear. However, as 17 of the 18 cutblocks containing retention with undefined objectives were dispersed reserves of small trees with limited economic value, these reserves will likely remain for the length of the rotation. The ESSF contained seven of the 18 (38.9%) reserves with undefined objectives, while the ICH and CWH each contained three (16.7%). The BWBS had one of these reserves, and the IDF and SBS each had two. As a result, 25% of the

128 cutblocks sampled in the study either had no retention, contained retention with undefined objectives, or contained reserves for purposes other than stand-level biodiversity.

One of the sampling criteria was that cutblocks had to be at least five hectares or larger; therefore, the lack of retention on those 12 cutblocks was probably not due to small cutblock size. The 12 cutblocks with no retention ranged in size from 5.6 to 61.2 hectares, with an average TAUP of 24.1 hectares. It is not known why no retention occurred on those 12 cutblocks; however, they occurred in all BEC zones except BWBS. In addition, there was no relationship between the presence or absence of reserves and the year of harvest.

Question #2. What is the total area of each reserve type across the sampled BEC zones?

Table 9 and Figure 3 show the area of retention by reserve type for each BEC zone. Dispersed retention area is calculated as a volume equivalency. See the Analysis Methods section for an explanation of volume equivalency.

Dispersed retention accounts for approximately 20% of the total area of retention, with dispersed wildlife trees comprising the majority of the dispersed area (13.8%). Patch retention accounts for the remaining 80% of the total area of retention, with wildlife tree patches comprising the majority of the patch area (45.2%).

Patch riparian reserves (PR) were most prevalent in the SBS (76% of reserves), but were not found in the BWBS, IDF or SBPS. Wildlife tree patch retention (PW) was found in all zones, but was only a minor component of SBS retention. Both the IDF and the BWBS had a large amount of dispersed wildlife trees.

Figure 3 shows the percent distribution of the reserve types. PW and PR are grouped together, as these types of reserves are patch retention set aside for stand-level biodiversity purposes. DW and DR are grouped together for the same reason. Therefore, the bottom two categories in Figure 3 represent the area set aside for stand-level biodiversity. The upper two categories (PU/PT/PS and DV/DU/DT) are retained for other purposes, or are temporary in nature.

Table 9. Total area of retention for sampled cutblocks within BEC zones by reserve type (dispersed calculated as a volume equivalency)

Res. Type[b]	BEC zone[a]														Total	
	BWBS		CWH		ESSF		ICH		IDF		SBPS		SBS			
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
DR	0.5	1.2	0.2	0.2	0.2	0.4	0.4	0.4	3.5	6.2			0.1	0.2	4.9	1.1
DT			0.2	0.1			7.6	7.1					0.8	2.5	8.5	1.9
DU	0.1	0.2	0.5	0.3	2.4	3.8	1.6	1.5	1.1	1.9			2.5	8.2	8.2	1.8
DV							5.6	5.2							5.6	1.2
DW	16.0	39.5	0.4	0.3	0.4	0.6	13.5	12.6	29.4	52.7	1.1	16.5	2.1	6.9	63.0	13.8
PR			28.9	19.2	11.9	18.6	3.4	3.2					23.4	76.0	67.6	14.8
PS			40.0	26.5											40.0	8.8
PT	11.0	27.1	1.5	1.0											12.5	2.7
PU	0.8	1.8	0.2	0.1			38.9	36.4							39.9	8.7
PW	12.3	30.3	79.0	52.4	49.1	76.1	36.0	33.7	21.9	39.2	5.7	83.5	1.9	6.2	205.9	45.2
Total	40.6	100	150.8	100	64.1	100	107	100	55.9	100	6.8	100	30.8	100	462.7	100

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

[b] DR=Dispersed Riparian; DT=Dispersed Temporary; DU=Dispersed Undefined; DV=Dispersed Visual; DW=Dispersed Wildlife; PR=Patch Riparian; PS=Patch Retention Silvicultural System; PT=Patch Temporary; PU=Patch Undefined; PW=Patch Wildlife.

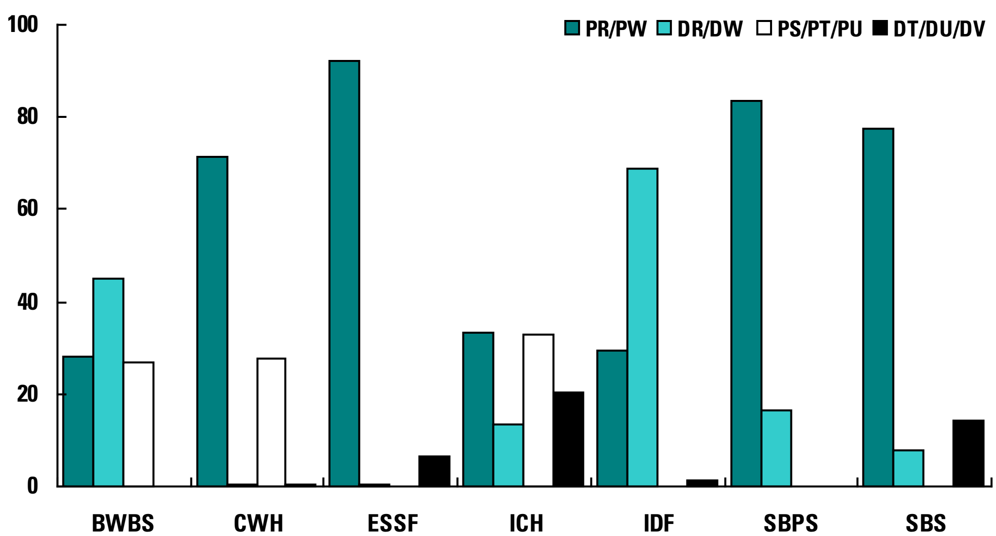


Figure 3. Percent of total reserve area (hectares) by reserve type by BEC zone.

Figure 3 shows that for the BWBS, CWH and ICH there is a substantial amount of reserve area retained for reasons other than wildlife tree and/or riparian reserves.

Question #3. What is the range in size of wildlife tree reserves?

Table 10 categorizes the distribution of patch reserves as greater or less than two hectares in size, by BEC zone.

TABLE 10. Distribution of patch reserves <2 hectares or ≥2 hectares, by BEC zone

BEC zone[a]	# reserves <2 ha			ha reserves <2 ha			# reserves ≥2 ha			ha reserves ≥2 ha		
	PR[b]	PW	other[c]	PR	PW	other	PR	PW	other	PR	PW	other
BWBS		7	3	6.8	3.9	0.8		2	1		8.4	11.0
CWH	9	31	15	2.6	26.2	3.8	4	14	2	23.1	52.8	37.8
ESSF	2	19		1.0	18.6		3	9	0	2.4	30.5	
ICH	1	18			13.8		1	7	1		22.2	38.9
IDF		10			11.5		0	4			10.4	
SBPS		5			5.7		0			23.4		
SBS		2			1.9		4			43.4		
Total	12	92	18	10.4	81.6	4.6	12	36	4	92.3	124.3	87.7

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

[b] PR=Patch Riparian; PW=Patch Wildlife.

[c] Other=patch reserves other than riparian or wildlife.

Ecological Guiding Principle 2 states that larger patches containing trees with valuable wildlife habitat attributes generally serve a greater number of ecological functions. Of the total 174 patch reserves, 52 (30%) were ≥2 hectares in size. When the area of all patch reserves is combined (PR + PW + other), 76% of the total area in patches was in reserves ≥2 hectares. Of the 128 wildlife tree patches (PW), 36 (28%) were ≥2 hectares in size. Approximately 60% of the total area in wildlife tree patches (PW) was in patches ≥2 hectares. Current policy allows patches ≥2 hectares to be designated as old-growth management areas (OGMAs) (See Administrative Guiding Principle 2).

Table 11 provides the average size of patch retention, by BEC zone.

The 24 PR reserves ranged in size from 0.1 hectares to 13.8 hectares, with an average of 2.8 hectares. The 128 PW reserves ranged in size from 0.1 to 10.3 hectares, with an average of 1.6 hectares. These ranges are consistent with Ecological Principle 2 – maintaining a diversity of wildlife tree retention strategies. However, the low averages indicate that larger retention areas are rare.

TABLE 11. Average size of patch retention, by BEC zone

BEC zone[a]	PR[b]				PW			
	# of reserves	Min ha	Ave ha	Max ha	# of reserves	Min ha	Ave ha	Max ha
BWBS	0				9	0.2	1.4	6
CWH	13	0.1	2.2	13.8	45	0.1	1.8	10.3
ESSF	5	0.8	2.4	3.6	28	0.2	1.8	5.8
ICH	2	1	1.7	2.4	25	0.2	1.4	4.1
IDF	0				14	0.3	1.6	4
SBPS	0				5	0.4	1.1	1.8
SBS	4	4	5.8	8.1	2	0.3	1.0	1.6
All Zones	24	0.1	2.8[c]	13.8	128	0.1	1.6[c]	10.3

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

[b] PR=Patch Riparian; PW=Patch Wildlife.

[c] Average weighted by sampled area.

Ecological Guiding Principle 3 (EGP 3)

It is particularly important to retain uncommon species, stand characteristics, and other elements of stand-level biodiversity. Consequently, relatively uncommon tree species in the block and adjacent subzones should form a larger proportion of the wildlife tree retention objective, provided these species exhibit, or have the potential to develop, valuable wildlife tree attributes.

EGP 3 – Evaluation Results:

To evaluate EGP 3, we asked the following question:
Were uncommon tree species, stand characteristics, uncommon habitat features, or other elements of stand-level biodiversity present in reserves?

Table 12 shows the presence, absence, or relative abundance within sampled cutblocks of three traits considered important for biodiversity – internal decay, uncommon species, and insect or disease activity. The presence of these traits was noted in sampled trees by the field assessors. The total number of trees with each trait was determined for each cutblock by summing all reserves within the cutblock. This total number of trees was then divided by the area of the cutblock (TAUP) to determine the abundance of the trait (average sph).

TABLE 12. Presence of internal decay, uncommon tree species and insects/disease, by BEC zone

		Internal decay		Uncommon tree species		Insects or disease	
BEC zone[a]	Total # of cutblocks	# of cutblocks with internal decay	Ave density (sph) within TAUP	# of cutblocks with uncommon tree species	Ave density (sph) within TAUP	# of cutblocks with insects or disease	Ave density (sph) within TAUP
BWBS	8	5	2.1	0	0	4	2.4
CWH	31	25	8.8	0	0	6	2.4
ESSF	30	10	1.1	1	0	5	2
ICH	30	21	14.4	3	0.2	10	0.6
IDF	14	8	1.6	2	0.3	5	2.9
SBPS	6	2	0.6	0	0	0	0
SBS	9	3	0.1	2	1.8	3	0.7
Total/ Ave	128	74 (58%)	4.1	8 (6%)	0.3	33 (26%)	1.6

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

Figure 4 shows the percent of internal decay, uncommon species, or current insect/disease activity, by BEC zone.

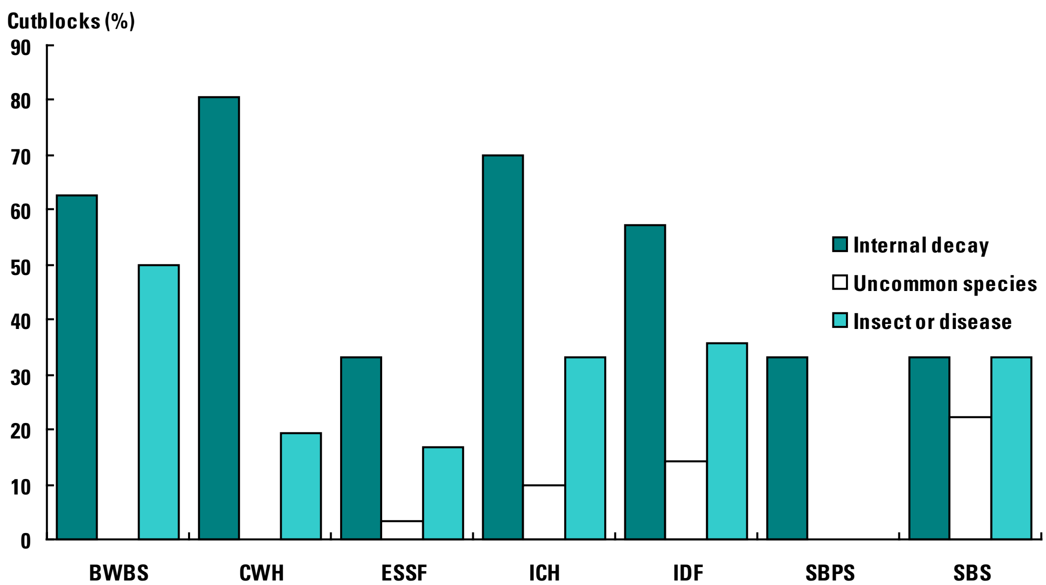


Figure 4. Percent of cutblocks with internal decay, uncommon species, or insect/disease activity, by BEC zone.

For all cutblocks sampled, just over half (58%) contained trees with signs of internal decay. Cutblocks in the CWH and ICH zones had the highest average density of trees with indications of internal decay (e.g., visible heart/sap rot, bird/animal excavations, etc.). The CWH and ICH zones also had the greatest number of cutblocks containing high-value wildlife trees and the greatest number of cutblocks rated as having high ecological value.

No uncommon tree species were noted in cutblocks within the BWBS, CWH, ESSF or SBPS zones. The abundance of uncommon tree species was low in the other three zones. Overall, only 6% of all cutblocks had any uncommon tree species. It is not known whether these levels of uncommon tree species are representative of natural stands.

Current insect or disease activity was noted in 26% of the sampled cutblocks. The presence of insects and disease are important factors that can contribute to wildlife tree habitat value. However, wildlife tree retention should be designed in a way to ensure that insects and disease do not contribute to future forest health issues.

With the available data, it is difficult to determine whether retention areas with internal decay, uncommon species, or current insect or disease activity were actively selected for or are representative of the pre-harvest stands.

No uncommon habitat features (e.g., bat roosts, raptor nests, etc.) were found in any of the sampled reserve areas. While these features are not common in the landscape, it is surprising that none were found in the sampled cutblocks. This may be a factor of the survey design, and requires further investigation.

Ecological Guiding Principle 4 (EGP 4)

Those trees/areas chosen for wildlife tree retention should be designated for a minimum of one rotation.

EGP 4 – Evaluation Results:

To evaluate EGP 4, we asked the following question:
Were wildlife tree reserves designated to be retained for a minimum of one rotation?

Seventy-five percent of the silviculture prescriptions for cutblocks with reserves did not mention the longevity of wildlife tree retention. In the other 25%, a minimum retention time of one rotation length was specified.

One of the questions in the District Questionnaire asked district staff if they expected wildlife tree reserves to be harvested in the future. In all cases, staff indicated that, in their opinion, wildlife tree retention areas would be retained for at least one rotation. Nine of the 11 districts that reported indicated that wildlife tree retention areas may be harvested at the end of the rotation. The other two districts reported that wildlife tree retention areas would not be harvested in the future.

Ecological Guiding Principle 5 (EGP 5)

Trees/areas chosen for wildlife tree retention should be designed to minimize windthrow and the potential for contributing to insect infestation in adjacent stands.

EGP 5 – Evaluation Results:

EGP 5 was grouped together with EGP 10. See results under EGP 10.

Ecological Guiding Principle 6 (EGP 6)

If trees chosen as wildlife trees have been felled, they should be left in place to function as coarse woody debris, unless they pose a significant forest health or other concern.

EGP 6 – Evaluation Results:

To evaluate EGP 6, we asked the following question:
If wildlife trees were felled, were they left in place?

The presence of felled trees within plots located in patch reserves was noted by field assessors. The results are shown in Table 13.

Table 13. Summary of felled trees found in plots, by reserve type and BEC zone

BEC zone[a]	# of trees	Reserve type	Description of felled tree(s)[b]
BWBS	5	PT	SW – ave dbh 30 cm
CWH	3	PR	HW – ave dbh 74 cm
CWH	1	PW	Ba – 51 cm dbh
CWH	1	PW	Ba – 59 cm dbh
ESSF	1	PW	SX – 104 cm dbh
ESSF	1	PW	Se – 36 cm dbh
Total	12		

a BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

b SW=white spruce; HW=western hemlock; Ba=amabalis fir; SX=spruce hybrid; Se=Englemann spruce.

Twelve felled trees were found in plots within six of the 128 sampled cutblocks (5%). Eight of the 12 felled trees were left on site. Five felled SW trees were found in a BWBS cutblock within a temporary patch retention area. Three felled HW trees were found within a riparian reserve in a CWH cutblock – two of those trees were removed from the site. The other two trees that were felled and removed were a 59 cm Ba and a 36 cm Se.

Field assessors also recorded general observations of felled trees within reserves, but outside of plots. Four patch reserves in addition to those noted in Table 13 had felled trees. Three of these had only minor cutting (<10% of stems) for safety reasons, with the stems remaining on site. One patch had >10% of stems cut and removed due to a seismic line running through the reserve.

In total, felled trees within reserves were found in 10 of 144 patch reserves, or 6.9% of patch reserves in harvested cutblocks. Removal of cut stems was found in four of 10 patches.

Felling trees within reserves was not a common occurrence in the sampled cutblocks. Where cutting in reserves did occur, the majority of felled trees were left in place. It is anticipated that trees within reserves are rarely felled, but when they are, it is primarily for safety reasons.

Ecological Guiding Principle 7 (EGP 7)

Selection of appropriate WTR areas should consider existing wildlife trees on the site. Planning for a diversity of wildlife tree classes will better meet future large wildlife tree and CWD objectives (including recruitment and longevity).

EGP 7 – Evaluation Results:

(Also refer to EGP 1 and 2 Evaluation Results)

To evaluate EGP 7, we asked the following question:
Are a variety of wildlife tree classes being retained?
(Refer to Appendix VIII for the wildlife tree classification system).

Table 14 shows the distribution of retained stems by wildlife tree class, and also indicates the average density of retained stems (sph) on all cutblocks in each BEC zone. The absolute number of trees in each wildlife tree class was determined for each reserve within a cutblock. These absolute numbers were summed by cutblock, and an average density of trees per wildlife tree class was determined by dividing by the total number of hectares in the cutblock (TAUP). An average density (sph) for each wildlife tree class was then calculated for each BEC zone. The 12 sampled cutblocks with no retention were not included in these calculations.

Table 14. Average density (sph) based on TAUP per wildlife tree class for sampled cutblocks with reserves, by BEC zone

WT class	BEC zone[a]							Ave.[b]
	BWBS	CWH	ESSF	ICH	IDF	SBPS	SBS	
1	87	51	81	57	21	19	41	57
2	30	37	19	45	28	29	34	33
3	16	2	3	3	5	1	1	4
4	12	1	3	3	2	2	2	3
5	3	1	5	9	1	0	1	4
6	1	2	0	1	0	0	1	1
7	1	1	2	4	0	0	0	2
8	3	1	1	2	3	0	1	2
9	0	2	0	0	0	0	0	1
Total sph	152	97	116	125	59	53	81	

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.
[b] Average weighted by sampled area.

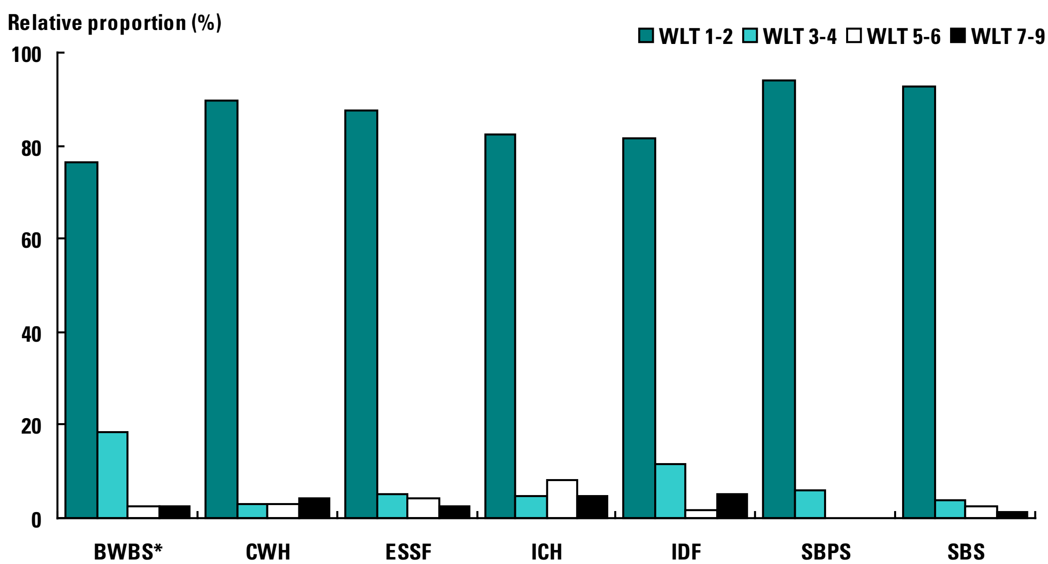
Wildlife tree classes 1 and 2 are live trees, and are generally not considered to contribute significant immediate wildlife tree value other than perching and nesting sites for raptors. They will, however, contribute habitat value over time, particularly where the tree has or develops internal decay. The mid-range classes (3–6) are beginning to decay and soften, and provide high habitat value. The last three classes (7–9) are highly decayed and valuable over the short term, eventually contributing to CWD. It is important to have a full range of wildlife tree classes present on a site.

For all sampled cutblocks, the majority of retained trees were in classes 1 and 2. The only BEC zone where all wildlife tree classes were represented was the CWH. Classes 6–9 were the least abundant classes. The lower abundance of trees in wildlife tree classes 3–9 may be attributed to the commonly held belief that only wildlife tree classes 1 and 2 are safe to retain, and that leaving more advanced wildlife tree classes will result in unsafe conditions and potential WCB violations. Proper assessment of trees in wildlife tree classes 3–9 using the wildlife danger tree assessment process could alleviate some of this concern and lead to the retention of more advanced wildlife trees.

Figure 5 groups the nine wildlife tree classes into four categories –WLT1–2, WLT3–4, WLT5–6, and WLT7–9. When this grouping is done, all four categories are present in each BEC zone, with the exception of the SBPS, which is missing WLT5–6 and WLT7–9.

This may be due to the small sample size in the SBPS (6 cutblocks), or could be a function of species composition and the way in which trees decay in that ecosystem. Many of the tree species in the SBPS have small diameters and rarely go beyond a WLT5–6 because they tend to decay at the root collar and fall over – only those trees with larger diameters are able to reach WLT7–9. The extensive fire history associated with the SBPS may also be a contributing factor to the lack of higher wildlife tree classes.

The natural distribution of wildlife tree classes within the study area is not known. As a result, it is unclear how these results compare to natural ecosystem distributions of wildlife tree classes.



* BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

Figure 5. Relative proportion of average sph in wildlife tree classes, by BEC zone.

Table 15 shows the abundance of stems in wildlife tree classes by reserve type using reserve area rather than TAUP. Actual area, as opposed to volume equivalency, is used for dispersed retention. The total number of stems by reserve type in each wildlife tree class was summed over all cutblocks by dividing the total stems by the total area applicable to all reserves of that type.

Table 15. Average density (sph) by wildlife tree class, by reserve type

WLT class	Reserve type[a]									
	AW	DR	DT	DU	DW	PR	PS	PT	PU	PW
1	90	63	29	7	18	379	240	310	237	392
2	171	30	34	7	16	189	85	47	292	200
3	50		7		2	14		65	1	28
4	21		2		2	37		26	18	26
5	30	11	2			16	1	24	270[b]	14
6	43					4	15	1	7	9
7						14			35	8
8				1	1	22	18	11	37	4
9						15	1	1	0	3
Total ave sph	405	104	74	15	39	691	359	483	896	684
Total ha of reserve	5	31	50	628	849	68	40	13	40	206

[a] AW= Alternative Wildlife Tree Reserve; DR=Dispersed Riparian; DT=Dispersed Temporary; DU=Dispersed Undefined; DW=Dispersed Wildlife; PR=Patch Riparian; PS=Patch Retention Silvicultural System; PT=Patch Temporary; PU=Patch Undefined; PW=Patch Wildlife.

[b] This relatively high number is the result of two cutblocks with a high number of small diameter stems in WLT class 5.

Table 15 also shows an average of total stem density by reserve type. Figure 6 provides the proportional relationship of wildlife tree class by reserve type. For dispersed retention, DR has the highest average density. The average total stem density for PW is higher than PR; however, there is a much smaller total reserve area of PR compared to PW.

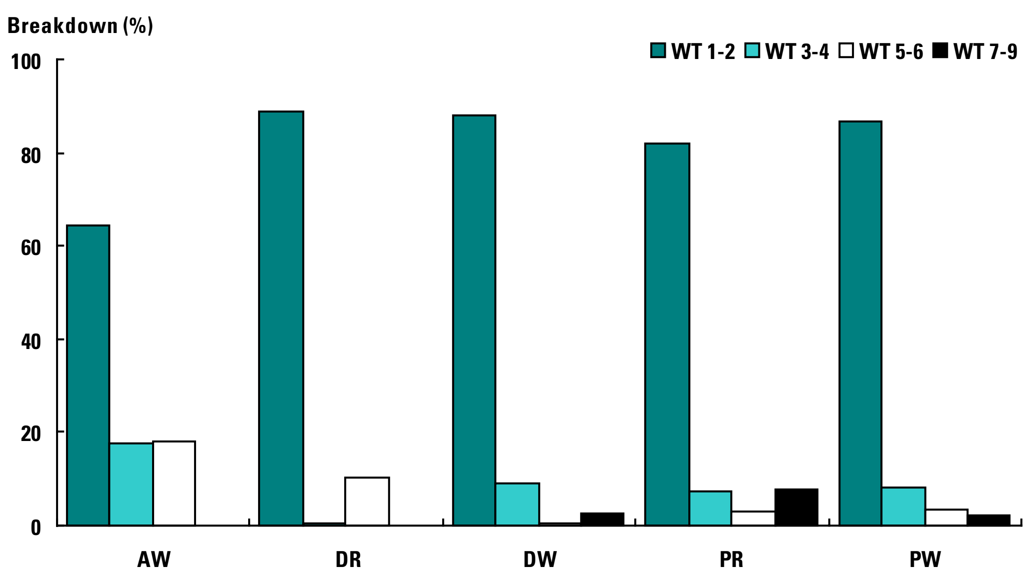


Figure 6. Percentage breakdown of grouped wildlife tree class abundance by reserve type.

The same general pattern is consistent regardless of reserve type – the majority of stems are in wildlife tree classes 1 and 2, with a much smaller proportion in the higher value classes (3–9). Patch reserves contained more wildlife trees in classes 3–9 than dispersed reserves, which tended to have very few of the higher-value wildlife tree classes. This is consistent with the removal of more decayed stems in dispersed retention areas due to safety concerns.

The AW reserves, selected by the field assessors as the best available retention areas for the pre-harvest cutblocks, had a higher percentage of stems in the more decayed wildlife tree classes. This is to be expected, as the assessors could select the best available wildlife tree habitat without engineering or logistical constraints. In six out of the 10 pre-harvest cutblocks, the assessors felt the prescribed retention captured the best available wildlife tree habitat.

Ecological Guiding Principle 8 (EGP 8)

How the characteristics of individual trees may affect the potential to achieve or maintain a particular stand structure (e.g., shade tolerance, tree longevity, disease/pest resistance, etc.) should be considered when selecting appropriate retention areas. Ensure that the trees being retained have the potential to achieve the desired stand structure.

Ecological Guiding Principle 9 (EGP 9)

It is important to consider the dynamic nature (caused by succession and other natural factors such as wind) of both individual trees and forest stands – individual and patch reserves will not remain in the same condition forever, and therefore may not provide the same habitat attributes over a rotation.

Ecological Guiding Principles 8 and 9 were not evaluated. These two principles articulate the importance of considering the dynamic nature of forest stands, and are intended to encourage prescribing foresters to think about these dynamics when retaining wildlife trees (e.g., Will there be sufficient trees of the right species to ensure attributes such as heart rot, sloughing bark, hollow trees, coarse woody debris, etc.? Will these attributes be present in the stand over the length of the rotation?).

To assess how successful various wildlife tree retention strategies were in meeting the objectives of these two principles, an evaluation would need to:

- sample specific cutblocks and their stand characteristics at various times over the rotation; or
- compare cutblocks harvested over the last 50–80 years in the same BEC zones and with similar retention schemes to the cutblocks sampled in this study.

This sort of study was beyond the scope of this project, but should be considered in the design of future stand structure evaluations.

Ecological Guiding Principle 10 (EGP 10)

The most windfirm reserves, and therefore the most likely to remain standing after harvesting, are reserves that consider the site, stand and individual trees during layout. For individual trees, size (low height/diameter ratio) is generally a much more reliable indicator of windfirmness than species.

Ecological Guiding Principle 5 (EGP 5)

Trees/areas chosen for wildlife tree retention should be designed to minimize windthrow and the potential for contributing to insect infestation in adjacent stands.

[**Note:** Ecological Guiding Principles 5 and 10 are grouped together due to their similarity].

EGP 5 and 10 – Evaluation Results:

This evaluation did not collect the data required to directly measure EGPs 5 and10. However, the evaluation did attempt to determine if windthrow was a management concern in the sampled cutblocks and identify any consistent relationships between reserve attributes and windthrow occurrence and/or patterns. It was assumed that a low level of occurrence of windthrow in the sample cutblocks would indicate appropriate design and/or location of wildlife tree retention areas.

To indirectly evaluate EGP 5 and 10, we asked five questions.

Question #1. How much windthrow is associated with the reserves in the sampled cutblocks?

Field assessors evaluated each reserve for windthrow, and estimated the percentage of windthrow in each reserve. Table 16 categorizes windthrow at the cutblock level by weighting the estimates of windthrow by reserve area. This was done for the 118 cutblocks that had been harvested.

Table 16. Number of cutblocks with windthrow in reserves, by BEC zone

Percentage of windthrown stems	BEC zone[a]							Total
	BWBS	CWH	ESSF	ICH	IDF	SBPS	SBS	
0–5	5	22	19	24	6	4	3	83
6–20	2	3	8	6	5	2	4	30
21–40	0	2	1	0	1	0	1	5
>40	0	0	0	0	0	0	0	0
TOTAL	7	27	28	30	12	6	8	118

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

The results presented in Table 16 indicate that 83 of the 118 harvested cutblocks (70%) had less than 5% windthrow. Windthrow was less than 20% in 113 of 118 cutblocks (96%). Five of 118 cutblocks (4%) had reserves with windthrow levels greater than 20%. None of the cutblocks sampled had windthrow levels of greater than 40%.

Question #2. Is there a difference in the amount of windthrow by reserve type?

Table 17 details the windthrow levels found by reserve type on the 118 harvested cutblocks. These numbers are based on percentage estimates for each reserve determined by the field assessors.

Table 17. Percent of reserve types experiencing windthrow

Reserve type[a]	0–5% windthrow	6–20% windthrow	21–40 % windthrow
PW and PR	70	21	9
P other	77	18	5
DW and DR	75	23	2
D other	72	25	3

[a] DR=Dispersed Riparian; DW=Dispersed Wildlife; PR=Patch Riparian; PW=Patch Wildlife.

There does not appear to be much difference in the amount of windthrow between reserve types. In at least 70% of all reserve types sampled, the level of windthrow observed was less than 5%. None of the reserves sampled indicated a level of windthrow greater than 40%. It is important to note that no cutblocks in this evaluation were logged prior to 1996, and, as such, no conclusions can be drawn concerning windthrow over the long term.

Question #3. Are windthrow reduction techniques being used for reserves?

Each reserve was assessed to determine if windthrow reduction techniques, such as feathering or pruning, were used. Only three cutblocks were observed to have feathering or pruning. Two of these cutblocks were in the CWH, one was in the ESSF. Stubbing was noted as a technique for windthrow reduction in three of the ICH cutblocks. Based on the sampled cutblocks, it appears that windthrow reduction techniques are rarely used. Furthermore, given the small number of cutblocks where windthrow reduction techniques were observed, it is not possible to make any inferences concerning the effectiveness of these practices.

In the District Questionnaire, all reporting districts indicated that decisions concerning windthrow design are primarily left to the forester developing the silviculture prescription. District/licensee intent is to emphasize placement of wildlife tree patches in the most windfirm locations. Windthrow reduction techniques were reported to be used by one district. It is common to accept a threshold level of windthrow, especially where beetles are not a concern. Two districts indicated that wildlife tree retention areas with severe windthrow would generally be salvaged and replaced with other suitable habitat.

Question #4. Has windthrow resulted in a loss of ecological value?

In addition to assessing reserves for windthrow management techniques, the field assessors noted whether any windthrow resulted in a loss of some ecological value (i.e., key values such as large high-value wildlife trees). Concern over the ecological impact of windthrow was noted in 10 of the 118 cutblocks sampled (8%).

Question #5. What level of insects/disease are occurring in reserve areas?

Field assessors estimated the percent of stems affected by insects and disease in the sampled reserves. This was accomplished through a visual assessment of the total reserve area. The results of this assessment are presented in Table 18.

Table 18. Level of insects/disease in reserves

Level of insects/disease in reserves (% of stems)	Number of reserves sampled
<20	277
20–40	2
>40	0
Total	279

Table 18 shows that 99% of the reserves had less than 20% of stems affected by insects and disease. In two situations, the assessors noted that some trees had been removed from reserves to manage for mountain pine beetle. It is unknown whether the levels of insects and disease found in the sampled reserves are representative of natural conditions.

Ecological Guiding Principle 11 (EGP 11)

The importance of WTR areas within cutblocks increases with the size of the cutblock. WTR areas should generally be centred around the most suitable trees and distributed throughout the cutblock; distances between wildlife tree patches should not exceed 500 metres.

EGP 11 – Evaluation Results:

To evaluate EGP 11, we asked two questions.

Question #1. How far were sampled wildlife tree retention areas from the nearest mature forest cover?

Field assessors recorded the approximate distance from wildlife tree retention areas to the nearest mature forest cover. The total number of reserves was tallied by BEC zone and distance category. The results are presented in Table 19 and Figure 7.

Table 19. Number of reserves and distance to nearest mature forest cover, for harvested cutblocks with reserves, by BEC zone

Distance to habitat	BEC zone[a]							Total	%
	BWBS	CWH	ESSF	ICH	IDF	SBPS	SBS		
0–100 m	16	56	40	43	21	7	9	192	76
101–200 m	6	11	5	1			3	26	10
201–300 m		2	5	3	1	2	6	19	8
301–400 m		1						1	
401–500 m		2	1					3	1
>500 m		8	1	2				11	4
TOTAL	**22**	**80**	**52**	**49**	**22**	**9**	**18**	**252**	

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

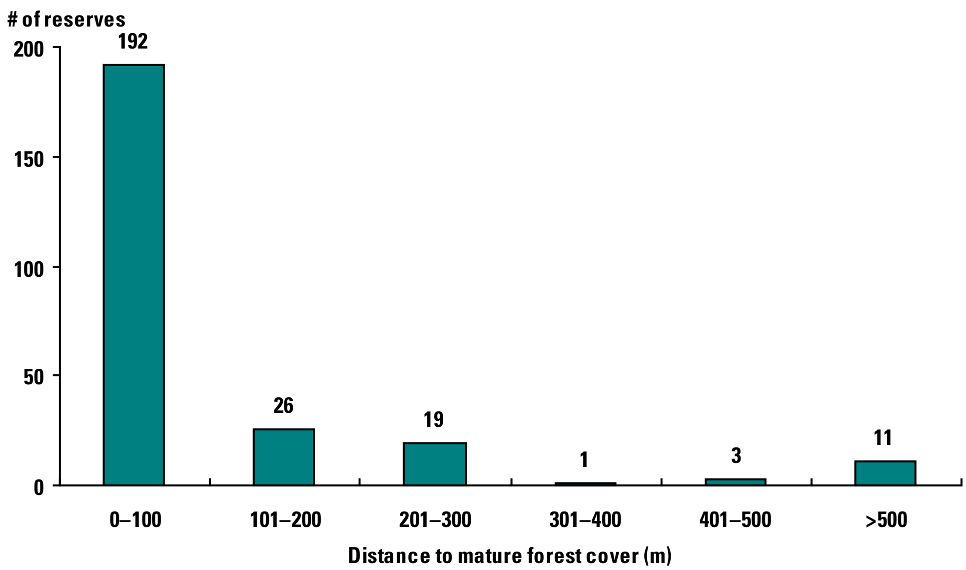


Figure 7. Distance from reserve boundaries to the nearest mature forest cover.

Of the 252 reserves sampled, 192 (76%) were less than 100 metres to the nearest mature forest cover, and 96% of the reserves were within 500 metres of the nearest mature forest cover. Eleven of 252 reserves (4%) exceeded the 500-meter distance to the nearest mature forest cover recommended in Ecological Guiding Principle 11. Eight of the 11 reserves with distances greater than 500 metres were in the CWH zone. This is likely attributed to the long history of harvest in the CWH areas sampled, where harvested stands are usually surrounded by immature second growth, and distances to the nearest mature forest cover are generally greater.

Question #2. Is there a relationship between cutblock size and the level of retention and/or the number of high-value wildlife trees per hectare?

Figures 8–10 present the relationships between cutblock size (TAUP) and reserve area/cutblock, area of reserves and abundance of high-value wildlife trees, and cutblock size and average size of reserves. Figures 8–10 represent the trends for all sampled cutblocks, and are not broken down by BEC zone.

Figure 8 indicates a slight relationship between cutblock size (TAUP) and the percent of TAUP retained in wildlife tree and riparian patch reserves. As cutblock size increases, there was proportionally less reserve area retained. This relationship did not change when dispersed reserves were included. There are four factors that may contribute to this relationship:

1. riparian reserves are more likely to exceed wildlife tree retention targets on smaller cutblocks than on larger cutblocks;
2. it is often more difficult to attain smaller patch targets on small cutblocks, and crews often exceed the targets to avoid failing to meet them;
3. to meet the minimum 500 metres between suitable wildlife habitat, larger cutblocks require the retention to be spaced across the cutblock, often resulting in smaller patches; and
4. leaving no-work zones to protect high-value wildlife trees has a proportionally larger impact on smaller cutblocks. The retention of only a few no-work zones on a small cutblock can have a relatively large impact on the % of TAUP in reserves.

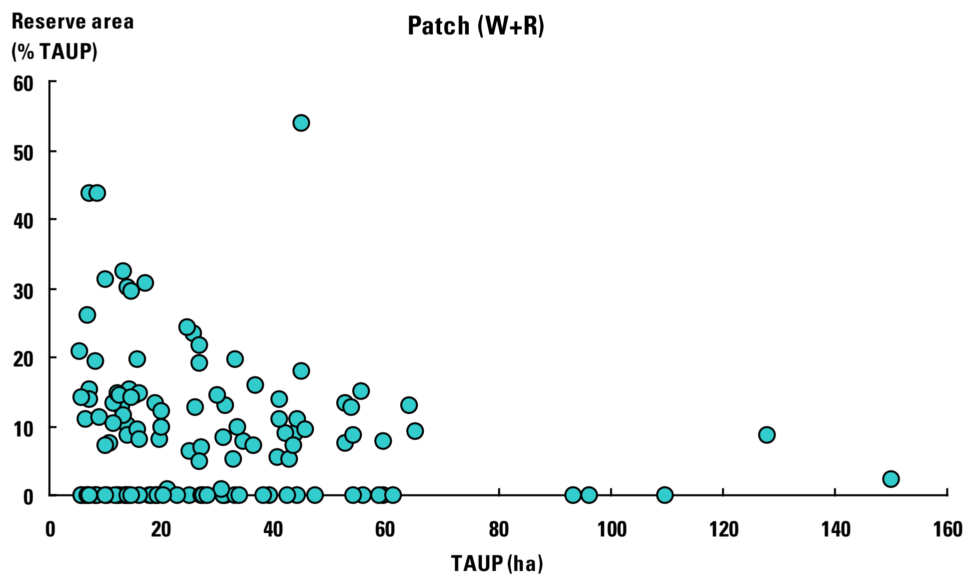


Figure 8. Reserve area (%TAUP) as a function of TAUP.

Figure 9 indicates a slight negative relationship between reserve size and the stems per hectare of high-value wildlife trees in reserves. It appears that there are more high-value wildlife trees per hectare left in smaller reserves than larger reserves.

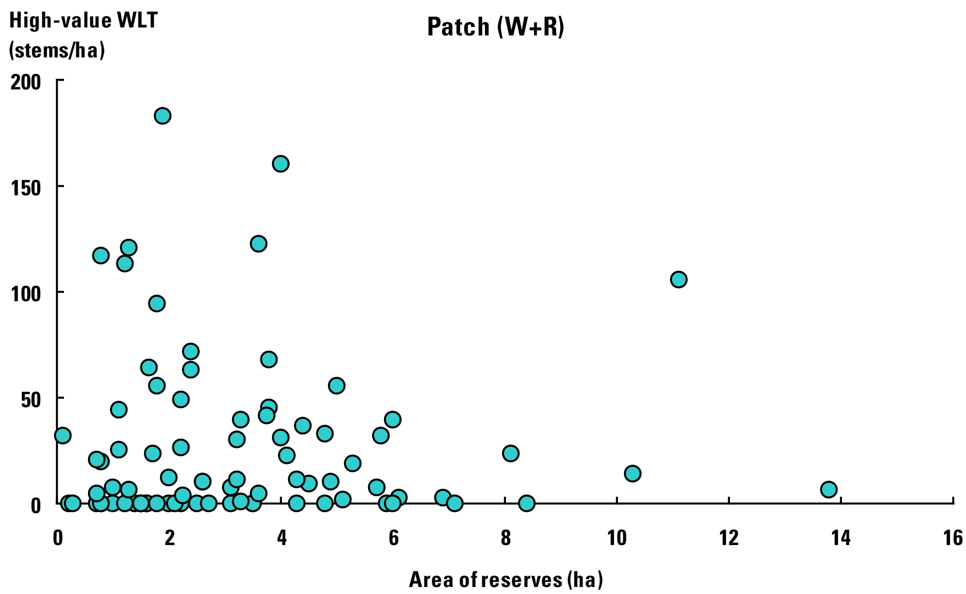


Figure 9. Number of high-value wildlife trees (stems per hectare in reserve) as a function of reserve size.

Figure 10 indicates there is no relationship between cutblock size (TAUP) and the average size of reserves. As TAUP increases, there is no increase in the average size of reserves.

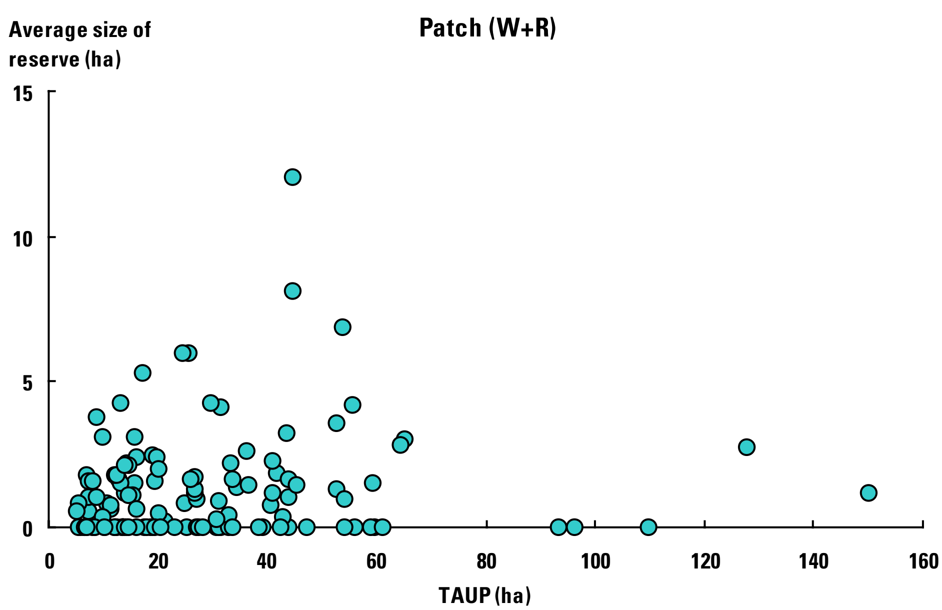


Figure 10. Average size of reserve (hectares) as a function of TAUP.

Administrative Guiding Principle 1 (AGP 1)

WTR requirements calculated by biogeoclimatic (BEC) subzone are targets to be met at the subzone level. Individual cutblock retention percentages may vary according to biological considerations.

To evaluate AGP 1, we asked the following question:
How do actual WTR levels compare with targets set at the district level?

In the District Questionnaire, eight of 11 districts reported using the *Biodiversity Guidebook* or the *Landscape Unit Planning Guide* as guidance for determining appropriate wildlife tree retention levels. The other three districts set district target levels. All districts allowed for site-specific variance.

Wildlife tree retention targets were available for 121 of the 128 cutblocks sampled in the study. Retention targets for each cutblock (regardless of how they were set) were compared with actual retention levels found in the cutblocks (see Table 20).

Table 20. Wildlife tree retention targets (% of TAUP) compared to actual retention levels (cutblocks with known targets only – includes non-contributing and timber harvesting land base)

BEC zone[a]	Number of cutblocks with WTR targets	Actual retention level		Range of WTR target (%TAUP)	Range of WTR actual (%TAUP)
		At or above target	Below target		
BWBS	3	2	1	8.7–36.1	6.4–32.1
CWH	31	21	10	1.0–18	0.1–53.8
ESSF	28	14	14	0–10.0	0–43.7
ICH	30	20	10	1.0–10.0	0–31.7
IDF	14	6	8	6.0–13.0	0–41.8
SBPS	6	1	5	9.0–11.0	0–15.8
SBS	9	4	5	9.0–10.0	0–18.1
	121	68	53		

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

The results in Table 20 show the average actual retention level (wildlife tree + riparian) met or exceeded the target retention level in 68 of the 121 cutblocks with designated targets (56%).

Table 21 compares the 'total hectares required to meet retention targets' with 'total hectares of actual wildlife tree and riparian retention' for each BEC zone. Actual retention exceeded targets in the CWH, ESSF, ICH and IDF zones, while in the BWBS, SBPS and SBS, actual retention levels were below target levels. However, when averaged across all BEC zones, the total hectares of actual wildlife tree and riparian retention exceeded targets.

Table 21. Wildlife tree retention targets (total hectares) compared to actual retention levels (cutblocks with known targets only)

BEC zone[a]	Number of cutblocks with WTR targets	Sum of TAUP – all cutblocks with targets	Total hectares required to meet targets	% of TAUP required to meet targets	Total hectares of actual WTR + riparian	% of TAUP actual WTR + riparian
BWBS[b]	3	84	18.0	21.4	16.8	20.0
CWH	31	896	86.9	9.7	108.5	12.1
ESSF[b]	28	782	53.7	6.9	61.8	7.9
ICH	30	718	40.2	5.6	53.3	7.4
IDF	14	463	43.2	9.3	54.8	11.8
SBPS	6	223	22.2	10.0	6.8	3.0
SBS	9	356	33.7	9.6	27.5	7.7
All Zones	121	3522	298	8.5	329.5	9.4

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

[b] Zones containing cutblocks with unknown WTR targets.

Table 21 also reports the total hectares of reserves retained for wildlife tree and riparian objectives (329.5 ha) found on cutblocks with known wildlife tree retention targets. These 329.5 hectares are based on the area within TAUP, and do not distinguish between non-contributing (NC) areas and/or the timber harvesting land base (THLB). If the total actual hectares of wildlife tree and riparian retention are divided by the sum of TAUP (329.5/3522), approximately 9.4% of TAUP is being retained for wildlife tree retention.

The 9.4% of TAUP being retained for wildlife tree retention in Table 21 is not directly comparable to the area impact presented in the timber supply impact – sampled cutblock analysis (6.6% for the sampled cutblocks). The 6.6% area impact in the timber supply section only considers unconstrained areas, as reserves that are constrained (i.e., riparian reserves) do not have a timber supply impact.

Table 21a reports the total hectares of all reserves, and reserves retained for wildlife tree and riparian objectives, for all cutblocks sampled. Given that many of the reserves retained for reasons other than wildlife tree or riparian retention had undefined objectives and/or are likely short term in nature, they were not included as contributing to wildlife tree retention targets.

Caution should be used when interpreting the data in Tables 20, 21 and 21a, and the related text. In some cases, either very high or very low retention levels on an individual cutblock can be attributed to the fact that some districts/licensees may use one large reserve to meet multiple cutblock requirements. Cutblock variation from district targets based on biological values is an encouraged practice as indicated in provincial policy, provided retention does not go to zero. In other cases, high levels of retention may have been left to account for special values and/or previous adjacent harvesting practices/levels.

Table 21a. Retention on sampled cutblocks as total area and % of TAUP (all sampled cutblocks)

BEC zone[a]	Sum of TAUP	Total hectares of actual retention (all reserve types)	% of TAUP (all reserves)	Total hectares of actual WTR + riparian	% of TAUP actual WTR + riparian
BWBS	184.4	40.6	22.0	28.8	15.6
CWH	895.9	150.8	16.8	108.5	12.1
ESSF	830.2	64.1	7.7	61.6	7.4
ICH	717.5	107.0	14.9	53.3	7.4
IDF	463.4	55.9	12.1	54.8	11.8
SBPS	223.3	6.8	3.0	6.8	3.0
SBS	356.2	30.8	8.7	27.5	7.7
All Zones	3670.9	462.7	12.6	341.3	9.3

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

Wildlife tree retention targets were not assigned on seven cutblocks. Two stated reasons included a fire salvage cutblock and a cutblock that was approved pre-Code. Of the seven cutblocks where the target level of wildlife tree retention was unknown, five were in the BWBS and two were in the ESSF. Interestingly, the average retention level in the seven cutblocks without targets was the same as the average retention level for the 121 cutblocks with wildlife tree retention targets.

Administrative Guiding Principle 2 (AGP 2)

Wildlife tree patches (WTPs) are stand-level reserves. However, WTPs ≥2 hectares, that contain appropriate old-growth attributes, can contribute to landscape-level seral requirements, such as old-growth management areas (OGMAs). Where OGMAs occur within, or adjacent to a cutblock, they count towards WTP requirements (as constrained areas).

AGP 2 – Evaluation Results:

To evaluate AGP 2, we asked the following question: ***What percentage of wildlife tree reserves are ≥2 hectares in size and could potentially be designated as OGMAs?***

Wildlife tree patches ≥2 hectares in size can potentially be designated as old-growth management areas (OGMAs) in cases where landscape unit planning designation has not been completed and where the patch contains appropriate old-growth attributes.

For the 128 cutblocks sampled, approximately 60% of the area in PW reserves is from reserves ≥2 hectares. These patches would need to be evaluated to determine what old-growth attributes they contain. This was not done as a part of the evaluation.

Administrative Guiding Principle 3 (AGP 3)

Wildlife trees should be included within the total area under prescription (TAUP) of a cutblock to allow for auditing and tracking. The percentage to be reserved within the TAUP can either be in hectares, basal area equivalency, or both. However, where large non-treed areas, (e.g., wetlands) occur within the TAUP, WTR requirements may be reduced by that area.

AGP 3 – Evaluation Results:

To evaluate AGP 3, we asked two questions.

Question #1. Did the sample cutblocks have stand-level biodiversity retention areas associated with them? If so, was the area located within the TAUP? Was the stand-level biodiversity retention contiguous with the cutblock?

The evaluation methodology required field assessors to examine retention areas identified within the sample cutblocks and indicate the constraints associated with those reserves. All silviculture prescriptions were examined to determine the objectives of the reserves. In addition, both the number of riparian areas adjacent to the surveyed cutblocks and the number of cutblocks that had wildlife tree retention outside of the TAUP were identified (see Table 22). It was noted that some reserves, such as lakeshore management zones, were not included as part of the TAUP or the retention scheme for wildlife trees. As a result, these types of areas were not assessed, and it is not known if they contained suitable wildlife tree habitat.

Table 22. Stand-level retention associated with cutblocks

Description	Number of cutblocks	% of all sampled cutblocks
Total number of cutblocks sampled	128	100
Total number of cutblocks with retention designated for stand-level biodiversity	96	75.0
Total number of cutblocks with retention with undefined objectives or reserves for purposes other than stand-level biodiversity (DU, PU, DV, DT)[a]	20 (18 reserves with undefined objectives) (1 reserve with visual objectives) (1 temporary reserve)	15.6
Total number of cutblocks with no retention	12	9.4
Total number of cutblocks with either no retention, retention with undefined objectives, or reserves for purposes other than stand-level biodiversity	32 (12 – no reserves) (18 reserves with undefined objectives) (1 reserve with visual objectives) (1 temporary reserve)	25.0
Total number of cutblocks with retention outside of TAUP and adjacent to the cutblock	10	7.8
Total number of cutblocks with retention outside of TAUP and not adjacent to the cutblock	6	4.7

[a] DU=Dispersed Undefined; PU=Patch Undefined; DV=Dispersed Visual; DT=Dispersed Temporary.

Current provincial wildlife tree policy recognizes the importance of wildlife tree retention for stand-level biodiversity. The policy indicates that stand structure should be retained within the TAUP of each cutblock to meet habitat requirements and help facilitate future tracking and monitoring.

Of the 128 cutblocks surveyed, 12 (9.4%) had no retention. An additional 20 cutblocks (15.6%) contained retention with undefined objectives or reserves for purposes other than stand-level biodiversity. When combined, 25% of the sampled cutblocks had either no retention, contained retention with undefined objectives, or contained reserves for purposes other than stand-level biodiversity. Of the 116 cutblocks with some retention, 10 identified stand-level retention outside of the TAUP, but adjacent to the cutblock. Six cutblocks were identified as having stand-level retention outside of the TAUP and not adjacent to the cutblock. These areas were not sampled.

Question #2. Were riparian reserves used as part of wildlife tree retention?

For this evaluation, riparian retention was considered to contribute to wildlife tree retention requirements. Based on information in the silviculture prescriptions, only 25 out of 128 cutblocks sampled (20%) had stand-level reserves identified as either dispersed riparian (DR) or patch riparian (PR). Of the cutblocks with riparian reserves, 22 (89%) designated the riparian reserve zone to function as wildlife tree retention; four of these had reserve zones that were not adjacent to the cutblock. Four cutblocks had reserve zones (lakeshore management zones) adjacent to the cutblock that were not identified as stand-level biodiversity retention. A number of silviculture prescriptions identified wildlife tree retention associated with riparian management zones (S4 to S6 streams). These types of streams have no required reserve zone; however; best management practices in the *Riparian Management Area Guidebook* recommend some retention associated with these streams.

Administrative Guiding Principle 4 (AGP 4)

Minor salvage must not occur in WTR areas (i.e., WTPs) as per the Timber Harvesting Practices Regulation, Section 28, unless approved in a silviculture prescription (SP), or unless the person has received, in writing from the district manager, the terms and conditions that allow minor salvage operations.

AGP 4 – Evaluation Results:

To evaluate AGP 4, we asked the following question:
Was salvage noted in wildlife tree retention areas?

The year of harvest for the sample cutblocks varied from 1996 to 2001. During the period since harvest, salvage was not a major factor in any of the cutblocks sampled. Only four of the cut-blocks had trees felled and removed from patch reserves (See Ecological Guiding Principle 6). On one of these cutblocks, the removal was attributed to seismic line development. It is unknown whether the other cutblocks experienced salvage or if the trees were removed at the time of harvest for some other reason. Some of the "salvage" noted in this evaluation may have occurred during harvest; however, there is no way of confirming this.

In the District Questionnaire, nine of 11 districts reported that salvage of windthrow and beetle infestation occurred. In six of the districts where salvage was reported, district policy guided the salvage, while the other three districts reported that salvage was managed on a site-specific basis.

Administrative Guiding Principle 5 (AGP 5)

Where WTPs are salvaged (e.g., high forest health risk), they should be replaced with equivalent suitable habitat as close to the original WTP as possible.

AGP 5 – Evaluation Results:

This principle was not evaluated. However, Question 2 in the District Questionnaire provides some insight into district thinking regarding the replacement of wildlife tree patches.

Although the question was not explicitly asked in the District Questionnaire, one of 11 districts indicated that where salvage occurs in wildlife tree retention areas, licensees are asked to establish a replacement area. In addition, one other district reported that salvaged wildlife tree retention was compensated through retention on partially cut areas. Four of nine district manager policies included a requirement to replace salvaged wildlife tree retention areas with suitable habitat.

Administrative Guiding Principle 6 (AGP6)

Individual dead trees can be retained in forestry operations, provided a qualified wildlife/danger tree assessor has assessed them as safe.

AGP 6 – Evaluation Results:

To evaluate AGP 6, we asked the following question:
Are dangerous trees being left in cutblocks where there has been wildlife tree retention?

Field assessors evaluated trees within the sample plots for the potential to impact worker safety. Trees were assessed as being either safe or dangerous during each of the following categories: harvesting, next most likely activity (e.g., future silviculture work), or both harvest and next most likely activity. Table 23 details the breakdown of trees considered dangerous by BEC zone.

Table 23. Percent of stems retained considered dangerous to forest workers, by BEC zone

BEC zone[a]	% of stems considered dangerous during harvest	% of stems considered dangerous for next most likely activity	% of stems considered dangerous for both harvest and next activity
BWBS	0	0.1	0.1
CWH	0.1	0.4	0
ESSF	0	0.4	0
ICH	0.3	0	0
IDF	0	0	0
SBPS	0	0	0
SBS	0.1	0	0.1
Average all zones	0.1	0.2	0

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

As seen in Table 23, the number of trees considered dangerous during harvest ranged from 0–0.3% across the BEC zones; with an average of 0.1%. The percent of stems considered dangerous for the next most likely activity ranged from 0–0.4%, with an average of 0.2%. The percent of stems considered dangerous for both harvest and the next activity ranged from 0–0.1%, with an average of 0%. The results suggest there are very few instances of safety related issues in wildlife tree management.

Methods to Minimize Costs of Wildlife Tree Retention While Achieving Ecological Objectives

As part of the evaluation process, field assessors identified practices they observed that retained ecologically appropriate wildlife tree habitat while minimizing operational costs. Table 24 is a summary of their observations. No new or unexpected practices were observed by the field assessors.

Table 24. Summary of methods to minimize costs of wildlife tree retention while achieving ecological objectives

Method	Rationale
Leave larger wildlife tree patches.	• Less impact on overall growing site than many smaller dispersed patches. • Larger patches are often more windfirm than small patches and dispersed trees – resulting in less windfall and salvage. • Results in fewer reserve areas requiring modification to yarding corridors, road/landing locations, skid trails, etc. (i.e., fewer areas to "work around").
Use wildlife tree patches to retain dangerous trees.	• Act as effective no-work zones for dangerous trees, which are often expensive and dangerous to remove.
Leave class 1 and 2 wildlife trees when retaining dispersed trees.	• These trees provide valuable future habitat, while requiring less assessment and adjustments to cutblock operations.
In high-value stands, where dispersed retention is desired, conduct a pre-harvest wildlife tree assessment in order to retain valuable trees in wildlife tree classes 3–6 in the most appropriate (ecologically and operationally) locations.	• A pre-harvest assessment would help ensure retention of high-value wildlife trees and reduce operational and safety implications/concerns.
Retain immature clumps around high-value wildlife trees.	• Vet trees and other large, old trees are often surrounded by younger or immature trees. These young trees have low economic value in the short term, but provide a good no-work zone and future habitat.
Anchor wildlife tree retention to other reserves and retention opportunities, especially riparian management areas and wetlands.	• Placement of wildlife tree patches within riparian reserves has clear operational advantages, as the area is already fully constrained. It also allows for the exclusion of areas often associated with greater logging difficulties, and excludes ground that often carries higher silviculture liabilities than the rest of the cutblock. Riparian management zones are also partially constrained and should be considered for anchoring wildlife tree retention.

Method	Rationale
Focus retention in areas with lower economic returns (e.g., vets, “wolf” trees), difficult operations/greater operational costs/inoperable areas (e.g., poor deflection, less stable slopes), and/or high future silviculture liabilities (e.g., wet/fine textured soil areas).	• Immediate and/or future costs can often be avoided by using “operationally difficult” areas as anchor points for wildlife tree retention.
Establish retention areas along slope breaks and/or yarding split lines, or along cutblock boundaries and roadsides (only if roads are to be deactivated and salvage/firewood cutting is not an issue).	• Results in fewer modifications to yarding corridors, and landing/road and skid trail locations.
Focus a portion of dispersed retention on less common/less commercially valuable species (e.g., cottonwood, aspen, etc.).	• Deciduous and less common species often have high wildlife value and lower commercial value.
Ensure communication between planners/cutblock layout personnel and operational crews.	• Helps avoid costly mistakes.
Locate high-value wildlife tree areas during harvest planning stages.	• Proper planning helps preserve the best habitat, while minimizing operational or economic implications.

Timber Supply Impacts of Wildlife Tree Retention

The second primary objective of this evaluation was to determine the timber supply impacts of current wildlife tree retention practices. Attention was therefore focussed on determining the volume and area of wildlife tree retention that would otherwise have been harvested had it not been retained for wildlife habitat.

For the timber supply impact analysis, the data from 127 of the 128 sampled cutblocks were used in the calculations, as one cutblock did not have any pre-harvest cruise information available. There were 275 reserves in the 127 cutblocks.

Field assessors evaluated each reserve for potential constraints – riparian, operational (e.g., rock outcrops, wet sites, low volume areas) or other – which would preclude harvesting. If a reserve (or part of a reserve) was not constrained for the above-mentioned reasons, then it was assumed that that reserve could have been part of the timber harvesting land base (THLB) and harvested during the normal course of operations. Table 25 shows the reserves in the surveyed cutblocks and the THLB component of those reserves.

Table 25. THLB component of reserves

Reserve type[a]	Reserve area (ha)	THLB component of reserve (ha)	Volume equivalency of reserve area (ha)	Equivalent THLB area (ha)
DR	31.2	14.9	4.9	0.2
DT	50.3	40.9	8.5	8.4
DU	628.2	445.2	8.2	5.1
DV	17.3	17.0	5.6	5.5
DW	875.8	843.4	63.0	60.7
PR	67.6	2.7		2.7
PS	40.0	39.1		39.1
PT	12.5	11.5		11.5
PU	39.8	20.1		20.1
PW	205.9	150.5		150.5
Total	1968.5	1585.3	90.2	303.8

[a] DR=Dispersed Riparian; DT=Dispersed Temporary; DU=Dispersed Undefined; DV=Dispersed Visual; DW=Dispersed Wildlife; PR=Patch Riparian; PS=Patch Retention Silvicultural System; PT=Patch Temporary; PU=Patch Undefined; PW=Patch Wildlife.

In order to calculate the area impact of wildlife tree retention on timber supply, it was necessary to estimate the volume equivalency area of the trees in dispersed reserves where single trees were left throughout the reserve. The volume equivalency area occupied by these trees was estimated using the following formula:

> Volume equivalency area = (merchantable volume of the trees in the post-harvest reserve/ merchantable volume of the pre-harvest reserve) × area of the reserve.

Only reserves located in the THLB have an impact on the timber available for harvest. Therefore, dispersed wildlife (DW) and patch wildlife (PW) reserves were the only reserve types in the evaluation that were directly removed from the THLB. The timber supply volume impact is the post-harvest merchantable volume in the unconstrained DW and PW reserves expressed as a percentage of the total pre-harvest merchantable volume that could have been harvested (total potential THLB). The timber supply area impact is the area of the unconstrained DW and PW reserves expressed as a percentage of the total area that could have been harvested (total potential THLB).

Three sets of timber supply analyses were completed:

1. *Sampled Cutblocks* – applies only to the 127 cutblocks included in the timber supply analysis.
2. *Sampled Strata* – since the strata in the population were not sampled proportional to the strata sizes, the data from the sampled cutblocks were weighted based on their sampling fraction within the strata (22 BEC zone/forest district combinations that contained sampled cutblocks – see Table 1). This analysis is therefore pertinent to all cutblocks in the 22 strata.
3. *Provincial Extrapolation* – this analysis extrapolates the data from the sampled cutblocks beyond the sampled strata to give an estimate of provincial timber supply impacts.

In addition to the weighting system selected (number of harvested cutblocks in each district/BEC zone), other weighting methods were considered, including weighting by district AAC and weighting by district THLB. Weighting by harvested cutblocks in the sampled strata was selected as the most appropriate technique because:

- it was consistent with the sample design;
- weighting by net area to be reforested (NAR) gave essentially the same results; and
- weighting by AAC and/or THLB is representative of potential harvest rather than actual harvest, and this evaluation was to assess current not future wildlife tree retention practices.

Furthermore, weighting by AAC or THLB in the BWBS, where the AAC and THLB were large compared to the actual harvest level, would have resulted in a misleading interpretation of the timber supply impacts for all 127 sampled cutblocks, given the high level of wildlife tree retention in the eight cutblocks sampled in the BWBS (a significant portion of which was deciduous).

The estimated timber supply volume impacts presented in this section could be reduced when potential mitigating factors, as discussed at the end of the section, are taken into account. No attempt has been made to quantify the level to which these potential mitigating factors might apply.

Timber Supply Impact – Sampled Cutblock Analysis

The timber supply volume impact is the post-harvest merchantable volume in the unconstrained DW and PW reserves expressed as a percentage of the total pre-harvest merchantable volume that could have been harvested (total potential THLB). Timber supply volume impact of sampled cutblocks = (post-harvest volume in unconstrained PW + DW reserves)/(pre-harvest net volume in cutblocks + net volume in unconstrained patch areas). Timber supply volume impact = (47417 + 12059)/(1034055 + 95719) = 5.3%.

The timber supply area impact is the area of the unconstrained DW and PW reserves expressed as a percentage of the total area that could have been harvested (total potential

THLB). Timber supply area impact of sampled cutblocks = (unconstrained PW + DW area)/ (net area to be reforested + unconstrained patch area). Timber supply area impact = (150.5 + 60.7)/(2995 + 223.9) = 6.6%.

The lower volume impact indicates that there is not a one-to-one relationship of pre-harvest volume compared to reserve volume. When the average pre-harvest cutblock volumes were compared to the post-harvest reserve volumes, the reserves contained approximately 92% of the pre-harvest cutblock volume/hectare.

Timber supply volume and area impacts for the various BEC zones in the sampled cutblocks were also determined. Table 26 shows the results of this analysis.

Table 26. Timber supply area and volume impacts by BEC zone for the sampled cutblocks

BEC zone[a]	Number of cutblocks	Volume impact (%)	Area impact (%)
BWBS	8	14.2	16.3
CWH	31	5.0	6.3
ESSF	30	4.0	5.3
ICH	30	6.5	6.7
IDF	13	8.3	11.8
SBPS	6	1.0	1.1
SBS	9	1.0	1.1

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

Timber supply impacts varied considerably across the BEC zones in the sampled cutblocks. The very large impact in the BWBS and the very small impacts in the SBPS and SBS may be a result of the small sample sizes in those BEC zones.

Timber Supply Impact – Sampled Strata Analysis

Volume impact

The total post-harvest volume in the THLB component of PW and DW reserves and total pre-harvest volume in the potential THLB were calculated. These volumes were appropriately weighted according to the strata sizes and their ratio determined. Strata are the 22 different combinations of BEC zones and forest districts that were sampled (as shown in Table 1). Using this method, ratios were also calculated for each BEC zone using districts as strata within each zone. Standard errors were calculated using the combined ratio method for stratified sampling described in Cochran (1977, section 6.11). A summary of this method is provided in Appendix IX.

Table 27. Timber supply volume impacts for the sampled strata

BEC zone[a]	Number of strata	Number of cutblocks	Standard error of ratio (%)	Conf. interval (%)	Lower conf. limit (%)	Volume impact (%)	Upper conf. limit (%)
BWBS	1	8	4.2	10.0	4.3	**14.2**	24.2
CWH	4	31	1.0	2.2	1.2	**3.4**	5.6
ESSF	6	30	1.0	2.1	1.3	**3.5**	5.6
ICH	5	30	1.3	3.5	3.6	**7.1**	10.6
IDF	2	13	4.9	11.9	-1.9	**10.0**	21.9
SBPS	2	6	0.3	0.7	0.5	**1.3**	2.0
SBS	2	9	0.5	1.5	-0.7	**0.9**	2.4
Overall	22	127	0.5	1.1	2.4	**3.5**	4.6

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

The results in Table 27 show there is an estimated 3.5% (±1.1% at the 95% confidence level) volume impact on the THLB due to wildlife tree retention. Table 27 also shows there is a wide range of estimated impacts from wildlife tree retention across the BEC zones. Impacts ranged from 0.9% in the SBS to 14.2% in the BWBS. The confidence interval also varied widely from ±0.7% in the SBPS to ±11.9% in the IDF. The size of the confidence limits in any particular BEC zone were reflective of how widely retention levels varied between cutblocks sampled in that BEC zone, and the number of cutblocks sampled. Volume impacts for individual strata for each BEC zone and district are provided in Appendix X.

Area impact

Similar to the volume calculations described above, the strata-weighted area of the THLB component of the PW and DW reserves and the area of the potential THLB were calculated and the ratios compared. Area ratios were also computed for the various BEC zones in the strata sampled.

Table 28. Timber supply area impacts for the sampled strata

BEC zone[a]	Number of strata	Number of cutblocks	Standard error of ratio (%)	Conf. interval (%)	Lower conf. limit (%)	Area impact (%)	Upper conf. limit (%)
BWBS	1	8	5.1	12	4.3	**16.3**	28.3
CWH	4	31	1.6	3.5	1.1	**4.6**	8.1
ESSF	6	30	1.5	3.1	1.7	**4.9**	8.0
ICH	5	30	1.6	4.2	3.3	**7.5**	11.6
IDF	2	13	5.9	14.2	-0.2	**14.0**	28.3
SBPS	2	6	0.4	1.1	0.5	**1.6**	2.7
SBS	2	9	0.5	1.2	-0.1	**1.1**	2.3
Overall	22	127	0.8	1.7	2.6	**4.3**	5.9

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

Table 28 shows there is an estimated 4.3% (±1.7% at the 95% confidence level) area impact on the THLB due to wildlife tree retention. Table 28 also shows that there is a wide range of estimated area impacts from wildlife tree retention across the BEC zones. Impacts ranged from 1.1% in the SBS to 16.3% in the BWBS. The confidence interval also varied widely from ±1.1% in the SBPS to ±14.2% in the IDF. The size of the confidence limits in any particular BEC zone were reflective of how widely retention levels varied between cutblocks sampled in that BEC zone, and the number of cutblocks sampled.

Coastal/Interior impacts

In addition to calculating the overall volume and area impacts, and the impacts by BEC zone, the sampled strata data was examined to see if there were differences between coastal and interior parts of the province. Coastal cutblocks were those sampled in the North Coast, Chilliwack and South Island Forest Districts. Interior cutblocks were those sampled in the Chilcotin, Quesnel, Clearwater, Kamloops, Arrow, Kootenay Lake, Fort Saint John, Prince George and Kispiox Forest Districts. Table 29 shows the volume and area impacts broken down by Coast and Interior.

Table 29. Timber supply impact for the sampled strata in Coastal and Interior British Columbia

Location	Type of impact	Standard error of ratio (%)	Conf. interval (%)	Lower conf. limit (%)	Timber supply impact (%)	Upper conf. limit (%)
Coast	Volume	0.1	2.2	1.1	**3.3**	5.5
Interior	Volume	0.6	1.3	2.3	**3.6**	4.9
Coast	Area	1.5	3.4	1.1	**4.5**	7.9
Interior	Area	0.8	1.8	2.4	**4.2**	6.0

At the sampled strata level of analysis, the volume and area timber supply impacts for Coastal and Interior British Columbia are similar (within 0.3 of a percentage point for both volume and area).

To calculate the area contribution from the THLB to wildlife tree retention for the Coast and Interior, the following formula was used: (unconstrained PW + DW)/(PW+DW+PR+DR). Dispersed retention was converted to volume equivalency area. All retention areas were weighted according to the sampled strata weights.

The contribution from the THLB for wildlife tree requirements was higher in the Interior (49%) than on the Coast (32%). These THLB contributions are close to the original wildlife tree policy assumptions stated in the *Forest Practices Code Timber Supply Analysis* (Prov. of B.C. 1996). In that document, THLB contributions to wildlife tree retention requirements were assumed to be 50% in the Interior and 25% on the Coast.

Timber Supply Impact – Provincial Extrapolation Analysis

In this analysis, inference can be made to all the cutblocks that could have been sampled throughout the province. To accomplish this, the 22 strata, forest district and BEC zone combinations were treated as clusters. It was assumed that the clusters sampled had been chosen as a simple random sample from the 138 clusters that were available. Total potential pre-harvest and post-harvest volumes were calculated for each cluster, and their sums used to estimate the ratio. The standard error was calculated for the ratio as per Cochran (1977, section 2.11) (see Appendix IX).

Table 30. Summary of provincial estimation of timber supply impacts of wildlife tree retention

Type of impact	Number of strata	Standard error of ratio (%)	Conf. interval (%)	Lower conf. limit (%)	Timber supply impact (%)	Upper conf. limit (%)
Volume	138	0.9	1.9	1.6	**3.5**	5.4
Area	138	1.2	2.6	1.7	**4.3**	6.9

The results in Table 30 show that there is an estimated 3.5% (±1.9% at the 95% confidence level) volume impact on the provincial THLB due to wildlife tree retention. The area impact, as expected, is somewhat larger than the volume impact due to the fact that there is not a one-to-one relationship between the pre-harvest volume per hectare and the post-harvest reserve volume per hectare. The area impact of wildlife tree retention is estimated at 4.3% of the provincial THLB (±2.6% at the 95% confidence level).

Mitigating factors for WTR timber supply impacts

Three mitigating factors have been identified that could result in a reduction of the short- and long-term volume impacts associated with wildlife tree retention.

1. **Use of patches ≥2 hectares as old-growth management areas.**

Wildlife tree patches ≥2 hectares in size can potentially be designated as old-growth management areas (OGMAs) in cases where landscape unit planning designation has not been completed, and where the patch contains appropriate old-growth attributes. For the 128 cutblocks sampled, approximately 60% of the area in PW reserves is from reserves ≥2 hectares.

2. **Moving the location of wildlife tree patches following each rotation.**

District staff were asked whether wildlife tree patches would be harvested after one rotation. Nine of 11 districts that responded indicated yes. Moving the location of wildlife tree patches at the end of each rotation has the potential to significantly decrease the overall volume impact of wildlife tree retention by allowing the volume growth between rotations to be harvested. For example, for a lodgepole pine stand (site index 20), moving wildlife tree retention (8% of TAUP) following each rotation would, after three harvests, reduce the long-term volume impact from 8% to 6.4%. This equates to an impact reduction of approximately 20%. For an analysis of this scenario and others, see Appendix XI.

3. **Allocating some large wildlife tree patches to more than one cutblock.**

District staff were asked whether any current wildlife tree retention areas would apply to future nearby cutblocks. Of the 11 districts that reported, four said no and seven said yes. The districts that said yes qualified their answer (in five of seven cases) indicating this would only occur for larger patches.

Cutblocks with ≥15% wildlife tree retention were assessed to determined how much of the "in cutblock" retention was located on the cutblock boundary. It was assumed, based on information provided by district staff, that where retention levels exceeded 15%, and where the retention was located on a cutblock boundary, it was likely those areas would be used for wildlife tree retention requirements on past or future cutblocks.

Report Summary

This evaluation project was conducted to answer the following questions:

- How effectively do current wildlife tree retention (WTR) practices meet the ecological and administrative guiding principles specified in the *Provincial Wildlife Tree Policy and Management Recommendations?*
- What are the timber supply impacts of current WTR practices? How much WTR is within the timber harvesting land base (THLB), and how much is within non-contributing or constrained areas (e.g., riparian reserves, operational constraints)?
- What structural and compositional changes are occurring in WTR areas following harvest? Have these changes affected the ecological value of the retention areas?
- Are there identifiable WTR practices currently being used that achieve ecological objectives and minimize costs?

The results of the evaluation are summarized by BEC zone and cutblock.

BEC Zone Summary

Table 31 summarizes some of the key results of the evaluation by BEC zone. The ecological value ratings for the sampled cutblocks are based on a synthesis of collected data, knowledge of the surrounding stand type, and the professional judgement of the field assessors.

The number of cutblocks sampled per BEC zone should be considered when interpreting the results in Table 31. The CWH, ESSF, ICH and IDF zones contained the highest numbers of sampled cutblocks. The BWBS, SBPS and SBS zones contained lower numbers of sampled cutblocks, and therefore the results in these zones are likely less reliable.

Some of the reserves included in the study were retained for reasons other than wildlife tree or riparian retention (e.g., temporary reserves, reserves associated with the retention silvicultural system, visual reserves, and reserves with undefined objectives). These types of reserves were considered to contribute to ecological value, but due to their unknown longevity and unclear objectives, it is difficult to estimate the contribution of these reserves to stand-level biodiversity over the long term. These reserve areas were not included in the timber supply impact analysis. Only wildlife tree retention was considered for the timber supply impact analysis, as riparian reserves are already removed from the timber harvesting land base.

Table 31. Summary of key evaluation results by BEC zone

Results	BEC zone[a]							Source table and EGP/AGP
	BWBS	CWH	ESSF	ICH	IDF	SBPS	SBS	
# of cutblocks sampled	8	31	30	30	14	6	9	Table 1
% cutblocks rated as high ecological value by field assessors	12.5	71	13	53	50	0	33	Table 2 EGP 1
% cutblocks rated as medium ecological value by field assessors	75	22.5	33	34	36	50	34	Table 2 EGP 1
% cutblocks rated as low ecological value by field assessors	12.5	0	37	10	7	17	22	Table 2 EGP 1
% of cutblocks with no retention	0	6.5	17	3	7	33	11	Table 2 EGP 1
% cutblocks with no high-value wildlife trees	38	13	60	20	43	67	22	Table 4 EGP 1
% cutblocks with >4 sph of high-value wildlife trees	38	45	20	27	0	0	22	Table 4 EGP 1
% of retained area in riparian reserves (dispersed and patch)	1	19	19	4	6	0	76	Table 9 EGP 2
% of retained area in wildlife tree retention (dispersed and patch)	70	53	77	46	92	100	13	Table 9 EGP 2
% of retained area other than riparian or wildlife tree retention	29	28	4	50	2	0	11	Table 9 EGP 2
%TAUP in PW >2 ha	4.6	5.9	3.7	3.1	2.2	0	0	Table 10 EGP 2
Average size of patch retention (PW) (ha)	1.4	1.8	1.8	1.4	1.6	1.1	1.0	Table 11 EGP 2
Average # of sph with internal decay	2.1	8.8	1.1	14.4	1.6	0.6	0.1	Table 12 EGP 3
% cutblocks containing trees with internal decay	63	81	33	70	57	33	33	Table 12 EGP 3
Average # of sph of live wildlife trees (classes 1 and 2), and % of total stems	117 (76%)	88 (90%)	100 (88%)	102 (82%)	49 (82%)	48 (87%)	75 (93%)	Table 14 EGP 7
Average # of sph of dead wildlife trees (classes 3 to 9), and % of total stems	36 (24%)	10 (10%)	14 (12%)	22 (18%)	11 (18%)	7 (13%)	6 (7%)	Table 14 EGP 7
% cutblocks with <5% of stems windthrown in reserves	71	81	68	80	50	67	38	Table 16 EGP 5 & 10
% reserves within 100m of mature forest cover	73	70	77	88	95	78	50	Table 19 EGP 11

Results	BEC zone[a]							Source table and EGP/AGP
	BWBS	CWH	ESSF	ICH	IDF	SBPS	SBS	
% of TAUP in wildlife tree and riparian retention	15.6	12.1	7.4	7.4	11.8	3.0	7.7	Table 21a AGP 1
% of TAUP in retention other than wildlife tree and riparian	6.4	4.7	0.3	7.5	0.3	0	1.0	Table 21a AGP 1
% of retained stems considered dangerous during harvesting	0	0.1	0	0.3	0	0	0.1	Table 23 AGP 6
% volume timber supply impact (weighted for the sampled strata)	14.2	3.4	3.5	7.1	10.0	1.3	0.9	Table 27
% area timber supply impact (weighted for the sampled strata)	16.3	4.6	4.9	7.5	14.0	1.6	1.1	Table 28

[a] BWBS: Boreal White and Black Spruce; CWH: Coastal Western Hemlock; ESSF: Engelmann Spruce–Subalpine Fir; ICH: Interior Cedar Hemlock; IDF: Interior Douglas-fir; SBPS: Sub-boreal Pine–Spruce; SBS: Sub-boreal Spruce.

As can be seen in Table 31, there was considerable variability in the implementation of wildlife tree retention between the sampled BEC zones.

Boreal White and Black Spruce Zone (BWBS)

There was some level of retention found in each of the eight cutblocks sampled in the BWBS. This was the only BEC zone where all sampled cutblocks contained retention areas.

Approximately 12.5% of sampled cutblocks in the BWBS were rated as having high ecological value; 75% were rated as having medium ecological value. In the BWBS, riparian reserves accounted for 1% of the retention area – there was very little riparian area in the sampled cutblocks. Twenty-nine percent of the retained area in the BWBS was in retention other than wildlife tree or riparian (27% of this was in temporary patches).

A high percentage of TAUP was in wildlife tree patches ≥2 hectares (4.6% – the second highest of all sampled BEC zones). Out of all the BEC zones sampled, the BWBS had the highest number of stems per hectare (sph) of dead wildlife tree classes 3–9 (36 sph).

Wildlife tree retention targets were available for three of eight cutblocks sampled in the BWBS. Wildlife tree retention averaged 15.6% of TAUP.

The BWBS had the highest timber supply impact of all sampled BEC zones (14.2% by volume, 16.3% by area – weighted by sample strata). This large amount of retained area likely contributed to the retention of some good ecological values. However, the evaluation indicates that the ecological value ratings of the retention in the BWBS could have been improved, while reducing the timber supply impact, if the retained areas had been more carefully selected from the available habitat.

Coastal Western Hemlock Zone (CWH)

Ninety-three percent of the 31 sampled cutblocks in the CWH contained retention. Seventy-one percent of cutblocks in the CWH were rated as having high ecological value (the highest percentage of all sampled BEC zones), indicating that, in the majority of cases, appropriate stand structure was being retained. None of the sampled cutblocks with retention were rated as having low ecological value; however, 7% of the cutblocks had no retention.

Almost half of the sampled CWH cutblocks (45%) contained more than 4 stems per hectare of high-value wildlife trees. This was the highest percentage of all sampled BEC zones.

Nineteen percent of the retained area in the CWH was in riparian reserves. Twenty-eight percent of the retained area was in retention other than wildlife tree or riparian (26.5% of this was in the variable retention silvicultural system).

Of all the sampled BEC zones, the CWH had the highest percentage of TAUP in wildlife tree patches ≥2 hectares (5.9%). It also had the highest percentage of cutblocks containing trees with internal decay (81%). Because of the long natural disturbance interval associated with the CWH, it might be expected to find 100% of cutblocks with reserves containing trees with internal decay in this BEC zone. However, 6.5% of the sampled cutblocks contained no retention, and approximately one-third of the cutblocks in the CWH were second-growth, where internal decay is less common.

Wildlife tree retention targets were set for all 31 cutblocks sampled in the CWH. Wildlife tree retention averaged 12.1% of TAUP. When the cutblocks are weighted by sample strata, and the retention from non-THLB areas (i.e., inoperable and non-contributing areas) are accounted for, the timber supply impact in the CWH was 3.4% by volume and 4.6% by area.

These timber supply impacts were coupled with the highest ecological value ratings of all sampled BEC zones. The results of the evaluation indicate that, except for the cutblocks where no retention occurred, ecologically appropriate areas are being selected for wildlife tree retention in the CWH.

Engelmann Spruce Sub-Alpine Fir Zone (ESSF)

In the ESSF, 83% of the 30 sampled cutblocks contained retention. Thirteen percent of ESSF cutblocks were rated as having high ecological value, 33% were rated as having medium ecological value, 37% were rated as having low ecological value, and 17% had no retention. Sixty percent of ESSF cutblocks contained no high-value wildlife trees.

Nineteen percent of the retained area in the ESSF was in riparian reserves (similar to the CWH). Four percent of the retained area was in retention other than wildlife tree or riparian (dispersed undefined). The remainder of the retained area came from the THLB.

Wildlife tree retention targets were available for 28 of the 30 sampled cutblocks in the ESSF. Wildlife tree retention averaged 7.4% of TAUP. When the cutblocks are weighted by sample strata, and the retention from non-THLB areas (i.e., inoperable and non-contributing areas) are accounted for, the timber supply impact in the ESSF was 3.5% by volume and 4.9% by area.

This level of timber supply impact is similar to the CWH, but the CWH had much higher ecological value ratings associated with wildlife tree retention. The results of the evaluation suggest that the ecological value ratings of retention in the ESSF could be improved with better selection of retention areas, and, in particular, ensuring that some level of retention occurs on each cutblock.

Interior Cedar Hemlock Zone (ICH)

Ninety-seven percent of the 30 cutblocks sampled in the ICH contained retention. Approximately half (53%) of the cutblocks in the ICH were rated as having high ecological value. Three percent of ICH cutblocks had no retention.

In the ICH, 4% of the retained area was in riparian reserves. Fifty percent of the retained area was in retention other than wildlife tree or riparian (36% of this was in patches with undefined objectives; however, only one-third of the patches were part of the THLB, two-thirds were inoperable).

Seventy percent of ICH cutblocks contained trees with internal decay, and the average density of trees with internal decay was 14.4 stems per hectare (sph) – the highest of all sampled BEC zones. The ICH had the second highest average density of dead wildlife tree classes 3–9 (22 sph).

In the ICH, all 30 cutblocks had wildlife tree retention targets. Wildlife tree retention averaged 7.4% of TAUP. When the cutblocks are weighted by sample strata, and the retention from non-THLB areas (i.e., inoperable and non-contributing areas) are accounted for, the timber supply impact in the ICH was 7.1% by volume and 7.5% by area. This is a relatively high timber supply impact considering the results of the evaluation suggest that the ecological value ratings of retention in the ICH could be improved with more appropriate selection of retention areas.

Interior Douglas-fir Zone (IDF)

Ninety-three percent of the 14 cutblocks sampled in the IDF contained retention. Fifty percent of the IDF cutblocks were rated as having high ecological value. Seven percent of IDF cutblocks had no retention.

The presence of high-value wildlife trees in the IDF was relatively low. Forty-three percent of IDF cutblocks had no high-value wildlife trees, and all of the sampled cutblocks in the IDF contained less than four stems per hectare of high-value wildlife trees. The level of high-value wildlife trees retained in the IDF is less than might be expected for this zone, which generally contains large Douglas-fir vets.

In the IDF, 6% of the retained area was in riparian reserves. Ninety-two percent of the retained area was in dispersed or patch wildlife tree retention. Only two percent of the retained area was in retention other than wildlife tree or riparian. The IDF had a high percentage of reserves in wildlife tree patches. Very little ecological value was contributed from retained areas other than wildlife tree or riparian retention, unlike most of the other sampled BEC zones. Ninety-five percent of the reserves in the IDF were located within 100 m of mature forest cover.

Wildlife tree retention targets were available for all 14 sampled cutblocks in the IDF. Wildlife tree retention averaged 11.8% of TAUP. When the cutblocks are weighted by sample strata, and the retention from non-THLB areas (i.e., inoperable and non-contributing areas) are accounted for, the timber supply impact in the IDF was 10.0% by volume and 14.0% by area.

Only the BWBS had a higher timber supply impact than the IDF. This impact can be attributed to the high level of wildlife tree retention in the IDF and the large amount of retained area compared to the other sampled BEC zones. The results of the evaluation suggest that the ecological value ratings of retention in the IDF could be improved with better selection of wildlife tree habitat, particularly the retention of large live and dead conifers that have survived previous stand disturbances characteristic of this zone.

Class 3 Douglas-fir wildlife tree in wildlife tree patch.

Sub-Boreal Pine–Spruce Zone (SBPS)

Sixty-seven percent of the six sampled cutblocks in the SBPS contained retention. None of the SBPS cutblocks were rated as having high ecological value, 50% were rated as having medium ecological value, and 17% were rated as having low ecological value. Thirty-three percent of SBPS cutblocks had no retention, and 67% contained no high-value wildlife trees (the highest of all sampled BEC zones). All of the cutblocks sampled contained less than four stems per hectare of high-value wildlife trees.

All of the retained area in the SBPS was in dispersed or patch wildlife tree retention. None of the wildlife tree patches in the SBPS were larger than two hectares in size, with an average patch size of 1.1 hectares.

Wildlife tree retention targets were available for all six cutblocks in the SBPS. Wildlife tree retention averaged 3.0% of TAUP. When the cutblocks are weighted by sample strata, and the retention from non-THLB areas (i.e., inoperable and non-contributing areas) are accounted for, the timber supply impact in the SBPS was low – 1.3% by volume and 1.6% by area. The results of the evaluation suggest that the ecological value ratings of retention in the SBPS could be improved with more appropriate selection of retention areas, and a substantial increase in the amount of retention, which could largely be achieved by ensuring some retention on every cutblock (a third of SBPS cutblocks contained no retention).

Sub-Boreal Spruce Zone (SBS)

Eighty-nine percent of the nine sampled cutblocks in the SBS contained retention. Thirty-three percent of SBS cutblocks were rated as having high ecological value, 34% were rated as having medium ecological value, and 22% were rated as having low ecological value. Eleven percent of SBS cutblocks had no retention, and 22% contained no high-value wildlife trees.

In the SBS, 76% of the retained area was in riparian reserves. Eleven percent of the retained area was in retention other than wildlife tree or riparian. None of the wildlife tree patches in the SBS were larger than two hectares in size, with an average patch size of 1.0 hectare (the lowest average patch size of all sampled BEC zones).

The SBS had the lowest average number of stems per hectare (sph) with internal decay (0.1 sph), as well as the lowest average number of stems per hectare of dead wildlife tree classes 1–3 (6 sph). One-half of the reserves in the SBS were more than 100 m from mature forest cover.

Wildlife tree retention targets were available for all nine sampled cutblocks in the SBS. Wildlife tree retention averaged 7.7% of TAUP. When the cutblocks are weighted by sample strata, and the retention from non-THLB areas (i.e., inoperable and non-contributing areas) are accounted for, the timber supply impact in the SBS was the lowest for all sampled BEC zones – 0.9% by volume and 1.1% by area.

The large amount of riparian retention in the SBS contributed to the low timber supply impact as these areas have already been removed from the timber harvesting land base. The results of the evaluation suggest that the ecological value ratings of retention in the SBS could be improved with more appropriate selection of retention areas, along with an increase in the amount of area being retained.

Cutblock Summary

Of the 128 cutblocks surveyed, 116 (90.6%) contained some form of retention. Of the 116 cutblocks with retention, 20 (15.6%) contained retention with undefined objectives or reserves for purposes other than stand-level biodiversity. Twelve of the 128 sampled cutblocks (9.4%) had no retention. When combined, 25% of the sampled cutblocks either had no retention, contained retention with undefined objectives, or contained reserves for purposes other than stand-level biodiversity (see Table 22).

In six out of the 10 pre-harvest cutblocks (60%), the field assessors felt the prescribed retention captured the best available wildlife tree habitat in the cutblock.

Based on a synthesis of collected data, knowledge of the surrounding stand type, and the professional judgement of the field assessors, approximately 41.4% of the sampled cutblocks contained reserves rated as having high ecological value; 34.4 % were rated as having medium ecological value; 14.8% were rated as having low ecological value; and 9.4% had no retention (see Table 2). It is important to understand that these ecological value ratings are subjective and relative. Cutblocks where the field assessors felt the retention was representative of the available habitat were given a high ecological value rating. The extent to which the retention actually meets the needs of wildlife species either in the present or future is unknown. Additional work would be required to make that determination.

Approximately 26% of the sampled cutblocks had at least four stems per hectare of high-value wildlife trees based on TAUP. Thirty-three percent of sampled cutblocks had no high-value wildlife trees (includes 9.4% of cutblocks with no reserves) (see Table 4).

The distribution of dispersed retention, patch retention, and a combination of the two was fairly evenly distributed across the 128 sampled cutblocks, indicating that a variety of retention strategies are being utilized. Seventy-one of the cutblocks contained only dispersed retention, 79 contained only patch retention, and 34 contained both. Twelve cutblocks contained no retention (see Table 8). Dispersed retention accounted for approximately 20% of the total area of retention across the sampled cutblocks. Patch retention accounted for approximately 80% of the total area of retention (see Table 9).

High-value wildlife trees are being retained with both dispersed and patch retention; however, patches generally provide more high-value wildlife trees than dispersed retention (see Tables 4a and 5).

The evaluation showed a trend towards smaller average heights and diameters in reserve trees compared to average pre-harvest heights and diameters. Of the 51 zone/species combinations, 94% showed reductions in average height. Fifty-nine percent of the 51 zone/species combinations showed decreases in average diameter. This trend towards smaller average heights and diameters in reserve trees is a concern given that taller, large diameter trees generally provide better wildlife tree habitat. It is difficult to determine the reason for the pre- and post- harvest height and diameter reductions. However, choosing lower site quality locations for retention areas, retaining understorey trees and advanced regeneration, or selecting lower height/diameter trees to reduce windthrow risk could have played a role (see Table 7).

Wildlife tree patch near Quesnel.

Approximately 60% of the total area in wildlife tree patches in the sampled cutblocks was in patches ≥2 hectares (see Table 10). Current policy allows patches ≥2 hectares to be designated as old-growth management areas (OGMAs) in cases where the retention contains appropriate old-growth attributes. This could contribute to reducing the timber supply impact of wildlife tree retention. The range of patch sizes in the sampled cutblocks was 0.1–10.3 hectares (see Table 11).

Fifty-eight percent of the sampled cutblocks contained trees with obvious internal decay; 6% had uncommon tree species; and 26% indicated the presence of insects or disease (see Table 12). Approximately 99% of all sampled reserves had less than 20% of stems affected by insects or disease (see Table 18). Without adequate baseline data, it is difficult to determine if the level of occurrence of these traits is within the range of natural conditions, or if the traits were being actively selected.

Felling trees within reserves was not a common occurrence in harvested cutblocks (only six cutblocks contained felled trees). Where felling within reserves did occur, the majority of felled trees (8 of 12) were left in place. During the period since harvest (1996 to 2001), salvage was not a major factor in any of the sampled cutblocks. (see Table 13).

For all sampled cutblocks, the majority (84%) of retained trees were in wildlife tree classes 1 and 2 (see Table 14). This result may be attributed to the commonly held belief that more advanced wildlife tree classes (3–9) present potentially dangerous situations from a WCB perspective. To determine if wildlife tree classes 1 and 2 are being appropriately represented in retention areas, a comparison with baseline data on the natural distribution of all wildlife tree classes would be required.

Approximately 70% of sampled cutblocks had less than 5% windthrow in the reserves, 96% had less than 20% windthrow, and only 4% had windthrow levels greater than 20%. None of the sampled cutblocks had windthrow levels greater than 40% (see Table 16). Windthrow reduction techniques were rarely used in the sample cutblocks (5 of 128 cutblocks). Field assessors expressed concern over the loss of ecological values due to windthrow in 8% of the sampled cutblocks.

Approximately 76% of sampled reserves were situated less than 100 metres to the nearest mature forest cover, and 96% of the reserves were within 500 metres of the nearest mature forest cover (see Table 19).

Of the 116 sample cutblocks containing retention, 10 identified stand-level retention outside of the TAUP, but adjacent to the cutblock. Six cutblocks identified stand-level retention outside of the TAUP and not adjacent to the cutblock (see Table 22).

Wildlife tree retention targets (% of TAUP) were known for 121 of the 128 cutblocks sampled. The average wildlife tree retention target for all 121 cutblocks with targets was 8.5% of TAUP, while actual retention on the cutblocks was 9.4% of TAUP. (see Table 21).

The percent of retained trees considered dangerous to forest workers was relatively low for all BEC zones (less than 0.4%). (see Table 23).

The estimated timber supply impacts due to wildlife tree retention weighted by the sample strata are 3.5% by volume (±1.1%) and 4.3% by area (±1.7%). Broken down by Coast and

Interior: Coast – 3.3% by volume (±2.2%) and 4.5% by area (±3.4%); Interior – 3.6% by volume (±1.3%) and 4.2% by area (±1.8%). (see Tables 27, 28 and 29).

Mitigating factors, such as designating patches ≥2 hectares as old-growth management areas (OGMAs) where the retention contains appropriate old-growth attributes, moving the location of wildlife tree patches following each rotation, and allocating some large wildlife tree patches to more than one cutblock, have the potential to reduce the short- and long-term timber supply volume impacts associated with wildlife tree retention.

The impacts of windthrow, insects/disease, and salvage were evaluated in the sample cutblocks to determine how wildlife tree retention areas may have changed in structure and composition up to six years after harvest. None of these factors appear to have impacted the ecological value of wildlife tree reserves over the period evaluated by this study (see Tables 16, 17 and 18, and EGP 6 and AGP 4).

A number of methods to achieve ecological objectives and minimize costs were identified in the evaluation. Some of the recommendations that best meet both of these objectives include: anchoring reserve areas on high-value attributes and operationally difficult sites, using larger versus smaller patch reserves, and ensuring effective communications between planners and logging crews. No new or unexpected practices were observed during the evaluation (see Table 24).

Dispersed retention (some fire killed) in the Kootenays.

Conclusions and Recommendations

From the results of this evaluation, it appears that wildlife tree retention has been widely implemented across the province. Wildlife tree retention was observed in 75% of the sampled cutblocks. However, 25% of the sampled cutblocks (32 out of 128) either had no retention (9.4%), or contained retention with undefined objectives or reserves for purposes other than wildlife tree or riparian retention (15.6%).

Forty-one percent of the sampled cutblocks were rated as having high ecological value, which indicated that, on those cutblocks, the trees being retained were considered representative of the available habitat by the field assessors. From this result, it appears there is room for improvement in the quality of wildlife tree retention in British Columbia. However, further work is required to accurately assess the contribution of current wildlife tree retention in meeting the habitat requirements of specific species in order to determine the actual ecological value of these reserves.

There is an estimated 3.5% volume impact on the provincial THLB due to wildlife tree retention. The area impact of wildlife tree retention is estimated at 4.3% of the provincial THLB. As expected, the area impact is somewhat larger than the volume impact because there is not a one-to-one relationship between pre-harvest volume per hectare and post-harvest reserve volume per hectare.

Recommendations for Immediate Action

Recommendation 1.

> ***Best management practices (BMPs) and related extension documents should be developed to reflect the importance of retaining large (both height and diameter) wildlife trees.***

The results of this evaluation indicate there is a trend towards smaller average heights and diameters in reserve trees compared to average pre-harvest heights and diameters. Ninety-four percent of 51 zone/species combinations showed reductions in average height; 59% showed decreases in average diameter. This trend towards smaller average heights and diameters in reserve trees is a concern, as larger trees (height and diameter) provide higher habitat values for wildlife tree users.

Recommendation 2.

> ***Continue to provide field staff the flexibility to make site-specific decisions on wildlife tree retention.***

A key modelling assumption in the *Forest Practices Code Timber Supply Review* (Prov. of B.C., 1996) is that 25% of wildlife tree retention on the Coast would come from the timber harvesting land base (THLB), whereas in the Interior the figure is 50%. These percentages are also used as policy direction in the *Landscape Unit Planning Guide*. The results of this evaluation largely support the modelling assumption. In this study, the contribution from the THLB for wildlife tree retention was 32% on the Coast and 49% in the Interior. It appears that the 25%/50% modelling assumption reasonably reflects actual average percentages of

THLB contributions to wildlife tree retention on the Coast and in the Interior even though there was significant variation on a site-by-site basis. Nevertheless, it is not desirable to unnecessarily restrict field staff in making appropriate site-specific decisions on wildlife tree retention by formalizing the modelling assumption into legislation.

Recommendation 3.

> ***Document the location, size, purpose, objectives and longevity of all retention areas.***

Almost 16% of the retention sampled in this evaluation was either undefined as to its purpose, or designated for a purpose other than wildlife tree or riparian retention. The longevity of such retention is unknown. A clear understanding of the location, size, purpose, objectives and longevity of all retention areas is critical if an accurate assessment of both timber supply impact and ecological value is to be made.

Recommendation 4.

> ***A provincial database should be created to facilitate effective future evaluations and/or audits, monitoring and timber supply analyses.***

This evaluation would not have been possible without information obtained from silviculture prescriptions and the Ministry of Forests' corporate database (ISIS). Stand-level plans, such as silviculture prescriptions, will not be submitted to government once the *Forest and Range Practices Act* is implemented. Information, such as retention location, size, purpose, objectives and longevity, is critical to facilitate future evaluations and to provide detailed information for timber supply analyses. Furthermore, this information would help ensure that wildlife tree retention is not harvested before the end of one rotation, and that wildlife tree retention areas are only attributed to more than one cutblock in appropriate situations (e.g., large area of retention within a single cutblock boundary).

Recommendation 5.

> ***Re-confirm and communicate the requirement of current wildlife tree policy that licensees should retain wildlife trees on every cutblock.***

Of the 128 cutblocks surveyed in this evaluation, 9.4% contained no retention of any kind. This lack of retention is inconsistent with current wildlife tree policy direction, which states that "…as a general rule, stand structure should be retained in all cutblocks."

Recommendation 6a.

> ***Ensure the lessons learned from this evaluation are adequately communicated to the right audiences (see Appendix XII – Lessons Learned).***

Recommendation 6b.

> ***Individuals planning to conduct and manage future effectiveness evaluations should receive adequate training prior to initiating projects to ensure efficient and effective use of resources.***

This evaluation was carefully planned and implemented. Despite these efforts, hindsight suggests many things could have been done differently. This experience and knowledge should be communicated to help improve future Results-based Code (RBC) evaluations. This could be accomplished through training processes, extension notes, and presentations on evaluation results, findings and lessons learned. In addition, valuable lessons regarding the resources required to conduct an extensive effectiveness evaluation have been learned from this project. These lessons should be extended to those responsible for developing the RBC evaluation program and budget.

Recommendation to Revise the Evaluation Methodology

Recommendation 7.

> ***The methodology for this evaluation project should be revised and published in 2003 to help improve the efficiency of future evaluations.***

Despite a rigorous design and testing process, several challenges with the evaluation methodology arose during the data collection and subsequent analysis. Although none of the challenges are critical or caused concern with respect to the results, the project methodology should be revised to improve the efficiency of future evaluations. Proposed changes include:

- simplifying the process for collecting data on small diameter trees;
- minor revisions to the field data forms;
- additional direction on when to use prism versus fixed area plots; and
- clarification/revision of the CWD and lichen data collection procedures (see Appendix XII – Lessons Learned).

Recommendation to Review Current Wildlife Tree Retention Policy and Best Management Practices (BMPs)

Recommendation 8.

> ***Work with stakeholders to review existing wildlife tree retention policy and BMPs. (see Recommendation 1)***

This evaluation, and the *Forest and Range Practices Act,* highlight the need to ensure existing wildlife tree retention policy and BMPs are clear and consistent. Many sources of information exist (e.g., district manager policies) to help guide field staff in implementing legislation and provincial policy. These sources of information, among others, should be considered in reviewing current policy/BMPs. Future policy/BMPs would be most effective if they recognize the diversity in natural conditions across the province (i.e., provide specific guidance for BEC zones), promote the anchoring of wildlife tree retention on high wildlife habitat attributes and operationally difficult sites, and require the documentation of wildlife tree retention objectives.

Recommendations for the Planned Next Phase of this Evaluation

Recommendation 9.

> ***Develop a proposal for the next phase of this evaluation project to evaluate the effectiveness of current wildlife tree policy.***

This evaluation helped determine the extent to which licensees are meeting the intent of current wildlife tree retention policy; however, it remains to be determined if existing policy is resulting in appropriate, long-term maintenance of stand-level biodiversity values. To answer this question, an effectiveness evaluation of current wildlife tree policy should be conducted as part of the planned next phase of this project.

Recommendation 10.

> ***As part of the next phase of this evaluation project, conduct further analyses to maximize the benefits from the existing database.***

The data collected on the 128 cutblocks in this evaluation is extensive. Many more questions can be asked of the database, and further analysis should be undertaken. The next phase of this evaluation could include:

- comparing baseline data from other information sources to try and determine the relationships between "natural conditions" and "post-harvest conditions;"
- obtaining full cruise data for a portion of the 128 cutblocks in the evaluation to help determine if baseline (pre-harvest) comparisons with post-harvest data can be derived from full cruise data (cruise summary data was used for this study);
- comparing ecological attributes on large versus small wildlife tree patches to determine if larger patches capture more or different attributes than a series of small patches adding up to the same area; and
- assessing gaps in the database and determining which of these gaps should be addressed in future studies (e.g., expanding the study to include more BEC zones).

Recommendation 11.

> ***Initiate a review of the feasibility of the following proposed initiatives.***

This evaluation highlighted several other initiatives related to wildlife tree retention that could be undertaken:

- Determine if the number of trees being retained in wildlife tree classes 3–9 could be improved by increasing the amount of wildlife/danger tree assessments. This would require an evaluation to determine the current level of wildlife/danger tree assessment being carried out by the forest industry.
- Initiate a long-term study to determine how dispersed retention and different sized patches change over time, and the role the retention plays in the future stand.
- Examine the ecological relevance of the recommendation to keep the distance between wildlife tree patches to a maximum of no more than 500 metres. This could include a literature review of existing research or a designed study.

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APPENDIX I – FIELD DATA COLLECTION FORM

Reserve Type: ____________ **Assessor:** ____________ **Date:** ____________ **Opening#** ____________ **District** ____________

Reserve ID ________ **Plot** ____________ **Size of Reserve (ha)** ______ **UTM or Lat/Long** __________ **Prism BAF** ________ **FIZ** ______ **page** _____ **of** _____

N.B: Min plot tree DBH is 12.5 cm

Tree #	Sp	DBH	Live Crown	CWD	Ht. Actual	Ht. Projected	Tree Class	Conk	Blind Conk	Scar	Fork or Crook	Frost Crack	Mistletoe	Rotten Branch	D or B Top	WLT Class	Use (F,N,D)	Vis.Int.Decay	Uncom. Sp	Feature	insect/disease	(L,M,H)	Lichens	Danger Tree	Cut Stump			Tree	Windthrow
																									Dia./Ht	Sp	Left Y/N		
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD

Sample Trees

#				**Comments**

Column D – "Live Crown" **1** – Live Crown <30% **2** – Live Crown 30–60% **3** – Live Crown >60%

Column E – "Fallen Tree/CWD" **F1** – Fallen log >3 m long with 3 m or more <20 cm above the ground **F2** – Fallen log >3 m long with <3 m within 20 cm above the ground **F3** – Fallen log <3 m – add CWD class to F1–F3 (i.e., F1-2 = F1 log + CWD class 2)

Column H – "Tree Class" **1** – Residual **2** – Suspect **3** – Dead Potential **4** – Dead Useless **5** – Veteran **6** – Live Useless **7** – Vet.Dead Pot. **8** – Immature **9** – Imm. Dead Pot

Column X – "Lichens" **A** – Arboreal lichen present **G** – Ground lichen present **B** – both A and G present

Column Y – "Danger Tree" **DH:** Tree was likely dangerous for harvesting level of disturb. **DF:** Tree will probably be dangerous for next most likely activity (level of disturb.) **DB:** Both DH and DF

Column AD – "Windthrow" **1** – Root Ball **2** – Root Plate **3** – Trunk Snap

APPENDIX II – INDIVIDUAL RESERVE AREA AND CUTBLOCK SUMMARY

Individual Reserve Area Questions – Answer the questions below for each reserve area

Opening #	Plot	Reserve ID	District	Date	Assessor

Question 1 What timber harvesting constraints apply to this reserve area? N.B: Specify % and ensure total adds up to 100%.				
1 None	2 Riparian Reserve	3 Operational (rock, wet, low volume, etc.) (Specify)	4 Other Constraints (Specify)	Comments

Question 2 Given the next proposed (or most likely) forest management activity, will any trees within the reserve require removal for safety?			
1 None/ Minimal removal	2 Some removal but minimal ecol. impact	3 Significant removal and ecol. impact	Comments

Question 3 Is the WTR ecologically appropriate when compared to other available habitat within the TAUP (when measured against the criteria in Attachment A)? N.B: Attachment A is the WTR value rating scheme.			
1 Yes, high ecol. value	2 Yes, medium ecol. value	3 No, low ecol. value	Comments

Question 4 Was the actual WTR location and size consistent with what was mapped on the SP?			
1 Yes	2 No, but no apparent ecol. impact	3 No, there is apparent ecol. impact	Comments

Question 5 How has the reserve changed since harvesting?			
Insects and disease: A1 – <20% of stems A2 – 20–40% A3 – >40%	Trees cut but left: B1 – 0% of stems B2 – <10% B3 – >10%	Trees cut and removed: C1 – 0% of stems C2 – <10% C3 – >10%	Other (specify):
Comments			

Question 6 Windthrow	Comments	
Estimate % of stems in reserve area windthrown		
Is there a pattern to windthrow (species, ht., location, etc.)?		
Have any obvious windthrow management activities taken place (i.e., topping, pruning, feathering, etc.)?		
Has the ecological value been impacted significantly?	Yes	No

Question 7	
What is the estimated distance to the nearest mature forest habitat? (i.e., WTP, mature forest edge, etc.)?	

Cutblock Summary Questions and Observations – Provide answers to the following questions and a summary of observations for the cutblock as a whole.

Opening #	**District**	Date	Assessor
Question 1: Were the reserves marked in the field?			
Question 2: Was there a specific length of time (i.e., rotation length) recorded on the SP, or elsewhere for the retention of the reserve area/trees? If yes, provide details for each reserve area (reserve ID and length of time).			
Observations/comments:			

Appendix III – Field Card Guide

Administration Section

Reserve Type: use codes DW (dispersed WLT), PW (patch WLT), RR (riparian), describe all others

Assessor: name of assessor

Date: date when field assessment was completed

Opening #: opening number reference from forest inventory maps and/or ISIS

District: identify district where cutblock is located

Reserve ID: identify reserve reference number from SP map, for dispersed reserves, use standards unit ID, if no reference from the SP, then use your own logical system.

Plot #: plot number for this reserve ID, start again at "1" for each new reserve area

Size of reserve (ha): area based on map or from field estimate

UTM or lat/long: location

Prism BAF: BAF used (do not change BAF within a reserve)

FIZ: forestry inventory zone

Page_of_: indicate if multiple pages per plot – please fully fill in admin section for each page

Field Data Collection Section

Column	Title	Description
A	Tree #	Tree number (e.g., 1–25)
B	Species	Species code for tree – use codes from inventory code list
C	DBH	DBH: measure DBH to the nearest tenth of a centimetre (estimate for all but sample trees in full count dispersed areas).
D	% Live Crown	1 if <30% 2 if 30–60% 3 if >60% Blank – dead tree

Column	Title	Description
E	Fallen Tree/CWD	F1 – fallen log >3 m long, 3 m or more < 20 cm above the ground F2 – fallen log >3m long with < 3m within 20cm of the ground F3 – fallen log <3m long Code fallen trees/CWD class (see Appendix V) (i.e., F1–2 = a class 2 piece of CWD >3 m long with at least 3m within 20 cm of the ground Blank – standing tree **NB:** • Trees >45 degrees from vertical are considered fallen/CWD • Trees <45 degrees from vertical are considered standing • Record as CWD only if dbh >12.5 cm
F	Height Actual	Estimated height of tree to nearest metre.
G	Height Projected	For broken top or snapped trees, estimate what the total height would have been to nearest metre.
H	Tree Class	Tree Class (see section 3.5.6 of cruising manual for more description): **1.** Residual – living tree, no external pathological indicators **2.** Suspect – living tree with 1 or more pathological indicators **3.** Dead potential standing or down >50% of original volume is sound wood **4.** Dead useless standing <50% of original volume is sound wood **5.** Veteran – mature living tree **6.** Live useless – 1 or 2 live limbs and <50% of original volume is sound wood **7.** Veteran dead potential **8.** Immature – immature tree within a mature stand **9.** Immature dead potential
I	Conk	Use path code by tree thirds, blank means not present
J	Blind Conk	Use path code by tree thirds, blank means not present
K	Scar	Use path code by tree thirds, blank means not present
L	Fork or Crook	Use path code by tree thirds, blank means not present

Column	Title	Description
M	Frost Crack	Use path code by tree thirds, blank means not present
N	Mistletoe	Use path code by tree thirds, blank means not present
O	Rotten Branch	Use path code by tree thirds, blank means not present
P	Dead or Broken Top	Use path code by tree thirds, blank means not present
Q	WLT Class	WLT class: class code 1 to 9 (coniferous) or 1 to 8 (deciduous)
R	Use (F,N,D)	Evidence of wildlife tree use F=feeding, N=nesting, D=denning. Blank means none present.
S	Visible Internal Decay	✔ or Y– if internal decay can be seen (e.g., hole in tree, or woodpecker cavity). Blank means none visible.
T	Uncommon Species	Your judgement that this tree species is uncommon for the area.
U	Uncommon Habitat Feature	✔ or Y if uncommon habitat feature present (e.g., raptor/owl nest, cavity nest, bat roost, bear den, bear marked tree, large hollow tree etc.). Blank means none present. Provide notes in comment section.
V	Current Insect/Disease	✔ or Y if insect or disease – provide notes in comments section. Blank means not present.
W	WLT Value (L,M,H)	See Appendix V for rating scheme.
X	Lichens	A – arboreal lichen present (*Alectoria* and *Bryoria* spp.) G – ground lichen present (*Cladonia*, *Cladina* and *Peltigera spp.)* within the drip line of the tree B – both A and G present [refer to Armleder, H.M, et al, *Estimating the Abundance of Arboreal Lichens*, Land Management Handbook, Field Guide Insert 7, June 1992, MOF Research Program]
Y	Danger Tree	DH – tree was likely dangerous during harvesting level of disturbance DF – tree will likely be dangerous for the next most likely activity (level of disturbance) DB – both DH and DB Blank means the tree is safe.
Z	Cut Stump: Diameter/Height	Record diameter at stump height; record average height of stump.

Column	Title	Description
AA	Cut Stump: Species	Record species, if known, by species code.
AB	CutSstump: Log Left Y/N	Record if fallen tree is present – Yes or No.
AC	Edge Plot "R" Tree	Edge Plot "R" Tree – tree also tallied from mirage plot, put an "R" in this column (two R's if tree counted from outside two polygon edges). Insert "0" if a mirage plot established but no trees recorded.
AD	Windthrow	1 – windthrow since harvest with root ball 2 – windthrow since harvest with root plate 3 – windthrow trunk snap since harvest

Sampling Full Count Plots

For a full count of all trees within a retention area, record the following for all trees greater than 12.5 cm dbh:

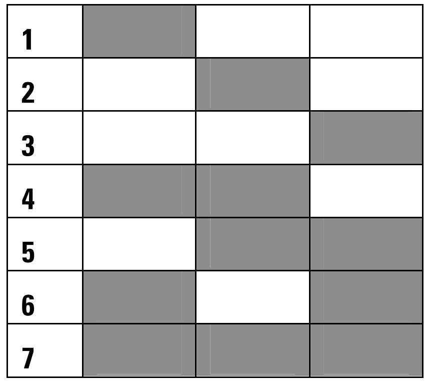
- The information in columns A (tree #), B (species), E (fallen tree/CWD), F/G (actual/projected heights), H (tree class), W (WLT value), Y (danger tree) from the field card.
- A sub-sample of the dispersed trees (for complete information). Twenty trees per dispersed reserve area should be measured. Therefore estimate the total population of dispersed trees and divide by 20 to determine the frequency of fully measured trees.
- Three tree ages from 3 dominant or co-dominant trees per cutblock.
- Answer the seven reserve area summary questions.

External Decay Indicators

Indicate presence of external decay indicators by using the appropriate code (listed below).

Refer to the box titled, Path Code by Tree Third. This indicates the numerical coding to be used in this section. The tree is schematically divided into thirds, with the left-hand cutblock representing the bottom third, the middle cutblock represents the middle third, and the right-hand cutblock represents the top third. The shading indicates in which third or thirds the defects occur. The applicable numerical code is shown to the left of the cutblocks. Thus, if the defects occur in the lower third only, "1" is entered under the class of defect; if they occur in both the middle and upper thirds, "5" is entered; and so on.

Path Code by Tree Third



Height Measurement Trees

- Measure one height per prism plot.
- Measure a selection of heights as necessary from the 20 sample trees per full count dispersed area.
- Trees must have a live top in order to be used as a height measurement tree.
- Select a dominant or co-dominant tree.
- Record measured height to the nearest tenth of a metre.
- Age is taken at breast height for 3 trees in each cutblock (i.e., first height measured tree in three reserve areas) if possible take ages from a variety of reserve types.

Summary Questions for Each Plot

The seven questions should be answered for each sampled reserve area based on the assessor's professional opinion after establishing required plots.

Summary for Cutblock

A cutblock summary should be written after all plots have been established in a cutblock. This is the assessor's professional opinion and general comments regarding the appropriateness of the retention in the cutblock.

Appendix IV – District Office Information Collection Procedures

Introduction

This document details the office preparation component of the provincial wildlife tree retention evaluation project. Cutblocks have been chosen for evaluation in 12 forest districts. Office data collection is a separate contract in each district.

Procedure

Post-harvest cutblocks

Forest Practices Branch will provide thirty opening numbers per district. These will be located in two BEC zones – fifteen cutblocks per zone.

The office contractor will determine if there is road access to the cutblocks. Road access is by four-wheel-drive truck, with a maximum one-hour walk if the road is obstructed. Collect documentation for the first seven cutblocks on the two subzone lists that have a good likelihood of road access.

Compile the documents identified in Table 1, for each of the fourteen cutblocks identified with road access.

Obtain the most recent air photos. If the most recent photos do not show the cutblock pre-harvest, a set of pre-harvest photos will also be required. Colour photocopies of air photos should be provided to the field contractor. Nancy Densmore, Forest Practices Branch, should be provided with a list of flight lines and photo numbers itemized by opening number.

Table 1. Checklist for documents collected for each opening #/cutblock

Document	Yes	No	Reference #
SP (including map)			
1:20 000 forest cover map			
Air photos (showing cutblock pre-harvest)			
Description or map showing how to get to cutblock			
Cruise Compilation (or plots where compilation covers area inconsistent with cutblock boundary)			

Fill in Table 2 for each of the fourteen cutblocks (as completely as possible).

Table 2. Summary of cutblock information

Opening #	Tenure	Silv. system	BEC*	TAUP	Rip. res (ha)	WLT res BA**	WLT res (ha)	Other res (ha)	Total reserve (ha)

* BEC to subzone
** Dispersed retention only

Fill in Table 3 for each opening.

Table 3. Summary of WTR areas derived from the SP opening #.___________

Reserve #	Reserve pattern (dispersed or group)	WLT Res (ha)	Basal area or SPH by species (dispersed only)	% WTR on boundary of cutblock (within TAUP)	% WTR outside of cutblock boundary (outside of TAUP)	% WTR inside, but not on, boundary

Organize all information by cutblock and provide to the field contractor. Note that cruise compilation data can be obtained later – it is required for the data analysis stage, not the data collection stage.

Send Nancy Densmore, Forest Practices Branch, a copy of the silviculture prescription and pre-harvest air photos for the first cutblock in each of the two subzones.

Pre-harvest cutblocks

Work with the district contact to find one cutblock (larger than 5 hectares) in each of the two subzones that has not been harvested, but has a completed silviculture prescription and cutblock layout (if available). Compile information as per Table 1, and provide this to the field contractor.

General information/documentation

If not already done by the district (check with district contact), then general information/documentation should be compiled as listed in Tables 4 and 5. This information should be forwarded to Nancy Densmore, Forest Practices Branch.

Table 4. General information/documentation

	Yes	No	Reference
LUP and/or TSR Operability Rules that impact WLT management			
District/Regional Small-scale Salvage Policy and any other plans/policies regarding WLT salvage			
Regional/District WTR direction			

Table 5. Questions for District/Licensee Planner (or other appropriate individual)

Name of Planner (or other appropriate individuals):
Position of person (if not Planner):
Contact information for above person (email/phone):
QUESTIONS:
As a district strategy, will any current wildlife tree retention (WTR) areas apply to future nearby cutblocks?
Does salvage occur on WTR areas in the district? If salvage does occur, is there a document that authorizes this salvage?
What documents are used to guide implementation of WTR in the district?
How is the appropriate WTR% for each cutblock determined?
How is windthrow potential factored into the design and management of individual WTR areas?
Do you expect WTR areas to be harvested in the future? If yes, when? Is this documented anywhere?

Appendix V – Results of District Questionnaire

Responses to the District Questionnaire were received from 11 out of 12 districts. A summary of answers to the questions, along with related policy interpretations, is presented here.

Question 1. As a district strategy, will any current wildlife tree retention (WTR) areas apply to future nearby cutblocks?

Current Policy Direction

Although this question is not explicitly addressed in the *Provincial Wildlife Tree Policy and Management Recommendations,* wildlife tree retention is considered stand-level retention that applies to each cutblock. The policy recommends that areas chosen for wildlife tree retention be within the total area under prescription (TAUP). This is to ensure that areas do not get counted for more than one cutblock, and that the retention is retained for at least one rotation. This question also has important implications for the analysis of timber supply impacts undertaken in this evaluation.

Question 1 Results

Of the 11 districts reporting, four responded no and seven responded yes to the question. Most of the districts that replied yes qualified their response (5 out of 7) to indicate that only larger wildlife tree patches would apply to future nearby cutblocks. What defined a 'larger patch' was not described.

Question 2. Does salvage occur on WTR areas in the district? If salvage does occur, is there a document that authorizes this salvage?

Current Policy Direction

Section 28 of the *Timber Harvesting Practices Regulation* defines wildlife tree patches as sensitive ecosystems. There can be no minor salvage in a sensitive ecosystem unless approved in a silviculture prescription or through a district manager's written approval (with defined terms and conditions). District managers can develop policy regarding conditions when minor salvage would be necessary. Stand-specific issues that influence the decision of where salvage may be appropriate for wildlife tree patches include:

- worker safety;
- significance of forest health risks to surrounding stands;
- ability of the retained wildlife trees to perform as suitable wildlife habitat; and
- availability of wildlife trees and coarse woody debris (CWD) in adjacent harvested areas.

In addition, wildlife tree policy indicates where all or part of a wildlife tree patch is salvaged, the salvaged area should be replaced with other suitable habitat in the nearest possible location. If a wildlife tree patch suffers blowdown, but is not salvaged, it need not be replaced.

A significant benefit of wildlife tree retention is the eventual input of CWD on the site. The natural dynamics of CWD is to have large fluctuations in the amount of CWD on the ground throughout the life of a stand. If a wildlife tree patch is salvaged after a windstorm, natural levels of CWD within the patch will not be present. Not allowing CWD inputs into the decomposition process will, over time, reduce the productivity of forest soils and the amount of available habitat for many species that use large rotting logs. This question also has important implications for the analysis of timber supply impacts undertaken in this evaluation.

Question 2 Results

In most districts (9 of the 11 that reported), salvage of windthrow and beetle infestation was reported to occur. In six of the districts where salvage was reported, district policy guided the salvage, while the other three districts reported that salvage was managed on a site-specific basis. It is interesting to note that very little salvage or felled trees were found within wildlife tree retention areas during the field surveys (see EGP 6, Table 13).

Although the question was not explicitly asked in the district questionnaire, one of 11 districts indicated that where salvage occurs in WTR areas, licensees are asked to establish a replacement WTR area. In addition, one other district reported that salvaged WTR was compensated through retention on partially cut areas. Four of nine district manager policies included a requirement to replace salvaged WTR areas with suitable habitat.

Question 3. What documents are used to guide implementation of WTR in the district?

Current Policy Direction

There are three provincial sources of policy direction concerning wildlife tree management: the *Biodiversity Guidebook* (BDG), the *Landscape Unit Planning Guide* (LUPG), and the *Provincial Wildlife Tree Policy and Management Recommendations* (PWTPMR). The BDG and LUPG detail suggested retention levels, while the PWTPMR details ecological and administrative guiding principles, and best management practices. In addition, the PWTPMR encourages the development of district- or region-specific procedures, where appropriate.

Question 3 Results

Nine of the 11 reporting districts had a district manager policy to guide the implementation of wildlife tree management. All district manager policies took guidance from one of the three provincial sources of policy direction. The two districts that did not employ district manager policies used the BDG and/or LUPG to guide WTR implementation.

Question 4. How is the appropriate WTR percentage for each cutblock determined?

Current Policy Direction

The *Landscape Unit Planning Guide* (LUPG), and the *Biodiversity Guidebook* (BDG) detail the method and amounts recommended for wildlife tree retention levels, by subzone, based on the area available for harvest and previous harvesting history. In addition, policy direction in the BDG, LUPG and the *Provincial Wildlife Tree Policy and Management Recommendations* promotes site-specific variation of retention levels set for landscapes.

Question 4 Results

Eight of the 11 districts that reported used the BDG/LUPG to help determine appropriate wildlife tree retention levels. The other three districts set district target levels as opposed to specific targets by BEC subzone. All districts allowed for site-specific variance.

Question 5. How is windthrow potential factored into the design and management of individual WTR areas?

Current Policy Direction

The following are quoted from the Ecological and Administrative Guiding Principles of the *Provincial Wildlife Tree Policy and Management Recommendations*:

- "The most windfirm reserves, and therefore the most likely to remain standing after harvesting, are reserves that consider the site, stand and individual trees during layout. For individual trees, size (low height/diameter ratio) is generally a much more reliable indicator of windfirmness than species.
- Trees/areas chosen for wildlife tree retention should be designed to minimize windthrow and the potential for contributing to insect infestation in adjacent stands.
- If trees chosen as wildlife trees have been felled, they should be left in place to function as coarse woody debris, unless they pose a significant forest health or other concern.
- Where wildlife tree patches are salvaged (e.g., high forest health risk), they should be replaced with equivalent suitable habitat as close to the original patch as possible."

The following paragraph is general information on windthrow found in the *Provincial Wildlife Tree Policy and Management Recommendations*:

> "Proper design, selection and layout of reserve areas/trees will significantly reduce windthrow. However, on most sites, some windthrow should be expected. An acceptable level of windthrow, based on forest health and other district-specific considerations, should, where appropriate, be determined prior to harvesting and stated in the SP and/or FDP as a cutblock-specific windthrow assessment. Any standards put into an SP must be both measurable and enforceable. Setting percentage windthrow tolerances based on district criteria will streamline the administration of salvage operations. It may be appropriate to incorporate windfirming techniques on reserves where there is a high level of risk. For example, WTPs placed within, or adjacent to, the riparian management zone can help to windfirm the riparian reserve. Other techniques, such as limbing and topping, may also be appropriate."

Question 5 Results

All reporting districts indicated that decisions concerning windthrow design are primarily left to the forester developing the silviculture prescription. District/licensee intent is to emphasize placement of wildlife tree patches in the most windfirm locations. Windthrow reduction techniques were reported to be used by one district. It is common to accept a threshold level of windthrow, especially where beetles are not a concern. Two districts indicated that wildlife tree retention areas with severe windthrow would generally be salvaged and replaced with other suitable habitat.

Question 6. Do you expect WTR areas to be harvested in the future? If yes, when? Is this documented anywhere?

Current Policy Direction

The following is quoted from the Ecological Guiding Principles of the *Provincial Wildlife Tree Policy and Management Recommendations*:

- "Those trees/areas chosen for wildlife tree retention should be designated for a minimum of one rotation."

Question 6 Results

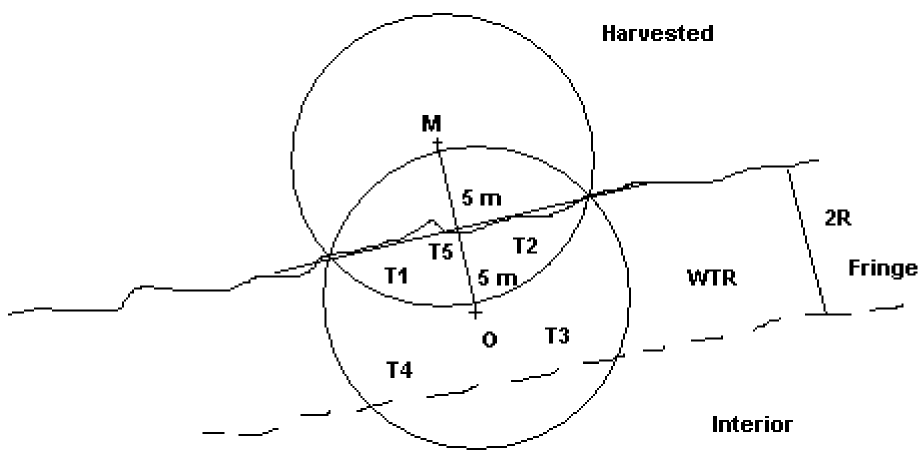
All 11 reporting districts indicated that WTR areas would be left for a minimum of one rotation. Nine of the 11 districts indicated that WTR areas may be harvested at the end of the rotation. The other two districts reported that WTR areas would not be harvested in the future.

APPENDIX VI – MIRAGE CORRECTION PROCEDURE

Edge Plot Details

- Use the identified BAF and the identified largest diameter tree of the stand to determine the fringe/exterior portion of the WTR polygon. For example, BAF = 4, DBH = 45 cm resulting in a PRF = R= 11.25 m; resulting fringe/exterior distance will be = 2R = 2* 11.25 = 22.5 m (R = tree radius). PRF is the plot radius factor – the largest radius for the plot based on the biggest tree.
- If a plot centre lands within 2R of the edge, then a mirage plot centre must be established/projected orthogonally across the edge/boundary, such that the original and miraged point are equidistant from the edge (and on a conceptual line perpendicular to it). For example, if the fringe distance is 22.5 m and a plot lands 20 m from the edge, then a miraged plot needs to be established by placing the mirage plot equally 20 m out from the edge.

Note: All trees are tallied on the same plot card – a tree may be counted more than once depending of the number of mirage plots established.



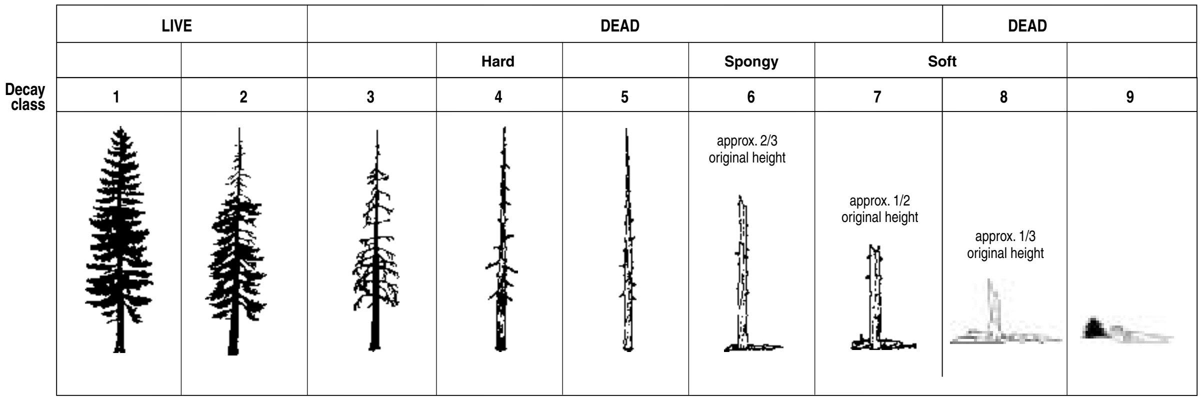
Example of simple mirage plot layout

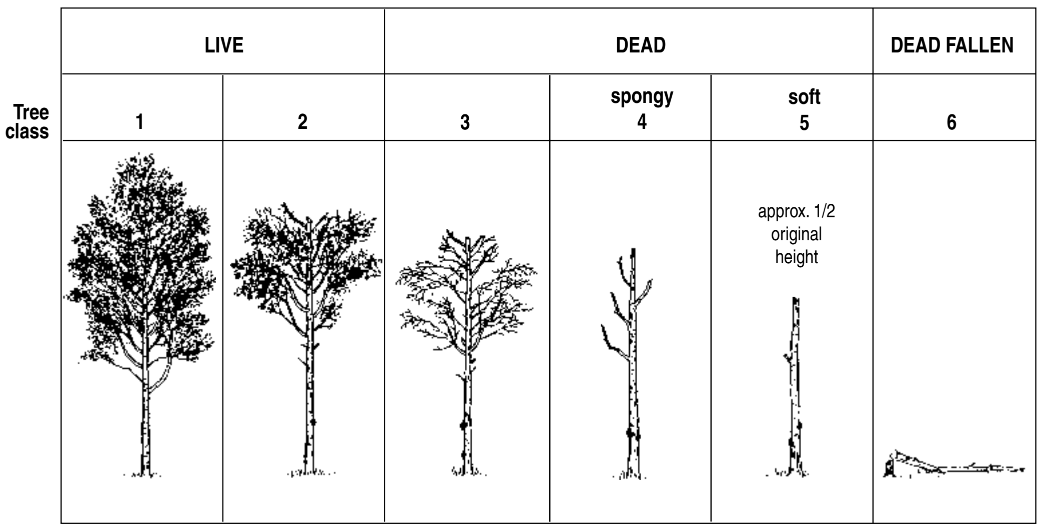
In the example, "O" original plot centre landed within the fringe area, the "M" mirage plot was subsequently located equidistant, perpendicular to the edge away. (all are recorded on the same tally card). For this example, tree T1, T2, and T5 are tallied twice, while trees T3 and T4 are tallied or counted just once.

APPENDIX VII – WILDLIFE TREE VALUE RATING

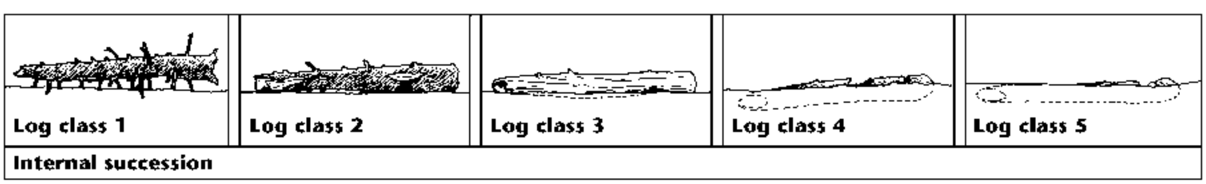
Wildlife Tree Value Characteristics
HIGH
A high-value wildlife tree has at least two characteristics listed below: • Internal decay (heart rot or natural/excavated cavities present) • Crevices present (loose bark or cracks suitable for bats) • Large brooms present • Active or recent wildlife use • Current insect infestation • Tree structure suitable for wildlife use (e.g., large nest, hunting perch, bear den, etc.) • Largest trees on site (height and/or diameter) and/or veterans • Locally important wildlife tree species
MEDIUM
• Large, stable tree that will likely develop two or more of the above attributes for High
LOW
• Trees not covered by High or Medium

APPENDIX VIII – WILDLIFE TREE AND CWD CLASSES





CWD Classes



Appendix IX – Statistical Methods for Volume and Area Impact Calculations

Estimates for the Strata Sampled

In this analysis, inference is restricted to the strata actually sampled in this study. Of the 138 forest district and BEC zone combinations found in ISIS, 22 strata were sampled. These strata comprised a connected but incomplete factorial. The BEC zones sampled within each forest district were generally those with the most cutblocks available.

1. Combined Ratio Estimates for the Impacts on Volume and Area

A combined ratio estimator was used to calculate the area and volume impact for 1) each BEC zone using the districts as strata and 2) overall using all 22 strata. These calculations follow Cochran (1977, section 6.11). Since the notation is cumbersome we will start with its definition:

Sample size variables:

N_h = number of cutblocks in the h^{th} stratum. This is indexed by $h = 1, 2, \ldots, H$, $(H = 22)$.

n_h = number of cutblocks sampled in the h^{th} stratum

f_h = sampling fraction for the h^{th} stratum ($f_h = n_n / N_h$)

N = total number of cutblocks in the population of 22 strata, $N = \sum_{h=1}^{H} N_h$

Pre-harvest variables:

x_{hj} = pre-harvest volume or area of the j^{th} cutblock in the h^{th} stratum.

$\bar{x}_h$ = average pre-harvest volume or area for sampled cutblocks in the h^{th} stratum,

$$\bar{x}_h = \frac{1}{n_h} \sum_{j=1}^{n_h} x_{hj}$$

X = Total pre-harvest volume or area for the entire population of 22 strata. We have to estimate this by $\hat{X} = \sum_{h=1}^{H} N_h \cdot \bar{x}_h$

Post-harvest variables:

y_{hj} = post-harvest volume or area of the j^{th} cutblock in the h^{th} stratum.

$\bar{y}_h$ = average post-harvest volume or area for sampled cutblocks in the h^{th} stratum,

$$\bar{y}_h = \frac{1}{n_h} \sum_{j=1}^{n_h} y_{hj}$$

The combined ratio estimator or the impact ratio is given by: $\hat{R} = \sum_h N_h \cdot \bar{y}_h \Big/ \sum_h N_h \cdot \bar{x}_h$

Calculating this ratio's variance involves a number of steps. They are:

1. Calculate a residual for each cutblock using $e_{hj} = y_{hj} - \hat{R} \cdot x_{hj}$.
2. For each stratum, calculate the variance of these residuals, s_h^2, using

   $s_h^2 = \frac{1}{(n_h - 1)} \sum_{j=1}^{n_h} (e_{hj} - \bar{e}_h)^2$, where $\bar{e}_h$ is the stratum mean of the residuals.

3. Then calculate the variance of the ratio as: $\text{var}(\hat{R}) = \frac{1}{\hat{X}^2} \sum_{h=1}^{H} \frac{N_h^2 (1 - f_h) s_h^2}{n_h}$

The standard error is simply the square root of $\text{var}(\hat{R})$, and confidence limits were developed using a t-statistic. The degrees of freedom were calculated using Satterthwaite's approximate methods described in Cochran (1977, section 5.4).

Provincial Estimates

In this analysis, inference is made to all the cutblocks that could have been sampled throughout the province. To do this, the strata, forest district and BEC zone combinations, were treated as clusters. It was assumed that the clusters sampled had been chosen as a simple random sample from the 138 clusters that were available. A 'lower bound' for the standard error and confidence limits was developed by ignoring the subsampling within each cluster.

2. Ratio Estimates for the Impacts on Volume and Area

Total potential pre-harvest volume and post-harvest volume were estimated for each cluster using the subsampled cutblocks. Their resulting sums were then used to estimate the ratio. The standard error was calculated for the ratio as per Cochran (1977, section 2.11). The notation is still cumbersome and requires some changes in definition. New notation or redefined notation is:

Sample size variables:

K = total number of clusters in the population.

k = number of clusters sampled.

f = sampling fraction for the cluster samples ($f = k / K$).

N_h = number of cutblocks in the h^{th} cluster. This is still indexed by h = 1, 2, . . . , k, (k = 22).

n_h = number of cutblocks sampled in the h^{th} cluster.

Pre-harvest variables:

$\hat{x}_h$ = estimated total pre-harvest volume or area for the h^{th} cluster, $\hat{x}_h = N_h \cdot \bar{x}_h$.

X = Total pre-harvest volume or area for the entire population of K clusters, $X = \sum_{h=1}^{K} x_h$. For volume we have to estimate this by $\hat{X} = \frac{K}{k} \cdot \sum_{h=1}^{k} \hat{x}_h$.

Post-harvest variables:

$\hat{y}_h$ = estimated total post-harvest volume or area for the h^{th} cluster, $\hat{y}_h = N_h \cdot \bar{y}_h$.

The impact ratio is then given by $\hat{R} = \sum_{h=1}^{k} \hat{y}_h \Big/ \sum_{h=1}^{k} \hat{x}_h$. Note that this exactly the same formula as the combined ratio estimator for the stratified approach, just written differently. Thus the estimates of the ratio remain unchanged.

The variance for this ratio is calculated using:

$$\text{var}(\hat{R}) = \frac{K^2 (1-f) \sum_{h=1}^{k} (\hat{y}_h - \hat{R} \cdot \hat{x}_h)^2}{k X^2 (k-1)}$$ where either X or $\hat{X}$ are used.

The degrees of freedom for the confidence limits is simply the number of sampled clusters minus one.

Appendix X – Volume Impacts for Individual Strata for Each BEC Zone and District

Table 1. Volume impact for individual strata – for each BEC zone and district separately

District[a]	BEC zone[b]	Number of cutblocks in strata	Number of cutblocks sampled	Standard error of ratio (%)	Lower conf. limit (%)	Volume impact (%)	Upper conf. limit (%)
DJO	BWBS	406	8	4.22	4.25	**14.22**	24.20
DCK	CWH	423	8	1.08	-0.57	**1.99**	4.55
DKI	CWH	40	6	4.93	-4.50	**8.18**	20.85
DNC	CWH	182	10	2.33	5.30	**10.58**	15.86
DSI	CWH	699	7	1.61	-0.43	**3.51**	7.45
DAR	ESSF	250	5	1.47	0.71	**4.79**	8.87
DCK	ESSF	42	3	2.85	-8.97	**3.31**	15.59
DCL	ESSF	276	7	1.70	-2.49	**1.68**	5.85
DJO	ESSF	27	2	12.12	-109.75	**44.24**	198.23
DKL	ESSF	185	9	2.17	-1.41	**3.60**	8.61
DPG	ESSF	115	4	1.46	-2.15	**2.50**	7.15
DAR	ICH	650	5	1.43	0.32	**4.29**	8.26
DCL	ICH	413	7	2.75	-2.41	**4.33**	11.06
DKA	ICH	187	7	2.03	-1.25	**3.72**	8.68
DKI	ICH	258	8	1.93	3.86	**8.42**	12.98
DKL	ICH	387	3	3.80	0.63	**16.99**	33.34
DCH	IDF	144	6	2.62	-1.69	**5.05**	11.80
DKA	IDF	516	7	6.25	-3.58	**11.72**	27.02
DCH	SBPS	1411	5	0.06	-0.05	**0.12**	0.30
DQU	SBPS	492	1	0.00		**2.30**	
DPG	SBS	1698	5	0.25	-0.20	**0.48**	1.16
DQU	SBS	887	4	1.61	-3.48	**1.64**	6.77
		9688	127				

[a] DJO: Fort St. John; DCK: Chilliwack; DKI: Kispiox; DNC: North Coast; DSI: South Island; DAR: Arrow; DCL: Clearwater; DKL: Kootenay Lake; DPG: Prince George; DKA: Kamloops; DCH: Chilcotin; DQU: Quesnel.

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

Table 2. Area impact for individual strata – for each BEC zone and district separately

District	BEC zone	Number of cutblocks in strata	Number of cutblocks sampled	Standard error of ratio (%)	Lower confidence limit (%)	Area impact (%)	Upper confidence limit (%)
DJO	BWBS	406	8	0.0979	16.10	**16.33**	16.56
DCK	CWH	423	8	0.0263	2.44	**2.50**	2.56
DKI	CWH	40	6	0.8284	7.10	**9.23**	11.36
DNC	CWH	182	10	0.0767	13.56	**13.73**	13.91
DSI	CWH	699	7	0.0268	5.40	**5.46**	5.53
DAR	ESSF	250	5	0.0477	8.00	**8.14**	8.27
DCK	ESSF	42	3	0.2365	3.09	**4.11**	5.12
DCL	ESSF	276	7	0.0528	2.16	**2.29**	2.42
DJO	ESSF	27	2	0.5799	19.25	**26.62**	33.99
DKL	ESSF	185	9	0.1511	4.86	**5.21**	5.56
DPG	ESSF	115	4	0.0862	4.00	**4.28**	4.55
DAR	ICH	650	5	0.0170	4.32	**4.37**	4.42
DCL	ICH	413	7	0.0481	4.35	**4.47**	4.59
DKA	ICH	187	7	0.0811	4.20	**4.39**	4.59
DKI	ICH	258	8	0.0440	7.78	**7.89**	7.99
DKL	ICH	387	3	0.0332	16.95	**17.09**	17.23
DCH	IDF	144	6	0.0832	7.75	**7.96**	8.18
DKA	IDF	516	7	0.1205	16.16	**16.45**	16.75
DCH	SBPS	1411	5	0.0005	0.21	**0.21**	0.21
DQU	SBPS	492	1	0.0000		**5.47**	
DPG	SBS	1698	5	0.0017	1.04	**1.04**	1.05
DQU	SBS	887	4	0.0048	1.20	**1.21**	1.23
		9688	127				

[a] DJO: Fort St. John; DCK: Chilliwack; DKI: Kispiox; DNC: North Coast; DSI: South Island; DAR: Arrow; DCL: Clearwater; DKL: Kootenay Lake; DPG: Prince George; DKA: Kamloops; DCH: Chilcotin; DQU: Quesnel.

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

Appendix XI – Mitigating Factor #2 – Moving the WLT Patches Following Each Rotation

Current wildlife tree policy states that wildlife tree retention should be maintained for a minimum of one rotation. At the end of the rotation, the choice is to either maintain the wildlife tree patch, or harvest the patch and replace it with an area of the managed stand.

Factors influencing this choice will likely include:

- Market demand for the type of timber available in the patches; and
- Ecological need for maintaining the wildlife tree patch for multiple rotations.

The following three figures show the yield curves for a managed and an unmanaged stand of coastal Douglas-fir (site index 30), interior Douglas-fir (site index 20), and lodgepole pine (site index 20). The TIPSY yield curve represents the managed stand, while the VDYP yield curve represents the unmanaged stand. The volumes presented in these yield curves are used in the example below to show the cumulative difference in harvest volume between maintaining a patch for three rotations, versus harvesting the patch at the end of the second rotation and replacing it with an area of the managed stand.

17.5 utilization standard

Age	VDYP	TIPSY	Age	VDYP	TIPSY
10	0	0	140	928.1	958
20	0	0	150	950.9	987
30	82.3	57	160	966.3	1009
40	212.9	204	170	974.3	1028
50	327.2	333	180	974.7	1048
60	427.7	455	190	984.3	1069
70	516.9	555	200	994.5	1086
80	597.2	645	210	1004.9	1101
90	670.2	727	220	1015.2	1119
100	737.1	787	230	1025.2	1132
110	799.1	840	240	1034.9	1139
120	856.9	889	250	1044.2	1147
130	896.7	927	260	1044.2	1158

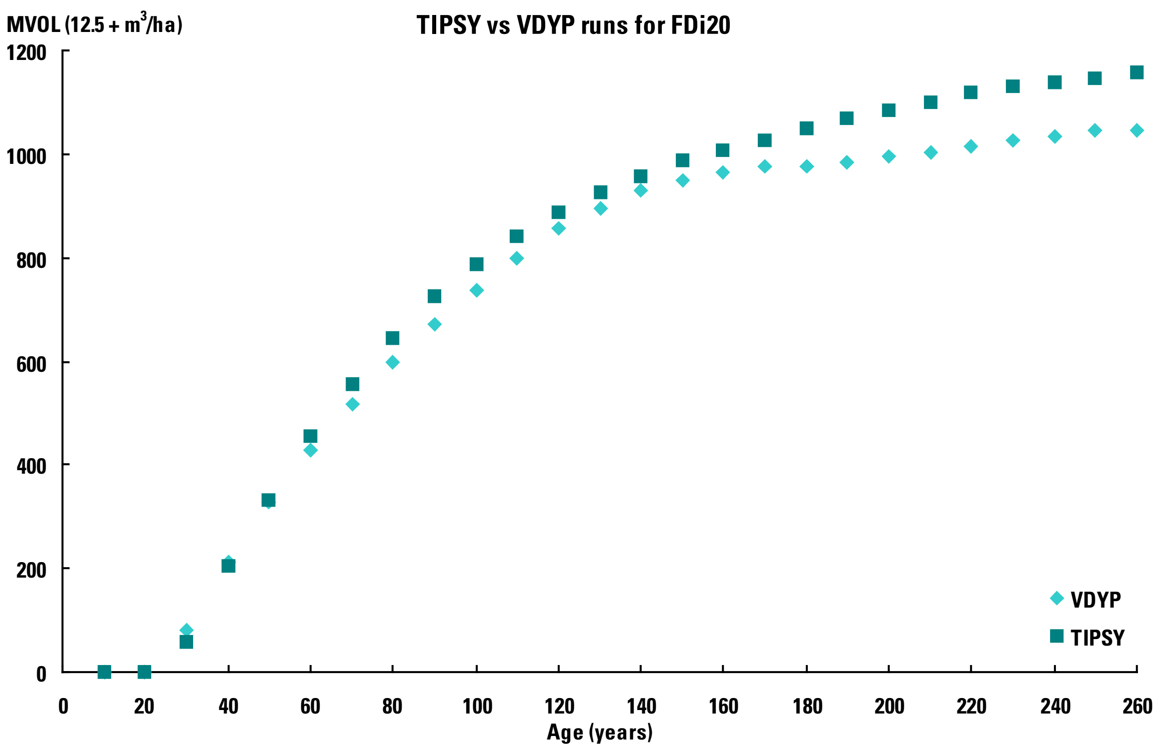


Figure 1. Yield curve comparison of a coastal Douglas-fir stand (site index 30).

Example: coastal Douglas-fir (site index 30)

No WTR – 20 hectare cutblock

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	20	737.1	100	VDYP	14742.0		
2	Cutblock	20	645	80	TIPSY	12900	27642.0	
3	Cutblock	18.4	645	80	TIPSY	12900	40542.0	0%

Stationary WTR – 20 hectare cutblock (1.6 ha of WTR maintained in same area for three rotations)

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	18.4	737.1	100	VDYP	13562.6		
1	WTP	1.6	737.10	100	VDYP	0	13562.6	
2	Cutblock	18.4	645	80	TIPSY	11868		
2	WTP	1.6	974.7	180	VDYP	0	25430.6	
3	Cutblock	18.4	645	80	TIPSY	11868		
3	WTP	1.6	1044.2	260	VDYP	0	37298.6	8%

Moving WTR – 20 hectare cutblock (1.6 ha of WTR location moves at second rotation)

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	18.4	737.1	100	VDYP	13562.64		
1	WTP	1.6	737.1	100	VDYP	0	13562.6	
2	Cutblock	16.8	645	80	TIPSY	10836		
2	WTP	1.6	974.7	180	VDYP	1559.52	25958.2	
3	Cutblock	16.8	645	80	TIPSY	10836		
3	WTP	1.6	1009	160	TIPSY	1614.4	38408.6	5.3

In this case, moving wildlife tree retention increased the cumulative harvest volume by 1110 m^3 (38408.6 - 37298.6) compared to stationary wildlife tree retention. This practice would decrease the impact of wildlife tree retention compared to no retention by 34%.

17.5 utilization standard

Age	VDYP	TIPSY	Age	VDYP	TIPSY
10	0	0	140	346.9	478
20	0	0	150	366	504
30	0	0	160	383.9	529
40	30.9	10	170	400.6	548
50	65.9	58	180	416.4	566
60	101.9	126	190	431.2	581
70	137.9	181	200	445.2	593
80	173.4	236	210	458.4	604
90	208	288	220	470.9	612
100	241.5	333	230	482.8	621
110	273.9	378	240	494.1	628
120	302.5	416	250	505	634
130	326.3	450	260	505	641

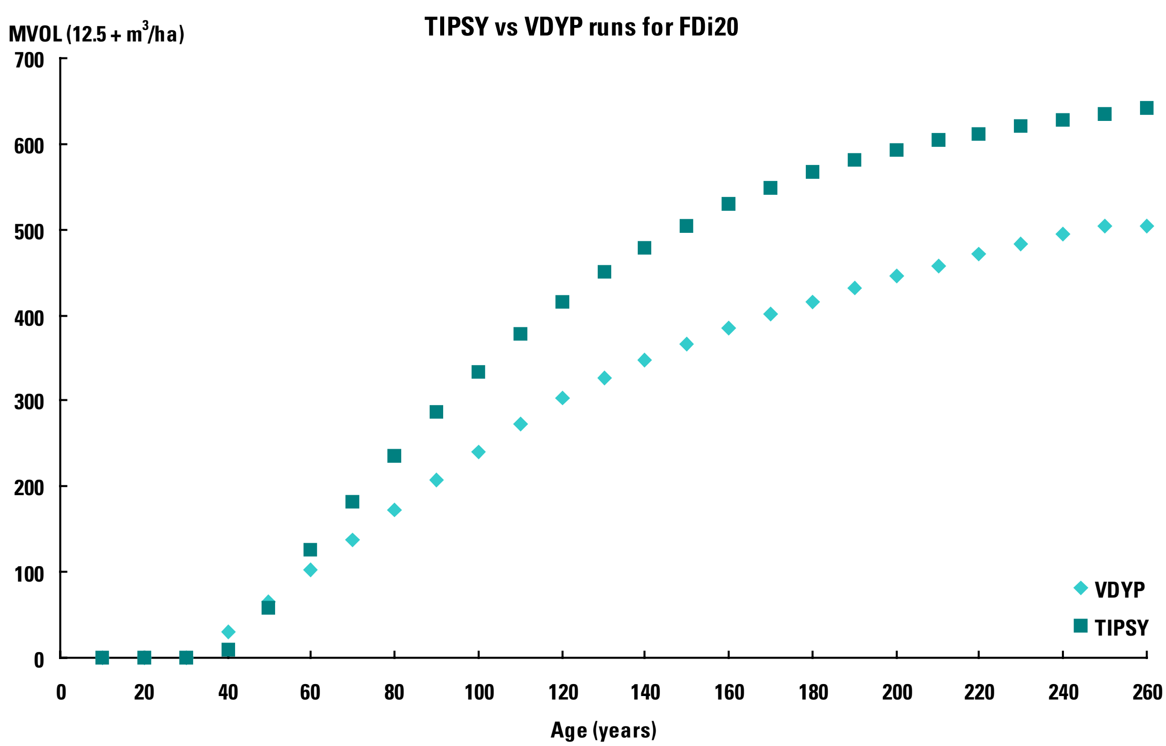


Figure 2. Yield curve comparison of an interior Douglas-fir stand (site index 20)

Example: interior Douglas-fir (site index 20)

No WTR – 20 hectare cutblock

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	20.0	241.5	100	VDYP	4830	4830	
2	Cutblock	20.0	236	80	TIPSY	4720	9550	
3	Cutblock	20.0	236	80	TIPSY	4720	14270	0%

Stationary WTR – 20 hectare cutblock (1.6 ha of WTR maintained in same area for three rotations)

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	18.4	241.5	100	VDYP	4443.6		
1	WTP	1.6	241.5	100	VDYP	0	4443.6	
2	Cutblock	18.4	236	80	TIPSY	4342.4		
2	WTP	1.6	416.4	180	VDYP	0	8786.0	
3	Cutblock	18.4	236	80	TIPSY	4342.4		
3	WTP	1.6	505	260	VDYP	0	13128.4	8%

Moving WTR – 20 hectare cutblock (1.6 ha of WTR location moves at second rotation)

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	18.4	241.5	100	VDYP	4443.6		
1	WTP	1.6	241.5	100	VDYP	0	4443.6	
2	Cutblock	16.8	236	80	TIPSY	3964.8		
2	WTP	1.6	416.4	180	VDYP	666.24	9074.6	
3	Cutblock	16.8	236	80	TIPSY	3964.8		
3	WTP	1.6	529	160	TIPSY	846.4	13885.8	2.8

In this case, moving wildlife tree retention increased the cumulative harvest volume by 757.4 m^3 (13885.8 - 13128.4) compared to the stationary wildlife tree retention. This practice would decrease the impact of wildlife tree retention compared to no retention by 65%.

12.5 utilization standard

Age	VDYP	TIPSY	Age	VDYP	TIPSY
10	0	0	140	432	458
20	0	2	150	444.6	461
30	29.1	54	160	453.3	465
40	88.2	143	170	458	468
50	141.2	218	180	458.9	468
60	188.2	280	190	455.9	468
70	230	326	200	458	468
80	267.7	358	210	460.6	468
90	301.9	387	220	463.5	468
100	333.4	410	230	466.5	468
110	362.5	428	240	469.4	468
120	389.8	444	250	472.2	468
130	415.6	451	260	472.2	468

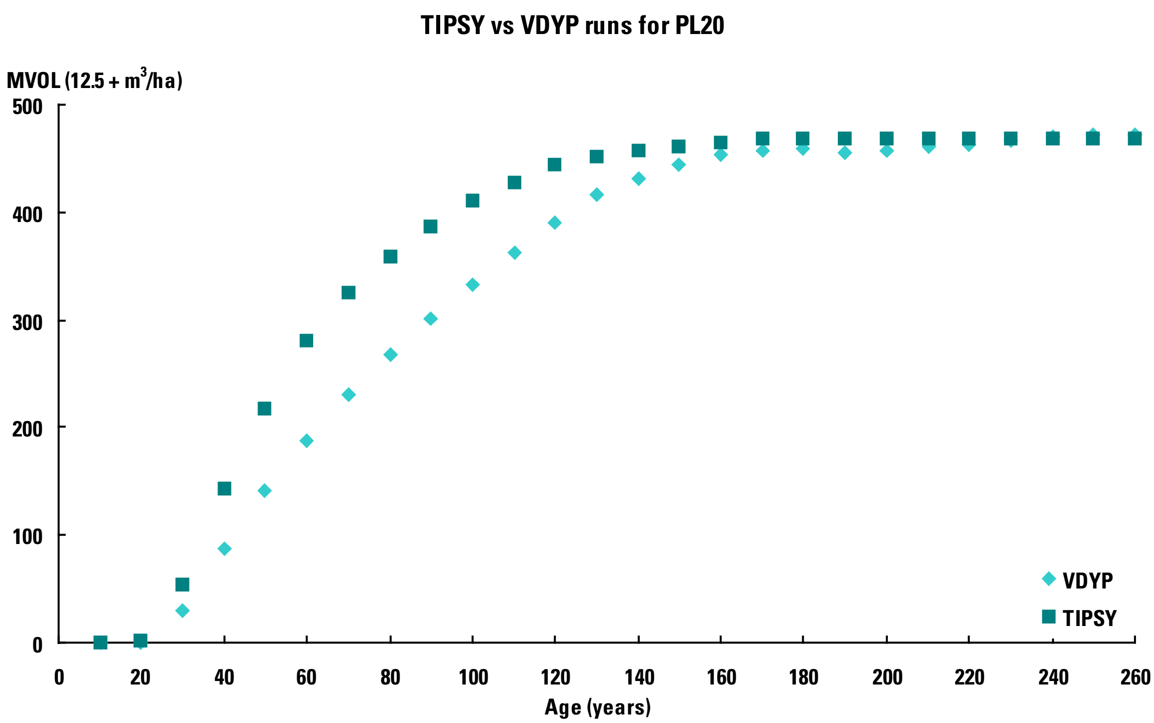


Figure 3. Yield curve comparison of a lodgepole pine stand (site index 20).

Example: lodgepole pine (site index 20)

No WTR – 20 hectare cutblock

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	20.0	333.4	100	VDYP	6668	6668	
2	Cutblock	20.0	358	80	TIPSY	7160	13828.0	
3	Cutblock	20.0	358	80	TIPSY	7160	20988.0	0

Stationary WTR – 20 hectare cutblock (1.6 ha of WTR maintained in same area for three rotations)

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	18.4	333.4	100	VDYP	6134.56		
1	WTP	1.6	333.4	100	VDYP	0	6134.6	
2	Cutblock	18.4	358	80	TIPSY	6587.2		
2	WTP	1.6	458.9	180	VDYP	0	12721.8	
3	Cutblock	18.4	358	80	TIPSY	6587.2		
3	WTP	1.6	472.2	260	VDYP	0	19309.0	8%

Moving WTR – 20 hectare cutblock (1.6 ha of WTR location moves at second rotation)

Cut #	Area type	Area ha	Vol/ha at harvest	Age at harvest	Yield curve	Blk vol harvested	Cumulative harvest volume	Impact
1	Cutblock	18.4	333.4	100	VDYP	6134.56		
1	WTP	1.6	333.40	100	VDYP	0	6134.6	
2	Cutblock	16.8	358	80	TIPSY	6014.4		
2	WTP	1.6	458.9	180	VDYP	734.24	12883.2	
3	Cutblock	16.8	358	80	TIPSY	6014.4		
3	WTP	1.6	465	160	TIPSY	744	19641.6	6.4

In this case, moving wildlife tree retention increased the cumulative harvest volume by 332.6 m^3 (19641.6 - 19309.0) compared to the stationary wildlife tree retention. This practice would decrease the impact of wildlife tree retention compared to no retention by 20%.

District staff in 9 of 11 districts expected that wildlife tree patches would be harvested after one rotation. These results indicate that moving wildlife tree retention during future harvests will likely occur in some cases. This would contribute to lowering the overall volume impact of wildlife tree retention.

Appendix XII – Lessons Learned

In hindsight, there are things the project team would do differently if conducting this type of evaluation again. The following, although not a complete list, highlights some of the key lessons learned.

Before you begin, understand your goals and what it will take to achieve them

This was a large project. More than 11 000 trees were sampled in 128 cutblocks. At the beginning of the project, several months were spent discussing and defining objectives, and designing and testing the evaluation methodology. The time taken to complete this process was valuable and should not be neglected in future work. While the project team eventually agreed on where we wanted to go and how we would get there, we didn't realize that part of the task (data input, compilation and analysis) would take many months longer than expected, thus delaying the entire project by several months.

Operationally test proposed methodologies

With large evaluation projects, it would be advantageous to go beyond field testing the methodology and data compilation procedures before initiating the project. Time, money and effort could have been saved if we had conducted full-scale operational testing of the data collection and input/compilation methodology (i.e., a pilot project). However, a pilot project would have added at least one year or more to the total length of the project.

Focus on the main issues

A significant amount of time (data collection and entry) was spent on small tree data. These small trees accounted for little timber volume and limited wildlife tree habitat. Each site to be evaluated had a maximum of one day for assessment. In some cases, efforts could have been better spent on assessing more significant aspects of stand-level biodiversity, or finishing the site early and moving onto the next cutblock, rather than spending time on small tree data collection.

Prepare and train thoroughly

Although a one-day training session was held to familiarize field assessors with the evaluation methodology, this was not sufficient given the new, relatively untested, and complex procedures. To help answer questions and clarify issues that arose during the collection of field data, an email distribution system was utilized.

Many of the small issues and concerns that caused some delay and time loss for field assessors could have been avoided with a small-scale operational trial and a more rigorous training session. This would have identified potential methodology changes ahead of time and solved many of the problems associated with data collection.

A two-day session, where field assessors visited several cutblocks to practice collecting data on each type of reserve would have been beneficial and cost effective. The assessors would have been able to assess the most appropriate survey methods and present their findings back to the project team. More time spent asking questions, generating discussion, and listening to solutions generated by the field assessors would have increased overall efficiency and effectiveness.

In addition, the project team could have benefited from project management training to assist in managing the various aspects of such a large-scale project.

Understand your stakeholders

Defining stakeholders (e.g., industry, environmental groups, etc.) and ensuring they are involved in the project, or kept well informed of the project's progress, is an important step in achieving desired objectives. The forest industry is a key stakeholder in the results of this wildlife tree evaluation project. The initial project team had a representative from the forest industry on it; however, this member later withdrew from the project. Ideally, a new industry member should have been sought at that time, but that did not occur. As a result, a valuable opportunity for the input and participation of a major stakeholder was lost.

Limit the scope of the project

This project tried to answer too many questions and had too many objectives for the limited funds and time allocated. A more focused evaluation, answering one or two key questions, may have been completed much quicker and at lower cost. Before initiating large evaluation projects, ensure that your objectives are clearly defined, attainable and measurable.

In addition, we added two components to the project at the last moment in the planning process (CWD and lichen assessment). This resulted in additional field time, and some inconsistencies in the collection of data for these two parameters. Adding additional objectives late in the planning process, without the same amount of testing and design rigour as the rest of the project, detracted from the value of the data collected on CWD and lichen. As a result, the CWD and lichen data are of limited use, and are not included in this report.

These things take time and resources

Effectiveness evaluations of complex ecological systems involving multiple objectives and a variety of stakeholders can require a significant amount of resources, effort and time to complete. Projects of this magnitude would benefit from multi-year commitments for staff and other resources.

Look for potential improvements

Part of the reflective component of every evaluation should be a critical look at what did and did not work, and how things could be improved next time. An evaluation of wildlife tree retention could have been carried out successfully many different ways. This evaluation project was successful; nevertheless, it could be improved next time around. The suggestions in this section (and the revisions to the methodology to be published at a later date) are intended to facilitate future improvements and provide some "food for thought" for those embarking on their own evaluations.