Woodlots BC

COMMERCIAL THINNING

A PRACTICAL GUIDE FOR WOODLOT LICENSEES IN THE NORTH-CENTRAL INTERIOR OF BRITISH COLUMBIA

VERSION 2.0
2025

PRINGE GEORGE WOODLOT ASSOCIATION

PREFACE

Interest in commercial thinning has been on the rise in British Columbia (B.C.). Practiced appropriately, commercial thinning can increase the value of forest land by improving tree growth and timber quality while at the same time, providing additional fibre to sawmills, pulp mills and pellet mills. As small managed area-based tenures located close to communities and wood processing facilities, B.C. woodlots are logical areas to practice commercial thinning.

In the B.C. interior, commercial thinning is in its infancy stage and much is yet to be learned about this emerging forest management practice. This guide has been prepared to serve as starting point for woodlot licensees interested in how commercial thinning could be conducted on their woodlots. This guide follows and builds upon two recent provincial-level publications[1] on commercial thinning and provides practical insights and additional information relevant to woodlot licences. This guide is expected to be updated in the future as more operational experience is gained in the B.C. interior.

Due to variability of operating and ecological conditions across the province, this guide has been specifically written for woodlot licensees operating within the Sub-Boreal Spruce (SBS) biogeoclimatic zone of the B.C. interior. However, some of the guide's content may also be applicable to other regions of the B.C. interior.

The information provided in this guidebook is not intended to provide legal or professional advice and the opinions expressed herein are those of the author and may not reflect the opinions of Woodlots BC or the Ministry of Forests (MoF). Licensees are responsible to manage their woodlots in accordance with the forestry legislation.

[1] Interim Guidance for Commercial Thinning – Interior British Columbia (Ministry of Forests, May 2021; https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/stand-tending/interim_guidance_for_commercial_thinning.pdf)

Thinning Guidance for British Columbia, April 1, 2025 https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/stand-tending/thinning_guidance_for_bc_2025.pdf

Operational Manual for Commercial Thinning In British Columbia (FPInnovations, December 2021; https://library.fpinnovations.ca/media/FOP/TR2021N93.pdf

ACKNOWLEDGEMENTS

The Prince George Woodlot Association would like to extend our deepest gratitude to the following for their financial contributions to this report.

Bulkley Valley Research Centre | Silviculture Innovation Program

Woodlots BC

Thank you Mike Trepanier, RPF and Industrial Forestry Services Ltd. authoring version 1 of this Manual. All the research and time spent are greatly appreciated.

IFS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Commercial thinning is the partial harvest of an immature even-aged stand of "merchantable sized" trees where poor-quality trees are cut and removed as useful products while a fully stocked stand of good quality trees is retained to grow into high value timber at maturity. The "commercial" aspect implies the sale value of the harvested trees will cover the costs of the thinning.

Commercial thinning has been practiced extensively in Europe and is regarded to be one of the most effective forest practices to control forest stand growth and improve timber quality. In Canada, commercial thinning has been limited to the eastern provinces of Nova Scotia, New Brunswick, Quebec and Ontario. To get a sense of how widely employed commercial thinning is in these regions, one only needs to view Google Earth's imagery to easily spot the tell-tale signature of commercial thinning in the forest canopy. See Figure 1 below.

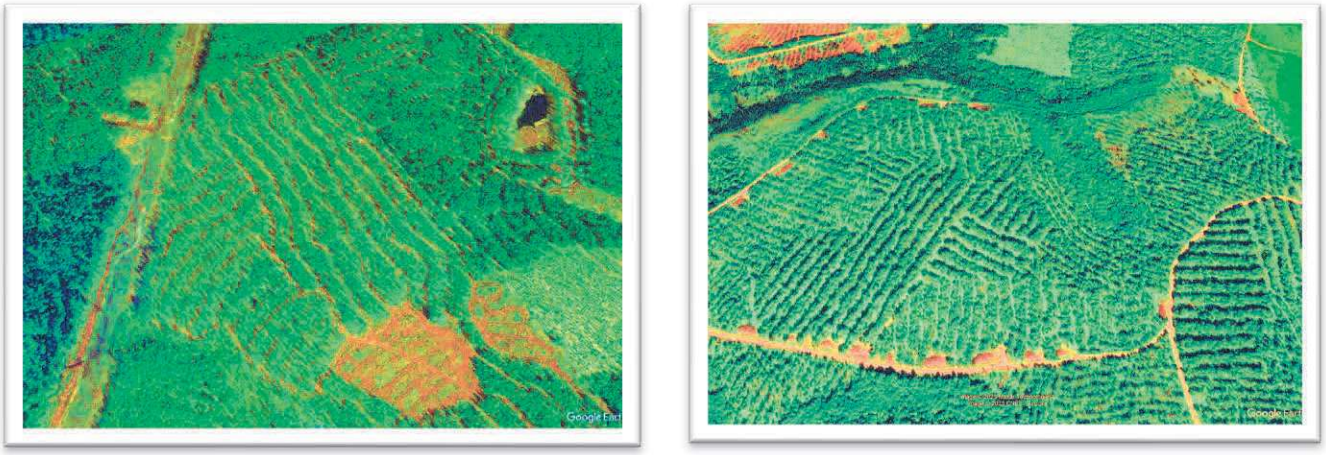

Figure 1. Commercial thinning in Finland (left) and New Brunswick (right). (Source: Google Earth)

In the B.C. Interior, commercial thinning has not been practiced to any significant degree mainly due the abundance of mature primary forest and a focus on salvaging forests damaged by insects and fire. With the shortage of economical wood fibre available to interior pulp, lumber and pellet mills combined with a growing abundance of immature second growth stands rapidly acquiring the structural characteristics suitable for commercial thinning, this form of harvesting has the potential to be practiced on a wider scale in the B.C. interior.

Figure 2. Commercial thinning on Woodlot Licence 272 in the Prince George Forest District, March 2021. Sawlogs are decked to the left and bio-logs decked to the right. The thinned forest stands in the background.

COMMERCIAL THINNING 101

GOALS AND BENEFITS

Commercial thinning has two principal goals. The first is timber management: to improve the growth and quality of the treated stand. This is accomplished by cutting and removing poor quality, defective or suppressed trees from the stand thereby reallocating resources needed for tree growth (light, moisture and nutrients) to fewer trees of better form and quality. The second goal is commercial: to extract economic value from poor quality, or low vigor suppressed trees that would likely die from canopy competition and whose value would eventually be lost to decay on the forest floor.

Commercial thinning can also provide other non-timber benefits, such as:

- reduction of forest fuels and wildfire hazard;
- helping younger stands develop old forest characteristics sooner by expediting tree growth and stand development;
- increase understory shrub development, improving browse for ungulates; and

- improve forest aesthetics and recreational potential.

To be clear, commercial thinning will not increase the absolute wood volume produced over the rotation of a stand, but will improve the piece size and quality of timber at time of final harvest. Generally, improved log size and quality from thinning comes with the price of less total stand volume. Well-planned commercial thinning operations will balance log quality objectives while minimizing total wood volume loss over the rotation. By implementing stand management practices like commercial thinning, a woodlot licensee can choose between stands composed of lots of smaller trees or stands with fewer larger trees.

Table 1. Common forestry terms

Common forestry terms used in this guide	
Site Index	Site index is an estimate of soil fertility and tree growth potential and is expressed as the height of a tree in metres at age 50 years. The tallest stems in a stand, not the average, are measured to determine Site index.
Basal Area	Basal area is the cross-sectional area wood at breast height (1.3 metres) of all trees in a one-hectare area. It is expressed as square meters per hectare (m^2/ha). The best way to measure basal area in the field is by using a cruising or wedge prism. A description of how to use a cruising prism is provided on page 32 of this guide.
Even-aged stand	Refers to a stand of trees where the age range of the majority of trees are within 20 years.
Live Crown	Live crown is the portion of a tree occupied by continuous living green branches and foliage.
Live Crown Ratio	Live crown ratio is the ratio of the length of the live crown of a tree to the entire height of the tree. Example: 25-metre-tall tree that has a live crown length of 10 metres has a live crown ratio of 40 percent.
Crown Closure	Is the proportion of the area occupied by tree crowns relative to the ground when viewing the stand aerially or directly overhead. Normally assessed from air photos or other imagery.
Residual Stand	Means the stand of trees remaining after completion of commercial thinning.

STAND CHARACTERISTICS REQUIRED FOR COMMERCIAL THINNING

Commercial thinning is best applied to well-stocked, uniform, even-aged, immature forest stands of commercial tree species that have reached a tree size that can be cut and processed into saleable log types (e.g., pulp logs bio-logs or sawlogs). In the B.C. interior, previously harvested and

regenerated cut blocks converted to "managed stands" of "second growth" are the stand types most likely provide the characteristics necessary for successful commercial thinning.

Any decision to undertake a commercial thinning treatment must be based on the candidate stand meeting all three of the following conditions:

1) the stand and its trees have grown large enough to provide commercially viable logs,
2) the stand is young enough to initiate vigorous growth response following the thinning, and
3) the diameter growth of trees within the stand is declining, or is at imminent risk of decline due to inter-tree and canopy competition.

Ideally, commercial thinning should be conducted as early as possible once the immature stand has grown to a merchantable size and is showing signs that inter-tree competition will reduce future vigour and diameter growth. Additionally, the candidate stand must contain enough "merchantable volume" so that the volume produced and sold from the commercial thinning will cover all costs associated with the activity.

In order to maximize its benefits, commercial thinning must be conducted while the stand is at an age where its growth is vigorous, well before culmination age[2] where the stands average growth rate (stand volume divided stand age) begins to level-off and decline. Typically, on medium to good sites in the B.C. interior, the culmination age for spruce and pine is about 85 and 65 years respectively. Ideally, thinning should occur at least 20 years before culmination age, therefore the maximum ideal commercial thinning age for spruce and pine is about 65 and 45 years respectively.

Some easily observable tree and stand characteristics that indicate an immature stand is becoming overcrowded and may benefit from thinning include:

- crown closure is greater than 65 percent;
- live crowns are lifting with some live crown ratios approaching 30 percent;
- outer growth rings of most of the canopy trees are beginning to narrow; and
- lack of herb and shrub layer development due to very little sunlight reaching the forest floor.

Commercial thinning is likely to reduce future harvest volume of a stand if one or more of the following conditions exist:

- crowns of main canopy trees have not closed or do not appear to be interacting with each other and most live crowns are greater than 40 percent;
- sunlight is reaching the forest floor and supporting a herb and shrub layer.

[2] The point of stand growth decline is technically known as the age of culmination of mean annual increment (CMAI) or culmination age.

In summary, general attributes of forest stands suitable for commercial thinning include:

- **stand age** between 30 to 65 years;
- composed of **commercial tree species** and tree sizes;
- the stand contains **sufficient merchantable volume** to provide at least 50m^3/ha of saleable logs from the thinning activity;
- **even-aged**, and **well stocked** with relatively **uniform tree height** and inter-tree **spacing**;
- located on productive growing sites with a **site index** of at least 16 (higher values are preferable);
- located on level to moderately sloped sites less than 30 percent slope; and
- showing signs that **diameter growth** is **declining** due to overcrowding and inter-tree competition.

THE STAND DENSITY EFFECT

Currently, there is little operational experience in the B.C. interior regarding the impact of commercial thinning on stand development and volume production. Much of the current understanding of thinning on timber production comes from growth and yield models such as B.C.'s *Tree and Stand Simulator* (TASS) growth model.[3]

At a practical level, silvicultural treatments like commercial thinning are undertaken to manipulate the interaction and competition between tree crowns with the goal of influencing volume growth at: 1) the stand level and 2) the individual tree level. In general, it can be said that denser stands will generally produce more total volume at the price of lower individual tree volume, while lower density stands will produce larger trees, however at the price of lower total volume. Within this context, the following points describe the impact and effect of stand density management:

1) Height growth of trees is independent of stand density. In other words, stand density does not influence tree height growth.[4]

2) Tree diameter growth is significantly influenced by stand density and tree competition.

3) Maximum diameter growth of individual trees occurs before crown closure occurs.

4) Maximum total volume production of a stand generally occurs just before tree competition begins to cause growth suppression and mortality within the stand.

[3] https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/growth-and-yield-modelling/tree-and-stand-simulator-tass

[4] Unless in very over-dense stands >10,000 stems per hectare (sph).

The figure below has been derived from TASS generated stand management diagrams[5] to illustrate some of the concepts discussed above.

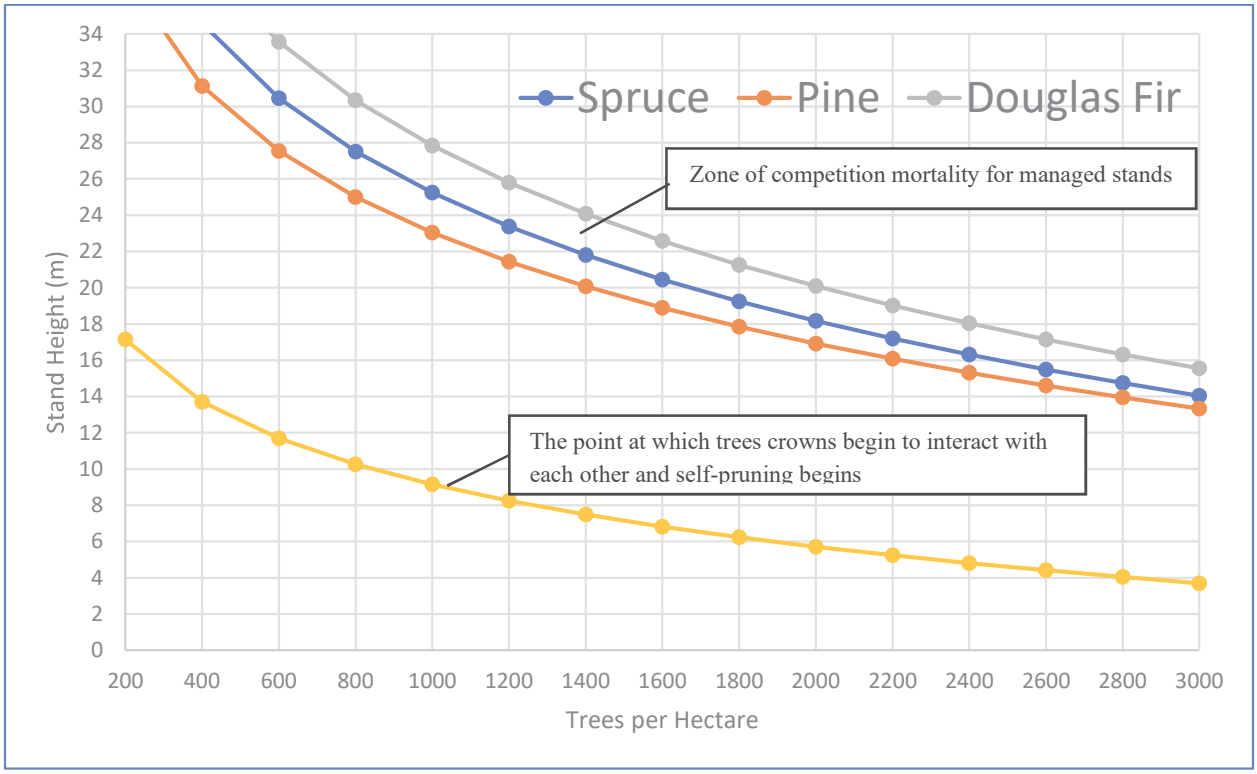

Figure 3. Illustration of the zone of imminent competition mortality (ZICM) expressed in stand height relative to stand density. (Note: trees per hectare are limited to the dominant and co-dominant crown classes)

The yellow line in Figure 3 represents the generalized point, where based on top height (metres) and stand density (trees per hectare[6]), tree crowns begin to interact and compete with each other for sunlight. Stands growing at height and densities below the yellow line are open grown with no inter tree competition and individual tree diameter growth is maximized, albeit at the cost of lower stand volume production. Above the crown closure line, trees are fully occupying the growing site, and with increasing tree height growth, competition for sunlight between trees increases. With increasing height growth, competition for sunlight increases between tree crowns and the lower portion of the crowns become "shaded out" causing shaded conifer needles to die. As shaded needles die in the lower crown, the live crowns begin to lift and become smaller relative to tree height (e.g., live crown ratio decreases). Smaller "lifted" crowns produce less carbohydrates

[5] https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/4605.pdf

[6] Includes only trees whose crowns are competing in the main canopy or overstory layer including dominant and co-dominant canopy positions.

needed for tree growth resulting in reduced tree vigour and diameter growth. As competition increases, some trees lose more vigour than others and the stand eventually enters the *zone of imminent competition mortality* (ZICM). The three upper lines in Figure 3 represent where the ZICM begins for pine, spruce and Douglas fir.[7] At densities above these lines, stands begin to suffer from competition induced tree mortality where self-thinning of the stand occurs. Stands with heights and densities just below the lines depicting the ZICM are expected to maximize stand volume production, albeit at the cost of smaller tree diameters. A good balance between optimizing diameter growth and stand volume can be found somewhere above the yellow crown interaction line and below the ZICM line. The woodlot licensee must decide what type of timber crop is desired at final harvest and how stand density can be managed to optimize the trade-offs between volume production and diameter growth. Commercial thinning can be used as a tool to achieve these stand management objectives.

Ideally, candidate stands for commercial thinning should be located near or at least closer to the ZICM than the yellow crown interaction line. When commercial thinning is completed, the residual stand should be at a lower density where if the stand was to grow for 30 years to final harvest, the future height growth, say about 10 metres, would place the stand back near the ZICM by the time the final harvest is planned.

Below the picture demonstrates a commercially thinned log cross section showing signs of diameter growth slow-down. Stands of trees exhibiting this general growth ring pattern might be a candidate for commercial thinning. In this particular example, commercial thinning could have been initiated a few years earlier.

[7] Height and density relationship of ZICM derived from TASS generated stand management diagrams, https://cfs.nrcan.gc.ca/pubwarehouse/pdfs/4605.pdf

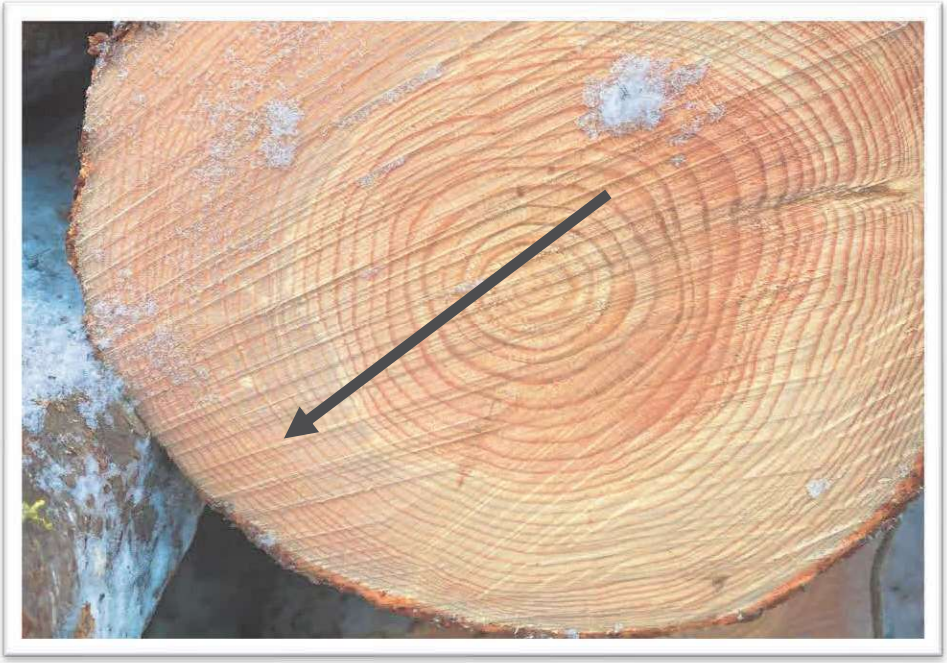

Figure 4. Commercially thinned log cross section.

Tip:

Shade tolerance is a tree's ability to maintain foliage and grow in shaded conditions.

Pine trees are shade intolerant while spruce and Douglas fir trees are more tolerant of shade.

Because pine needles do not tolerate shade, pine tree crowns will lift sooner under canopy competition compared to spruce or Douglas fir.

This is generally why pine dominated stands are suitable for thinning at a younger age and lower density compared to spruce and Douglas fir leading stands.

Stand Height and Basal Area

Stand height and basal area relationships can be also used to evaluate stands suitability for commercial thinning. Stands considered for commercial thinning should contain a minimum amount of pre-thinning basal area from saleable trees with a diameter at breast height (dbh) greater than or equal to 12.5cm. This ensures there will be enough commercial volume in the stand to support the economic viability of the thinning and enough "tree mass" occupying the stand to justify treatment. The minimum recommended basal area is dependent on the candidate stand's species and height. See Table 2.

Table 2. Recommended minimum initial basal area and minimum residual basal area for commercial thinning.

Dominant Species	Stand Height (m)	Recommended Minimum Initial Stand Basal Area (m^2/ha)	Recommended Minimum Residual Basal Area (m^2/ha)
Spruce & Douglas fir	14	27	16
	15	29	18
	16	30	19
	17+	31	20
Pine	14	22	14
	15	24	14.5
	16	25	15
	17	26	15.5
	18+	26	16

The above minimum recommended initial basal area values should be used in combination with spacing factor method to assess and rationalize a candidate stands suitability for treatment. At minimum, the decision to conduct commercial thinning can be rationalized by either method, and ideally, by both methods.

Table 2 also provides minimum post-thinning residual basal area values for a given stand height. These values can be incorporated into a post commercial thinning stocking standard as described later in this guided under the section titled Woodlot Licence Plan Stocking Standards.

Basal Area Explained

Basal area (BA) is the cross-sectional area of a tree trunk measured at breast height, expressed in square metres per hectare. It is used to describe stand density. For commercial thinning, it is a way mid rotation metric to replace stems per hectare that is used at the regeneration stage. To picture basal area, imagine making a cookie out of every tree at breast height and squishing them into a corner of a 100m by 100m square leaving no gaps or overlap between cookies. The area the new square cookies cover is the basal area of a hectare.

Basal area considers both size of the tree and number of trees. Larger trees have a higher basal area, so less trees need to be maintained to meet the basal area requirements.

Basal area is measured using prism. Using the prism, do a sweep and count all the in trees and every second borderline tree. Multiply the number of trees by the size of the prism. In younger

stands, target using a prism between 2 and 5. A basal area factor (BAF) of 3 is usually the most accurate. It is a balance between too few trees (higher BAF numbers) and too many trees from a smaller BAF. If you count 10 trees with a BAF of 3, the BA is 30.

Basal area can also be measured using an App. Arboreal Forest is a Swedish App: https://arboreal.se/en/arboreal-forest There is a subscription, but it can be paid by the week and when cancelled data can still be accessed. This app will collect DBH and calculate BA. It uses your phones camera and on newer phones, LIDAR.

There is also a way to use a plot cord. Use a 3.99 or a 5.64 m plot cord and measure the DBH of all the trees in the plot. Use this page: https://www.omnicalculator.com/biology/basal-area and fill in the DBH for each tree with the area the plot covers. A 3.99 m plot cord is 50m^2 and a 5.64m plot cord is 100m^2. It will calculate the basal area by ha.

EQUIPMENT AND SITE LAYOUT

For practical reasons, modern commercial thinning is mechanized using specialized small-scale harvesting equipment typically consisting of a harvester and forwarder combination as shown in Figure 6. Mechanized commercial thinning site layout commonly employs alternating 5-metre-wide machine access trails, separated by 15-metre-wide selection zones as shown in Figure 7.

In order to consider costs, know that a Ponsse Scorpion Harvester can cut 80 stems per hour, regardless of size. The hourly rate of the full size harvester can be found in the bluebook. In 2023 BCWS equipment rate for a 2023 Scorpion, the hourly rate, including fuel surcharge is $300.00/hr. The cost of the harvester is approximately $3.75 per log.

Figure 5. Harvester and Forwarder combinations currently in use in the North-Central Interior.

The harvester must have the ability to efficiently cut and process small stems within a relatively small 5-metre-wide access trail work space while minimizing damage to the residual stand of future crop trees.

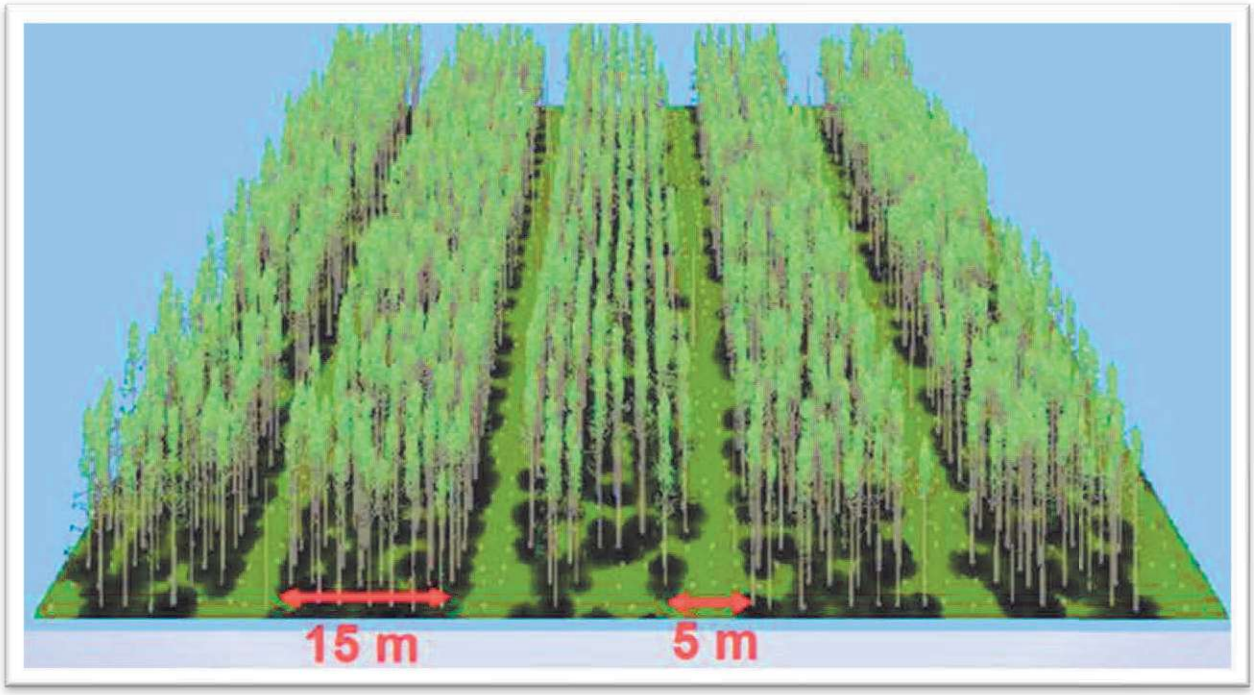

Figure 6. Illustration of alternating 5-metre-wide machine access trail and 15-metre-wide selection zone harvest layout employed in mechanized commercial thinning.

During mechanized commercial thinning, machine access trails are clear-felled removing all trees within the 5-metre-wide corridor, while actual selective cutting of poor-quality stems occurs within the 15-metre-wide selection zone. Therefore, 25 percent of the stand will be "clearcut" to provide access to the selection zone before any selective thinning of poor quality or low vigor stems takes place in the selection zones. This mechanized commercial thinning method is a compromise between the practicality and efficiency of mechanization and optimal distribution of growing space between residual crop trees. The shortfall of this mechanized process is a small loss of growing space to the "empty" access trail corridors and less than perfect redistribution of growing space between all residual crop trees. The wider the machine access trail, the greater the growing space loss and loss of future stand volume growth. If smaller equipment is used, such as shown in the bottom images of Figure 6, narrower access trail and selection zone spacing such as 3.5-metre-wide access trails and 10.5-metre-wide selection zones can be employed. The core principle is to ensure the access trails are no more than 5 metres wide and not exceed more than 25 percent of the treatment area.

Access trails should be aligned relatively straight with gentle bending to align with natural features. Excessive access trail meandering and intersections will result in unnecessary and undesirable gaps and openings in the forest canopy reducing the future growth potential of the residual stand.

Machine access trail orientation should consider wood flow direction to a roadside or landing area, decking and loading workspace, prevailing wind direction (e.g., windthrow risk), avoiding slide slopes, and other features such as wildlife tree patches and riparian management areas. Forwarding distances on access trails can be up to 600 metres from the roadside decking location.[8]

The commercial thinning stand may contain patches of deciduous, non-merchantable sized trees, low stocking areas, low productivity areas, or mature patches. These areas should be identified and excluded from the commercial thinning treatment.

[8] Smaller forwarders will have less reach due to smaller load capacity.

Figure 7. Commercial thinning layout in New Brunswick. (Source: Google Earth)

HARVESTING PROCESS

Mechanized commercial thinning begins with the harvester clear-felling an access trail corridor. As the harvester works its way along the access trail, it reaches up to 7 metres inside the selection zone to select, cut and remove poor-quality trees. Processing (delimbing and bucking) occurs within the 5-metre access trail creating a "brush mat" that will help protect soils from compaction and rutting as the harvester and particularly the forwarder, travel up and down the access trails. Processed logs are decked in small neat bundles just inside the selection zone with care taken to ensure adjacent leave trees are not damaged.

CUTTING RULES

In most situations, field marking individual trees to cut or retain is not practical, therefore, it is commonly left to the operator to select trees to be removed and to select crop trees to be retained for the residual stand. Cutting rules must be simple as machine operators have a limited field of vision, particularly upwards to the tree canopy, and may be operating in dark or stormy conditions.

To ensure the cutting plan/prescription objectives will be achieved, it is critical to conduct real-time monitoring of the harvesting operation and provide timely feedback to the machine operator so that any adjustments to cutting intensity and tree selection can be made before too much area is improperly treated.

Figure 8. Decked logs within the selection zone with branches and tops retained along access trail creating a brush mat.

Tip:

The brush mat retained on machine access trails will contain fine fuels that can act as a "fuel wick" for the first few years following a commercial thinning harvest. Over time, these fine fuels will breakdown into the soil removing potential fuel hazard.

WHAT TREES TO CUT WITHIN THE SELECTION ZONE?

Because the goal of commercial thinning is to improve the quality of a stand by removing less-desirable trees, priority trees to cut and remove are:

- trees with stem defects (crooks, forks, cankers, galls, frost cracks etc.) or poor form;
- suppressed and intermediate canopy class position trees; and
- trees with live crowns less than 30 percent.

Tip:

In most cases, removal of dominant trees with good form within the selection zone should be incidental and limited to less than 10% of stems cut within the selection zone.

ESTIMATING ANTICIPATED HARVEST VOLUME

The amount of harvest volume produced from commercial thinning is dependent on initial stand volume, thinning intensity, stem taper, bucking specs and utilization. However, a rough approximation of the harvest volume that would be produced by commercial thinning can be determined through the following formula:

*= initial basal area * percent basal area to be removed * average stand height * 0. 3*

Example:

- Initial stand basal area = $36m^2/ha$
- Average Stand height = 18m
- Basal area to be removed = 40 percent

Commercial thinning harvest volume estimate ***= $36m^2/ha$ * 0.4 * 18m * 0.3***

= $78m^3/ha$

Table 3. Commercial thinning harvest volume estimate (m^3/ha) based on initial stand basal area, average stand height.

Initial Stand Basal Area (m^2/ha)	Average Stand Height					
	14m	16m	18m	20m	22m	24m
	Estimated Commercial Thinning Harvest Volume (m^3/ha)					
22	34	38	43	48	53	58
24	40	46	51	57	63	68
26	44	50	57	63	69	76
28	46	53	59	66	73	79
30	46	53	59	66	73	79
32	55	62	70	78	86	94
34	59	67	76	84	92	101
36	59	67	76	84	92	101
38	63	72	81	90	99	108
40	67	77	86	96	106	115
42	71	82	92	102	112	122
44	76	86	97	108	119	130
46	76	86	97	108	119	130
48	80	91	103	114	125	137
50	84	96	108	120	132	144

*Commercial thinning harvest volume less than 50 cubic metres per hectare may not be economically viable.

Tip:

✓ About 2/3^{rds} of the volume produced from commercial thinning can be expected to come from machine access trail corridors while about 1/3rd of the thinning harvest volume will come from the selection zone.

✓ Limiting basal area removal to 40% will minimize risk of removing too many trees and destabilizing the stand.

Commercial thinning will produce a mix of sawlogs, pulp logs or bio-logs. Because trees will be cut to length processed, a single tree can produce sawlog and pulp log or bio-log material.

Table 4. Log types and general log attributes.

Log Type	Minimum Top Diameter (cm)	Minimum Length (m)	General Quality Comment
Peeler Logs	20	2.5	No rot or other defects.
Saw log	10	3.0	Some allowable limits for decay and defect.
Pulp log	5	3.5	Must be 50 per sound wood
Bio-log	Similar to pulp log and size must be "safe on truck"		

Estimates of the anticipated harvest volume by log type produced by thinning will provide insight on scaling factors which will impact:

- how much stumpage would be payable, and
- how much volume would be attributable to cut control.

POST HARVEST STAND CONDITION

The following guidelines are provided to help ensure commercial thinning will have a beneficial impact to the treated stand.

Access Trails and Basal Area Removal

- Machine access trails should be evenly spaced throughout the treatment areas and not occupy more than 25 percent of the treatment area.
- Sixty percent or more of the initial stand basal area should remain standing after thinning treatment.
- The basal area of residual conifer crop trees greater than 12.5 cm dbh should not be less than the values presented in Table 2. Residual basal area is the average basal area retained over the entire treatment area including access trails and selection zone areas combined.
- For pure pine stands (>80 percent of canopy), a residual basal area less than 20m^2/ha but greater than 16m^2/ha is acceptable provided the treatment was conducted in accordance with a Crop Plan[9] and minimum stocking standards were achieved one year after treatment.

[9] A clearly rationalized silviculture plan based on pre-treatment field survey and includes an estimate of future growth potential based on rotation age, growth models or stand density management diagrams.

Tip:

✓ Residual basal area is the average basal area retained over the entire treatment area including access trails and selection zone areas combined.

✓ Machine access trails greater than 5-metres wide or occupying more than 25 percent of the treatment area will result in a loss of future timber volume growth and lower final harvest volume.

Attributes of Individual Post Harvest Crop Trees

Retained crop trees should:

- have dbh greater than 12.5 cm;
- be of a commercially desirable species ecologically suited to the growing site;
- be the biggest and tallest trees free of stem defects (crooks, forks, frost cracks, broken or dead tops etc.)
- have a live crown ratio of at least 30 percent;
- be retained in an evenly spaced or regularized pattern; and
- free of unacceptable levels of forest health damage (e.g., disease, scarring and other defects such as forks) as described in the *B.C. Silviculture Surveys Procedures Manual*.

Figure 9. Uniform and regularized spacing of good quality leave trees within the Selection Zone. Poor quality and suppressed trees have been felled, processed and decked within the Selection Zone.

Tip:

- The biggest and tallest trees are generally the most windfirm.
- Tall spindly trees with less than 30 percent live crown should not be relied upon to support post-harvest stocking as they have a higher risk of being damaged by windthrow or snow press.
- Retain some deciduous stems ≥15cm dbh to provide deciduous leaf litter nutrient cycling input. Large deciduous trees typically have large branchy crowns that can damage neighboring conifer leave trees when felled.

POST-TREATMENT GROWTH RESPONSE

In most cases, commercially thinned stands will not produce more volume at final harvest compared to the same stand if left untreated. In fact, a commercially thinned stand will most likely contain less total wood volume at final harvest compared to the same untreated stand. However, the thinned stands lower volume will be allocated to fewer better-quality stems and will therefore provide more usable and valuable volume compared to the un-thinned stand. Moreover, the combined volume of the thinning and final harvest is likely to be comparable to the volume of the same untreated stand at the final harvest.

COMMERCIAL THINNING AND WOODLOTS

TO THIN OR NOT TO THIN?

Commercial thinning is but one of many tools available to a woodlot licensee to meet a range of timber and non-timber resource management objectives. The following sections outline important considerations when making a decision to employ commercial thinning on your woodlot licence.

WHAT ARE MY OBJECTIVES?

Any contemplation to undertake commercial thinning on a woodlot licence must be based on clear objectives and goals. In other words, "what am I trying to achieve" and "why do I want to achieve it." In this regard, a woodlot holder might undertake commercial thinning to meet the following economic and timber management objectives:

1) To improve the timber quality and log diameters of the future stand and produce specific log types that would be desirable by regional log buyers.
2) To shorten the period of time to final harvest by expediting diameter growth of the treated stand.

3) To redistribute future harvest scheduling over the woodlot area and fill gaps in future harvest scheduling.

Other non-economic objectives might also be considered:

1) Capture at risk volume that would otherwise be lost to stand development competition mortality and decay.
2) Increase the aesthetics and recreational potential.
3) Increase production of browse species and wildlife habitat.
4) Reduce fuels and fire hazard.

ECONOMIC FEASIBILITY OF COMMERCIAL THINNING

Done correctly, commercial thinning is a meticulous form of harvesting that produces lower value timber and profit margins will be tight. Given tight economic margins, a poorly planned or executed operation can result in financial loss to the woodlot licensee, or logging contractor or both. Woodlot licensees must carefully consider the full range of operating costs against expected value of logs produced.

Direct Costs of Implementation

The cost components associated with thinning include:

- planning costs (surveys, prescription, layout, administration etc.);
- supervision costs;
- harvest costs (tree to truck);
- log transport costs;
- stumpage; and
- post treatment surveys and reporting (RESULTS, WASTE etc.)

Sale value of logs

Commercial thinning harvests can produce a combination of three log product types:

- sawlogs;
- pulp logs; and
- bio-logs.

Sawlogs will yield higher value than pulp logs or bio-logs, and the higher the sawlog component produced by the thinning, the better the financial viability of the operation. Generally speaking, a sawlog is about two to three times the sale value of pulp logs and pulp logs may have marginally more sale value than bio-logs.

In some cases, it may be beneficial to delay the thinning by a few years to allow additional tree growth so that a greater portion of the trees grow into merchantable sizes and a greater portion of the merchantable trees are sawlog grade.

Operating conditions

The following are key physical operating conditions that significantly influence the viability of a commercial thinning operation.

- Homogeneous stands of evenly spaced trees will be more efficient to harvest resulting in lower thinning costs compared to stands with irregular structure and tree spacing.
- Short log-transport cycle times to processing facilities will provide significantly better economic viability compared to long log-transport cycle times.
- Size of the treatment area and total anticipated harvest volume should be considered relative to the costs of mobilization and demobilization of harvesting equipment.

Economic risk factors

Economic risk factors of commercial thinning include:

- the collective operating costs exceed the value of the logs produced from the thinning; and
- the commercial thinning stand contains a significant component of undersized non-commercial stems that must be cut to access larger commercial sized stems resulting in extra "non-paying" work for the harvester which can quickly render a thinning operation uneconomic.

The Opportunity Cost to Cut Control

Commercial thinning will produce timber volume attributable towards the woodlot licence cut control volume. The amount of commercial thinning volume attributable to cut control will be dependent on the log type produced, the type of processing facility the logs are delivered to and scaling stratum (see Scaling, Stumpage and Cut Control). Woodlot holders should consider the opportunity cost associated with displacing cut control volume with lower value commercial thinning logs at the expense of more profitable conventional log sale volume. This consideration is particularly applicable to woodlots that contain an abundance of mature green timber available for harvest.

What Else Can Go Wrong?

Despite the benefits associated with commercial thinning, there are stand damaging risks associated with commercial thinning.

Excessive thinning Intensity

A commercial thinning that removes too many trees or creates large gaps and openings in the canopy will reduce the overall final harvest volume of the treated stand. This can also occur if:

- machine access trails are more than 5 metres wide; or
- machine access trails occupy more than 25 percent of the treatment area.

Forest Health Factors

Caution should be exercised when contemplating commercial thinning in stands impacted by forest health factors. In particular, western gall rust is a significant concern in pine dominant stands in the B.C. North-Central Interior. Thinning plans and operations must contain deliberate strategies and tactics to ensure forest health factors are managed during thinning and the residual stand contains a sufficient number of healthy diseased free trees to meet treatment and stocking objectives.

Windthrow

The risk of post-thinning windthrow increases as wind energy is absorbed and buffered by fewer stems. Stands associated with one or more the following attributes will have a higher risk of being damaged by windthrow following a commercial thinning treatment:

- are located on lower or level slope positions with wet soils or elevated water tables;
- have shallow rooting due to a combination of species and soil factors such as elevated water table or compact sub-surface soil layers (e.g., compact till);
- dense uniform stands composed of tall and spindly trees;
- stands where the majority of trees live crown ratios are less than 30 percent;
- stands where the majority of "leave trees" have height to diameter ratios greater than 0.9.

Tip:

Height to Diameter Ratio = Tree Height (metres) / Tree Diameter (centimetres)

Example: a tree that is 15 (m) tall and has a dbh of 18 (cm) has a height to diameter ratio of:

=15/18

= 0.83

Snow Press

Snow press occurs during heavy or wet snow events where weight of the snow accumulation on the upper tree canopy causes the tree stem to bend over, often resulting in permanent damage to the tree in the form of a deformed (bent) stem and sometimes breakage or cracking of the stem. The risk of snow press damage increases after thinning as newly exposed tall spindly intermediate and suppressed stems may be unable to support increased weight of snow accumulation in the canopy.

Tip:

- ✓ Thinning levels greater than 40 percent basal area removal increase the risk of destabilizing the stand increasing risk of windthrow and snow press.
- ✓ Tall spindly trees retained after a commercial thinning treatment are prone to snow press and windthrow following commercial thinning. These trees should not be relied on to provide or contribute to stocking of the residual stand.
- ✓ Tall spindly trees with poorly developed crowns should be prioritized for removal during thinning as they will have a higher likelihood of damage by wind or snow press.

Logging Damage

Scaring the bark of leave trees mostly occurs during the felling and processing phase of thinning. Dense or branchy stands and lack of attention by the operator contribute to scarring of leave trees. Trees are most susceptible to scaring in the spring time (April-June) when tree bark tends to be sappy and soft.

Scaring should be minimized to the extent possible as gouging and scaring of the leave trees can introduce decay organisms into residual trees and reduce the quality of the future stand or render leave trees unacceptable in a post-treatment stocking survey. Unacceptable damage to individual trees occurs when scars and gouges are greater than 400 square centimeters (e.g., 20x20cm) or the scar or gouge that extends more than one-third of the stem circumference.

Root Damage

Damage to root systems can result from rutting on the machine access trails. Rutting can occur on any soil type when conditions are wet, particularity during the forwarding to roadside. Leaving a "brush mat" of tops and branches on the access trail and ensuring operations are conducted when soils are dry or frozen will minimize damage to root systems of the residual stand.

DO I NEED TO HIRE A FORESTER?

Woodlot licensees are ultimately responsible to ensure woodlot activities are conducted in accordance with an approved WLP, an active cutting permit and forest legislation.

When operating under this framework, a woodlot licensee does not have to retain the services of a forest professional[10] to carry out the planning and implementation of woodlot harvesting operations. However, given the complexities associated with commercial thinning, retaining the services of forest professional is advisable.

A forest professional[11] is, however, required to conduct or supervise or certify the post treatment stocking survey for the purpose of determining the status of the residual stand. See the *Woodlot Licence Plan Stocking Standards* section for more information regarding free growing obligations.

Table 5. Summary of activities which require the services of a Forest Professional.

Aspect	Forest Professional Required?	Comment
Woodlot Licence Plan	Conditional	Retaining a forest professional is only required to certify alternative performance requirements, results, strategies, standards and measures. A forest professional would be required to certify alternative performance requirements, results, strategies, standards and measures for commercial thinning.
Planning and Mapping	No	The licensee is responsible to ensure all obligations and requirements contained in an approved WLP, valid cutting permit and other forest legislation requirements are met.
Surveys, Site Plan or Cutting Plan Development	No	
Harvest Supervision and Monitoring	No	
Scaling	No	Scaling can only be completed by a Licensed Scaler.
Post Harvest Wildfire Hazard Assessment	No	The Wildfire Regulation provides that a licensee or qualified holder must conduct a wildfire hazard assessment.
Hazard Abatement	No	Woodlot licensees are responsible to abate wildfire hazards in accordance with the Wildfire Act and Regulation.
Post Harvest Survey	Yes	Post harvest surveys and stocking assessments for the purpose of making a milestone declaration (e.g., regeneration or free growing) must be conducted under the supervision of a forest professional.
RESULTS and Milestone Declarations	Yes	Declaration made in RESULTS must be made or supported by a declaration completed by a forest professional.

[10] Registered Professional Forester (RPF) or Registered Forest Technologist (RFT).

[11] Summarized from Woodlot Licences – Interim Guidance: Roles and Responsibilities of woodlot licensees, government staff and forest professionals; https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/timber-tenures/woodlots/interim_guidance_roles_responsibilities.pdf

Aspect	Forest Professional Required?	Comment
Waste Assessment	Yes	Waste assessment must be completed by a forest professional or a licensed scaler or logging residue surveyor. Electronic submission of logging waste into the provincial WASTE application can be made by a licensee

PLANNING PROCEDURE FOR COMMERCIAL THINNING

Given the complexity, uncertainty and higher costs associated with planning a commercial thinning, it is best to begin planning in a graduated logical sequence. A good planning approach takes one-step at a time, where the successful completion of one step leads to the next. If a problem is encountered at any given step, the project can be cancelled or deferred earlier in the process before unnecessary additional costs are incurred. A suggested planning process can take the form of the following steps:

1) office review of inventory maps to identify candidate stands
2) preliminary "pre-screening" walkthrough survey
3) site visit/walkthrough with harvesting contractor
4) detailed stand survey
5) prescription or Treatment Plan development

STEP 1– OFFICE OVERVIEW

The starting point to identify candidate stands for commercial thinning is local knowledge of the woodlot area followed by a review of the WLP map, inventory data, air photos or Google Earth. Inventory data and imagery should indicate candidate areas are between 30 and 65 years of age and are well stocked with a relatively closed and uniform canopy.

STEP –2 PRELIMINARY WALKTHROUGH

The purpose of the preliminary or "pre-screening" walkthrough is to walk the candidate commercial thinning stand identified in Step 1 to broadly assess suitability for commercial thinning.

The preliminary walkthrough will determine if the candidate area is:

1) obviously not suitable;
2) possibly suitable; or

3) obviously suitable for commercial thinning treatment.

Key questions to ask during the preliminary walk through:

- ***Where does my stand fit on a height to density graph? (see Figure 5)***
- ***Does my stand contain a sufficient amount of basal area? (see Table 2)***
- ***Is my stand within an age range suitable for commercial thinning?***
- ***Does my stand contain forest health factors that would preclude treatment?***
- ***Is the access and terrain suitable?***
- ***Are the crowns lifting due to inter-tree competition?***
- ***Are the growth rings of the last 5-10 years getting smaller?***
- ***How much volume would be produced from a thinning?***
- ***What log types could be produced*?**

STEP *3* – SITE VISIT WITH LOGGING CONTRACTOR

If observations during the preliminary walk through indicate that the stand has potential for commercial thinning, consider conducting a site visit of the proposed treatment area with a logging contractor experienced and equipped for commercial thinning. The purpose of the contractor site visit is to discuss thinning objectives, post-thinning stand condition (e.g., stocking), a potential cutting plan and confirm, from the logging contractor's perspective, that the stand would be commercially viable to treat. At the conclusion of the viewing with the contractor, there should be general consensus on the following key issues:

- ✓ woodlot holders' objectives for the commercial thinning treatment
- ✓ appropriate small-scale equipment to be employed
- ✓ cutting plan and tree selection criteria
- ✓ residual post thinning stand conditions
- ✓ site access
- ✓ anticipated volume to be removed
- ✓ log types that may be produced
- ✓ scheduling/timing of operations
- ✓ arrangement and scheduling for trucking
- ✓ logging rates or contractual arrangements for sale value of timber

STEP 4 – FIELD SURVEY AND PRESCRIPTION

Once a candidate stand has cleared preliminary screening for commercial thinning suitability, costs for field surveys and prescription development can be expended with somewhat lower risk.

Detailed Field Survey

The purpose of the detailed survey is to obtain a reliable estimate of important stand attributes such as species, height, density, basal area, volume, stem quality and canopy structure characteristics that will support:

- cutting plan and prescription development
- volume estimates and log profiles, (e.g., species, log types, grades etc.)
- logging and log sale agreements

The detailed survey will also provide an opportunity to assess the stand at a greater intensity where small areas not suitable for treatment (e.g., wet areas, deciduous patches, mature patches, etc.) can be mapped and suitable treatment areas can be stratified into one or more "treatment units" based on soil, ecology, tree species or stand structure.

FPInnovations[12] has developed an efficient and effective commercial thinning survey procedure based on the standard B.C. timber cruise process that adds the following data collection fields:

- crown class (suppressed, intermediate, co-dominant, and dominant)
- tree quality (three log quality classes)
- crown opening (relative exposure of tree crown to open sky)

The sampling grid should provide a sufficient number of samples depending on the variability and size of the stand. Stands that have a complex or variable structure and composition will require a greater number of plots or field samples compared to uniform stands. A cruise prism basal area factor (BAF) that captures at least 5 trees per plot is recommended and, in most cases in the interior of B.C., a prism with a BAF of 4 or 5 will be ideal.

[12] https://web.fpinnovations.ca/

Tip:

Using a Cruise Prism:

- ✓ Hold prism exactly over the plot center point
- ✓ Hold face of prism perpendicular to the line of sight
- ✓ Sight nearby trees at about breast height while looking over top of prism
- ✓ Trees that are fully displaced by the prism are considered "out" and not counted
- ✓ Tree stems that are not fully displaced by the prism are "in" can be counted towards basal area
- ✓ Trees that are "borderline" (e.g., neither fully out or in) can be counted as a half tree
- ✓ To determine basal area tally all in and borderline trees and multiple by the BAF (basal area factor) written on the prism

Plot: 29 **Date:** May 7th 2020 **BAF:** 4

Geographic coordinates: *Plot moved 50m North

C - conk; **BC** - blind conk; **FO** - fork or crook; **R** - rottnen branch; **M** - Mistletoe; **S** - scar; **FR** - frost crack; **DB** - dead or broken top

Tree No.	Sp.	DBH	Height	Tree class (1 -4)	Defect	Third	% d lost (S, FR)	Long butt. (m)	Down tree (Y/N)	Crown class (D, C, I, S)	Q-lty class (Q1-Q3)	V. tree (too big) Q4	Crown open. %
1	Bl	24.6	19.9	1	-	-	-	-	N	D	Q1	-	100
2	Fd	14.9	16.1	1	-	-	-	-	N	C	Q1	-	50
3	Fd	10.2	12.4	1	-	-	-	-	N	I	Q1	-	25
4	Fd	9.2	11.9	1	-	-	-	-	N	S	Q1	-	0
5	Bl	16.9	19.2	1	-	-	-	-	N	D	Q1	-	100
6	Ep	12.0	13.6	1	FO	2	-	-	N	I	Q2	-	25
7	Fd	11.1	12.3	1	-	-	-	-	N	I	Q1	-	25
8	Pl	21.8	18.4	1	-	-	-	-	N	P	Q1	-	100

Figure 10. Example cruise plot card for modified commercial thinning detailed survey (e.g., modified timber cruise).

For more information regarding the pre-treatment survey, please refer to *FPInnovations Operational Manual for Commercial Thinning in British Columbia*[13].

While conducting the detailed survey, it is also recommended that other site data normally collected as part of the Site Plan process be collected, including:

- BEC site series;
- soils; and
- non-timber resources such as riparian, cultural, wildlife features.

STEP 5 – SITE PLANS AND PRESCRIPTIONS

Although woodlot licences are exempt from having to prepare a Site Plan for cut blocks, it is recommended licences prepare a detailed plan for areas subject to commercial thinning. Terms such as "prescription", "site plan" or "treatment plan" can be used interchangeably and can take many different forms. The key principle is to ensure that there is a documented plan that contains all of the required elements of a traditional Site Plan plus additional commercial thinning specific information, including:

- statement of treatment objectives
- rationale for undertaking the treatment
- description of site ecology
- description of access trails (widths orientation, percent of area)
- description of selection zone widths
- description selection zone cutting rules
- damage threshold for leave trees
- description of post-harvest stocking requirements
- seasonal restrictions
- other restrictions (e.g., no treatment areas, riparian features, etc.)

It is also recommended that additional information such as a stand management diagram and crop plan that rationalize the thinning treatment be appended to the prescription.

[13] https://web.fpinnovations.ca/just-released-operational-manual-for-commercial-thinning-in-british-columbia/

IMPLEMENTATION OF COMMERCIAL THINNING

SITE LAYOUT

Depending on the situation, site layout or block layout (e.g., field marking) may be optional. Some harvesting machines may be equipped with on-board GPS navigation equipment where the operator is able to follow mapped boundary lines. However, there may be situations and features such as a woodlot licence boundary, riparian or other special features that require conventional boundary marking to ensure unintended encroachment is avoided.

THE HARVESTING CONTRACTOR

Of all the elements associated with commercial thinning (e.g., the right stand and a good plan), hiring a good harvesting contractor will ensure the commercial thinning operation is successful. An inexpert contractor/operator can ruin a well-planned commercial thinning operation while an experienced and competent contractor/operator can make the best of a marginally suitable stand and poorly conceived plan. The commercial thinning harvesting contractor should have:

- ✓ small-scale equipment (harvester and forwarder combination) appropriately sized to the tree sizes to be thinned;
- ✓ experience with commercial thinning harvesting;
- ✓ trained and competent operators;
- ✓ resources to adequately supervise operators; and
- ✓ good understanding of stand-level commercial thinning objectives including post-harvest residual stand condition.

THE LOGGING AGREEMENT

The agreement or contract between the licensee and logging contractor should contain the usual provisions of a conventional harvesting agreement, but with an added clause that gives the woodlot licensee the right to terminate operations at any time should the contractor be unable to meet the requirements specified in the cutting prescription.

Regarding financial arrangements between the woodlot holder and logging contractor, perhaps the most streamlined and low risk approach is to arrange for the receiving mill to directly pay the contractor a rate for delivered timber and directly pay the woodlot licensee the remaining balance for the timber. Allowing the harvesting contractor to market the logs produced from commercial thinning to various receiving mills is also a worthy consideration.

SUPERVISION AND MONITORING

In most cases, it may be impractical or unnecessary to pre-locate the 5m access trails or mark individual trees for removal or retention.[14] Therefore, it is the machine operator's responsibility to establish access trails and make selection zone cutting decisions in accordance with the commercial thinning prescription. With this approach, it is important to conduct real-time monitoring of commercial thinning operations to ensure that the operator is meeting post-harvest residual stand composition objectives specified in the cutting plan. Observations from monitoring can be conveyed back to the operator who can then make the necessary adjustments to trail locations, trail widths, selection criteria or cutting intensity. The following is a list of commercial thinning aspects that should be monitored daily for the first few days until operations have settled into a groove.

- ✓ access trail widths (5 metres)
- ✓ selection zone widths (15 metres)
- ✓ poor quality trees are being removed from the selection zone
- ✓ good quality trees are retained in selection zone
- ✓ scarring to residual trees is within acceptable limits
- ✓ average basal area retained throughout the treatments area is adequate
- ✓ required density (sph) of residual crop trees are retained throughout the treatments area
- ✓ inter-tree spacing is regularized in selection zone

[14] Marking individual trees may be a good option when working in stands that have a significant incidence of disease (e.g., western gall rust) or form issues (forked trees) to ensure these trees are prioritized for removal and healthy trees are retained.

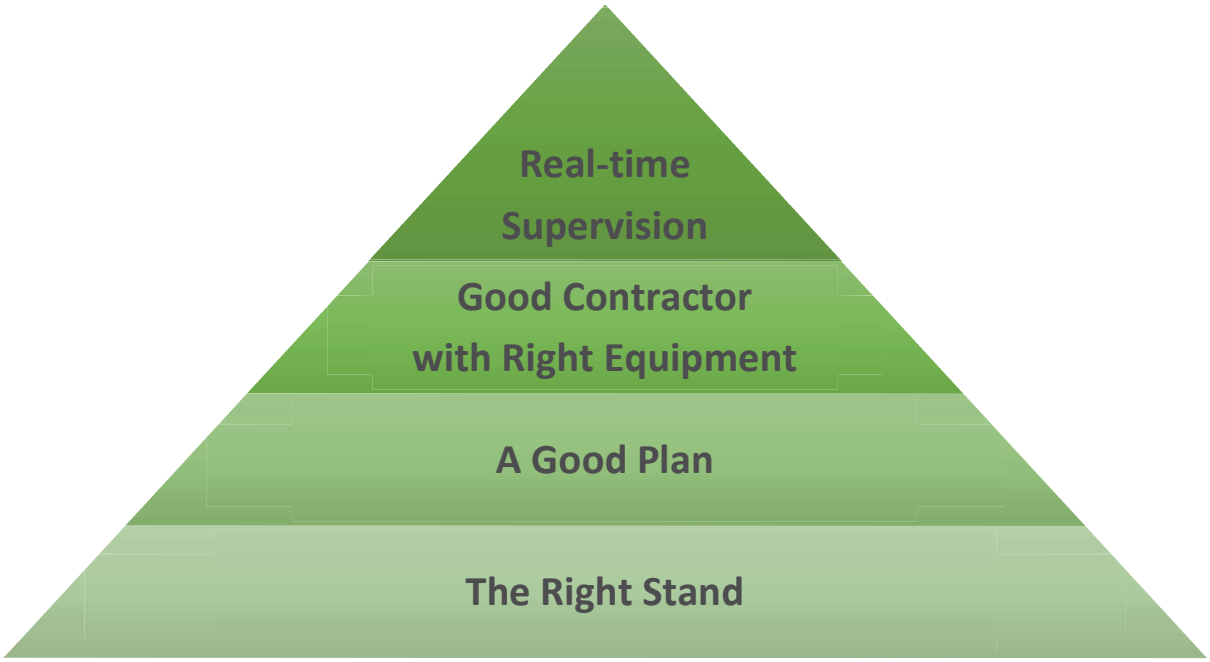

Figure 11. Key elements required for a successful commercial thinning operation.

Safety Warning

- The harvesting head of a mechanical harvester use a high-speed chainsaw that can discharge "chain shot" if the saw chain breaks. The small pieces of broken saw chain, or chain shot, can travel at speeds similar to bullets and cause serious injury or death.

- This safety concern should be discussed with your logging contractor during the pre-work.

- ***When supervising commercial thinning operations, maintain a distance of at least 90 metres from the harvester.***

What to watch out for

Because commercial thinning is a meticulous high-cost harvest operation that produces lower value logs, the logging contractor can be under pressure to decrease costs and increase revenue. This pressure can push the contractor to harvest and produce higher value timber in a low-cost expedient manner; a situation that can be characterized by following observations of commercial thinning:

- wider access trails being cut;
- narrower selection zones;
- minimal to no cutting in the selection zone;
- poor quality trees left in the selection zone;
- good quality (e.g., sawlog grade) trees are unnecessarily removed from the selection zone; and
- higher level of scarring to residual trees (e.g., lack of care taken while falling and processing).

These specific concerns should be addressed in cutting plans and logging agreements, and be explicitly discussed with the contractor during contract negotiations and logging pre-work meeting.

SCALING, STUMPAGE AND CUT CONTROL

Harvested timber must be scaled or otherwise measured in a waste assessment to support stumpage billing and harvest volume attributable to cut control. It is important to understand how commercial thinning harvest volume will be scaled and graded as these factors will impact the stumpage costs and cut control volume implications.

SCALING

In most cases, logs will be weighted scaled and the resulting volumes and grades will be dependent on the scaling stratum. It is important for woodlot licensees to have an understanding of weight scaling factors such as weight to volume conversion and log grades and it is recommended this be discussed with the receiving purchasing mill and the logging contractor before harvesting operations commence.

Concurrent Residual Harvest System

By nature, commercial thinning produces a significant amount of low-grade timber only suitable for delivery to non-sawlog facilities such as a pulp or pellet mill. To streamline scaling of low-grade harvest material, licensees may voluntarily use the provincial *Concurrent Residual Harvest System* (CRHS) which assigns a tabular weight conversion ratio and log grade profile to a particular log product type (e.g., green pulp, dry pulp, bio log etc.). Licensees who wish to use this

simplified alternative scaling system must receive prior authorization to do so by making an application to their Forest District office.

STUMPAGE

With tight revenue margins it is important to have a good estimate of the log sorts and grades expected to be produced by the thinning. These factors will greatly influence the amount of stumpage payable.

A stand that is likely to produce a higher proportion of low-grade logs destined for mills/scaling stratums with a high proportion of grade 4 logs will reduce the amount of stumpage payable. A summary of stumpage rates by log grade is provided in Table 6.

Table 6. Summary of stumpage rates and cut control implication by log grade.

Grade Code	Grade Name & Description	Applicable Stumpage Rate	Harvest Volume Attributable to Cut Control	Harvest Volume Credit
1	Premium sawlog	As prescribed in the Interior Appraisal Manual Table 6-2	Yes	No
2	Sawlog			
4	Lumber reject log	0.25	Yes, unless a Grade 4 Credit is requested	Yes – volume delivered to a facility that produces products from timber other than lumber or veneer can be reduced from woodlot harvest volume.
6	Undersized log	0.25	No	n/a
Z	Firmwood reject	n/a	No	n/a

At the time of this writing, stumpage associated with commercial thinning on a woodlot licence follows the same appraisal process as conventional harvesting.

CUT CONTROL

Billed harvest volume produced by commercial thinning will be counted towards the 5-year cut control harvest volume. Woodlot licensees should be aware of the opportunity cost associated of displacing high value conventionally harvested mature timber with lower grade commercial thinning timber within the available 5-year harvest volume allowance.

Cut control implications by log grade are summarized in Table 6. Woodlot licensees can achieve some relief from cut control volume impacts by applying to the District Manager for a 100 percent reduction of grade 4 harvest volume delivered to a non-sawlog/veneer facility.

STOCKING STANDARDS & REPORTING

WOODLOT LICENCE PLAN STOCKING STANDARDS

Section 34(2) of the Woodlot Licence Planning and Practices Regulation exempts woodlot licences from the requirement of establishing a free growing stand on areas where harvesting is limited to commercial thinning provided that a fully stocked residual stand is retained. Section 34(3) further specifies woodlot licensees must ensure that the residual stand retained within the area subject to commercial thinning meets the stocking standard requirements 12 months following completion of harvest. At the time of this publication (2024), most approved WLP's in the northern interior contain the default *Uneven-aged Stocking standards for single-tree selection* stocking standards for areas subject to commercial thinning. **This guide does not recommend use of the *Uneven-aged Stocking standards* for commercial thinning as managing to these standards could result in a significant amount of unoccupied growing space in the stand resulting in significantly less volume production over its rotation.**

RECOMMENDED STOCKING STANDARDS FOR COMMERCIAL THINNING

Woodlot licensees interested commercial in thinning are encouraged to update their WLP's Stocking in Specified Areas in a manner similar to the example provided below in consultation with their forestry consultant and local district office.

Example WLP Stocking Standard

Commercial thinning defined

Commercial thinning for a timber quality objective occurs when at least 90 percent of the treated area:

- *is an even-aged stand between 30-65 years of age,*
- *has a site index of at least 16m,*
- *no more than 40 percent of the stand's initial basal area has been removed,*
- *clear cut access trails occupy no more than 25 percent of the treated area, and*
- *poor quality trees between the access trails have been removed to encourage a growth response in the residual stems.*

Stocking Standard for Areas Subject to Commercial Thinning

1) Acceptable trees contributing to the post-harvest basal area targets must be:
   a. at least 12.5 cm dbh;
   b. of preferred and acceptable species for the BEC unit; and
   c. meet health and damage criteria specified in the Provincial Silviculture Survey Procedures Manual.

2) *Minimum acceptable residual basal area following commercial thinning by leading species and stand height.*

Dominant Species	Stand Height (m)	Minimum Acceptable Residual Basal Area (m^2/ha)
Spruce & Douglas fir	14	16
	15	18
	16	19
	≥17	20
Pine	14	14
	15	14.5
	16	15
	17	15.5
	≥18	16

3) *If, after 12 months following completion of a commercial thinning harvest:*
   a. *the commercially thinned stand has an acceptable tree basal over at least 90 percent the treated area, a silvicultural obligation is not incurred; or,*
   b. *over the 90 percent of the commercially thinned area does not have an acceptable tree basal area, the licensee incurs a silvicultural obligation.*

4) *If a silvicultural obligation is incurred, the licensee must ensure this area meets the minimum stocking requirements for the BEC site series in even-aged stocking standards provided for in this WLP.*

5) *The area subject to items (2) and (3) above may be stratified into 2 or more units to facilitate post-harvest assessments, reporting and any stand level actions (e.g., fill planting, etc.) if required.*

6) *Alternatively, a Free Growing declaration can be made when commercial thinning has been carried out in accordance with a Crop Plan or Stand Management Plan approved by a Forest Professional.*

RESULTS REPORTING

Commercial thinning must be reported into RESULTS by May 31 for all areas on which harvesting occurred in the previous calendar year. As RESULTS is going to be replaced in the next 24 months, reporting processes for commercial thinning will likely change. Typically, RESULTS reporting will consist of the following reporting components:

- Opening definition
- Disturbance report
- Forest cover update report
- Milestone report

Opening Definition

The opening definition report defines the area that was subject to commercial thinning. Commercial thinning will most likely occur within an existing managed second growth stand and the thinning area opening definition will likely fall inside of a preexisting cut block opening definition boundary. Currently, licensees are required to create a new opening for the block as it will have a CP and block number that need to be accounted for. Commercial thinning is considered a disturbance.

Disturbance report

Describes where and when a commercial thinning harvest has occurred.

Forest cover update report

Describes the forest cover of the residual stand as determined by a survey 12 months after thinning operation was completed.

Milestone report

With respect to milestone declarations, there are 2 possible scenarios:

1) the residual stand contains enough residual basal area such that a free growing obligation is not incurred. In this case, a No-Regeneration milestone declaration[15] can be made, OR
2) the residual stand does not contain enough basal area and a Free Growing obligation has been incurred. In this case a traditional milestone declaration must be made as supported by a rationale provided by a forest professional.

[15] A no-regeneration stocking standard ID must be created in RESULTS.

More information regarding RESULTS reporting can be found in the document entitled RESULTS Information Submission Specifications Form and Manner of Reporting.[16]

STAND TENDING FOR COMMERCIAL THINNING

Adding commercial thinning to your silviculture regime does not start when your stand is 35-55 years old. It starts when you harvest your mature stand and begin to plan for reforestation. By looking at your plantation as, not a free growing objective to meet in 20 years but rather as a long-term investment with a number of treatments and entries prior to the final regeneration harvest of mature trees you begin to see a new set of possibilities.

As we move into a new era of forestry in B.C., one with a far more holistic view including objectives not centered around timber production but still balancing economic health of our community we have to try new techniques. Techniques that have been well established globally in other parts of the boreal forest, Northern Europe.

The intent of commercial thinning is to develop a stand of high-quality saw logs at the end of rotation. This end product should fetch a premium price.

STAND TENDING FOR INCREASED LOG VALUE

Management of stand density throughout the rotation is required to grow high quality timber (e.g., tall, straight, large diameter, non-branchy) while minimizing volume losses. To optimize both quality and volume objectives, stand densities should be managed within the optimum or desired spacing factor throughout the rotation – see previous section titled *The Spacing Factor Method* on page.

Obviously, this approach would be operationally impractical and cost prohibitive to maintain on a continuous basis over the rotation. However, a simple stand management regime consisting of initial regeneration establishment followed by a mid-rotation commercial thinning is an effective and efficient approach to stand density management. As an option, a pre-commercial thin (also called a juvenile space) can also be considered prior to the free growing milestone to remove poorly spaced, poor-quality defective and/or diseased trees from the stand while retaining a healthy well stocked, evenly spaced young stand to develop into a candidate stand for commercial thinning.

Traditional B.C. stocking standards have been developed around a basic silviculture regime consisting of regeneration establishment followed by a final harvest with little consideration towards enhanced silviculture treatments such as commercial thinning.

[16] http://www.woodfor.com/WLGML/RISS-wl_Feb_24_2016.pdf

The most effective action woodlot licensees can undertake to establish young forest stands that will make good candidates for commercial thinning is to increase tree density at stand establishment. In the B.C. interior, cut blocks are commonly planted at densities between 1,200 to 1,600 stems per hectare, but if the goal is to maximize timber quality and value through stand density management actions such as thinning, higher planting establishment densities are needed.

Table 7. Recommended planting densities to establish managed forest stands for future commercial thinning opportunities.

Dominant Species	Recommended Planting Establishment Density (stems per hectare)	Comment
Pine	2,000 - 2,400	If pests or diseases are anticipated, plant towards the higher end of the range. Densities can be interpolated and adjusted for pine/spruce mixes in consideration of pest and disease factors.
Spruce and Douglas fir	1,800 - 2,000	

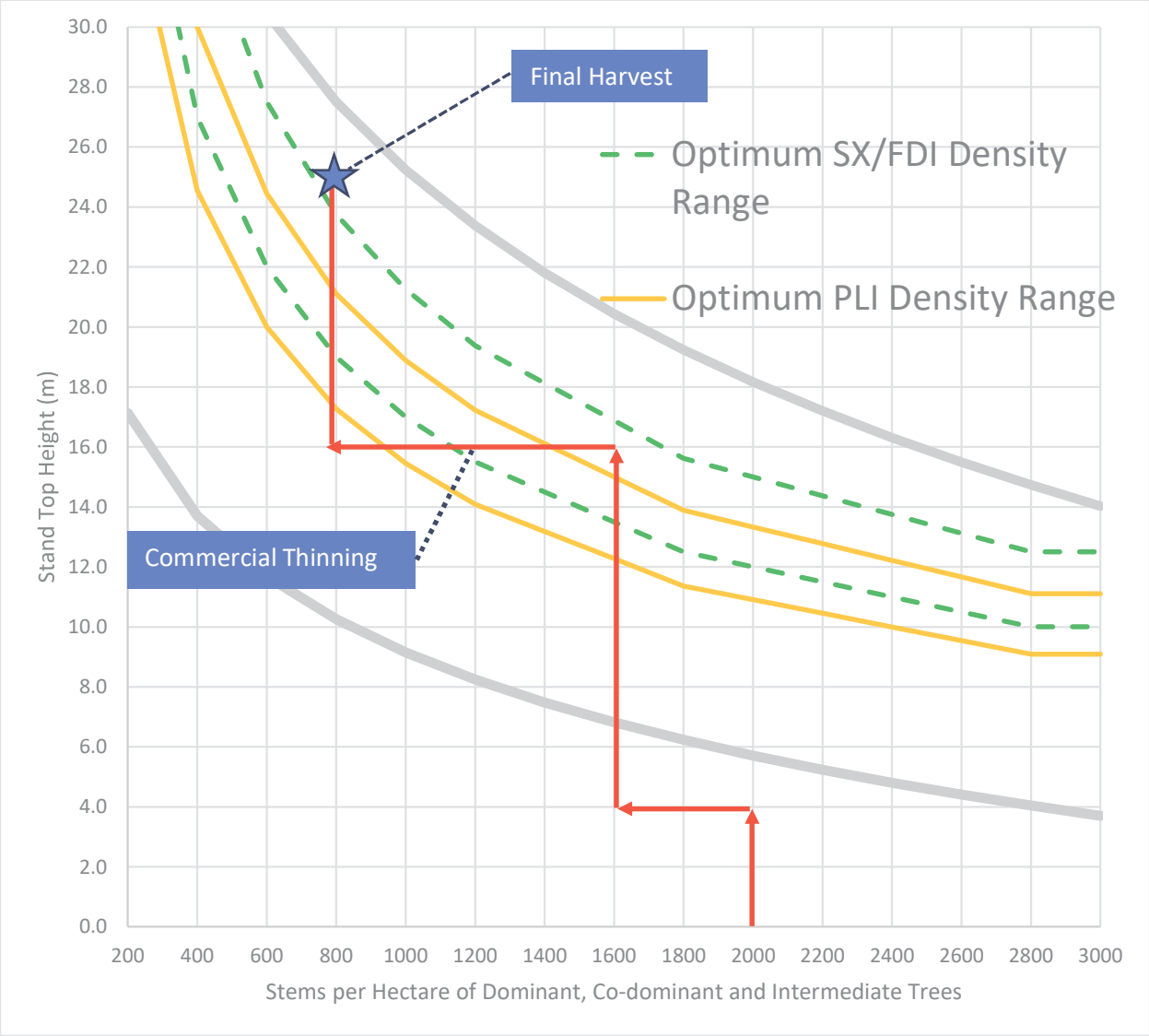

Figure 12. Generalized stand density management regime consisting of planting, juvenile spacing, commercial thinning and final harvest.

***Example**: After harvesting, the cut-block is planted to a density of 2,000 stems per hectare with pine and spruce trees. At age 12 when the stand is 4m tall, a juvenile spacing is conducted to remove poor quality poorly spaced trees, leaving the site with 1600 stems per hectare of good quality trees in regularized spacing. At age 40 when the stand is 16 metres tall, a commercial thinning is conducted to remove poor quality trees lowering the density to 800 good quality trees per hectare. A final harvest is conducted at age 80 when the stand is 25 metres tall.*

THE FINNISH MODEL

There are lessons to be learned from the Finnish Model. They have a similar climate, similar species and have a strong forestry culture. They have Woodlots, but they are smaller than ours. The difference is scale. The average woodlot size in Finland is 30ha. Due to the scale difference, there are things that a woodlot owner in Finland would be expected to do, that we can't due to size, finding labour and cost. However, investing in your plantations is important.

The three steps below unite processes from Finland with our tools and experiences.

Step 1: Planting[17]

To this end, setting up stands for commercial thinning starts at the planting stage, followed by a brushing and weeding treatment in some stands, a juvenile spacing and then a thinning treatment mid rotation followed by a final harvest at the end of the rotation.

The premise is to create a stand that has small calibre branches, straight boles with very little defect in the conifers. To achieve this, the plantation needs to start with a high quantity of trees, both conifers and deciduous. As time passes, the stand is managed to meet the end objective of straight boles with little or no branches, a product that can be sold at a premium.

In B.C. we have perfected the growing and planting of seedlings across the province. Planting should be completed as per your ecosystems regular schedule after harvest. The good news is, most stands have been set up in the planting stage. Densities at planting will vary due to ecotypes and species, but planting on the higher side of the range is the target, likely somewhere between 1600-2200 sph.

Keep in mind, you want to space down to around 2000 sph when the stand reaches 6-8 metres in height. In order to achieve this, regeneration will rely on planted stems, natural ingress and just as importantly broadleaf stems within the stand. Focus planting out the correct spot, choose the best microsite and well-spaced off of other choice microsites. The minimum tree distance still needs to be adhered to as the stand still needs to meet free growing guidelines; however, tightening up the target distance to hit all the best microsites would increase the planted stems per ha. Allow naturals to germinate and broadleafs stems to grow. The denser stand forces the conifers to grow straight and encourages self-pruning on species that self-prune and discourages large branches on those that don't. The broadleaf species also increase biodiversity and forage on your site.

The table below is the field guide to completing planting inspections. Within that guide there is a table that identifies target spacing to ensure prescribed planting density.

[17] Planting Quality Inspection: Guide to Completing the FS 704. April 2021. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/silviculture/tree-planting/plantingqualityinspecting.pdf

Table 8. Planting Density and Plantable Spots (Triangular Spacing)

Planting Density (trees/ha)	Contract Spacing (metres)	Allowable Plantable Spots (3.99 m plot)	Allowable Plantable Spots (5.64m plot)
2600	2.1	13	26
2400	2.2	12	24
2200	2.3	11	22
2000	2.4	10	20
1800	2.5	9	18
1600	2.7	8	16
1400	2.9	7	14
1200	3.1	6	12
1000	3.1	5	10
800	3.8	4	8
600	4.4	3	6

Step 2: Brushing and Weeding

Taking advantage of broadleaf species to develop a high-quality stand is a concept that is typically not utilized in B.C. In most cases, free growing obligations mean that broadleaf species are seen as competing and are brushed. Using the current Silviculture Survey Procedures Manual and the quadrant method, broadleaf can be maintained if the conditions in Appendix 8 are met. There are Working Groups across the province finding solutions for increasing broadleaf in stands. There is also an option to add broadleaf species into stocking standards in some areas of the province. Check out your options at the district level.

The next step is to potentially brush and weed. This has a different slant on it in the Northern European countries that commercial thin. It is recommended that brushing be completed when the trees are 2-4 metres tall, depending on species dominating the stand, growth and ecotype. The intent is to lightly go into the stand and organize the chaos. Brushing should occur before competition starts to hinder growth or cause damage. The objective is to go in and loosen up the spacing by:

- Removing deciduous from within a metre of the conifer,
- Removing branches or stems that may be damaging the conifer.
- Remove deciduous overtopping the crop tree if it is competing with the crop tree

The target is to maintain broadleaf that are not competing with conifers. Finland documentation suggests maintaining a minimum of 40% of the deciduous to reduce resprouting. Broadleaf stems are important to the ecosystem. Diversity in your stand reduces disease, like weevil. It increases biodiversity, gives wildlife habitat opportunities not provided by conifers and cycles nutrients through litter fall.

Loosing up the spacing creates resiliency for all species, trees and shrubs by reducing the need to out compete neighbours which ends in mortality of some individuals and slows growth in others. Old forest attributes are found at maturity and recruiting of old forest attributes means encouraging growth, not allowing a stand to stagnate.

This is also the time to assess for climate change conditions that might be becoming the norm. Consider your ecotype and site series, has it changed since harvest? If you're in a dry belt, and the stand is rocky with a south aspect, this might be the time to thin to reduce the number of trees on the site. Tree growth and vitality is based on available resources per each individual. If the site is dry, removing trees increases the amount of water available to each individual. This may reduce the risk of stand failure though drought and increase stand resilience.

Tip:

- Brushing and Weeding should be done if necessary to meet Free Growing Obligations, or more importantly if the commercial tree species growth and quality is being hindered.
- The brushing treatment should be light. Taking too much increase deciduous sprouting and the treatment may need to be repeated.
- The treatment should be well timed. Waiting too long, after growth has begun to slow or after damage is being sustained delays future treatments and your stand may not release effectively after the treatment.

Step 3: Pre-Commercial Thin or Juvenile Spacing

The next treatment is when the stand is between 5-8 metres tall. Again, as with brushing, spacing is completed just before the stand starts to show signs of reduced growth due to competition or when in spruce stands the broadleaf is beginning to overtop the crop trees.

Post treatment, the target spacing is 2000 stems per ha with 10-20% being broadleaf. The broadleaf would be scattered through the stand, but also in patches. These patches offer diversity in the stand. Any broadleaf retained need to be at least 1 metre away from the crop tree, allowing full access to the sun. Maintaining deciduous not only increase biodiversity, it also increases nutrient cycling as leaves fall and decompose on the forest floor.

The spacing prescription should focus on removing conifers that are damaged, smaller than their neighbours or not well spaced. Remove deciduous that are reducing growing space of commercial crop trees, but still maintain as many as possible.

Consider long term ecosystem resilience. Maintain any existing snags, mature sized trees or trees with mature bark.

A Strategy for the Wilds Of British Columbia

As our reality is larger blocks, further from communities and on crown land, being able to plant, brush/weed and then pre-commercial thin is unlikely, but not unachievable. There is an argument to be made for taking some of your profit from the woodlot and reinvesting it in the regenerating stands, especially if that increases log quality and volume at the commercial thinning stage.

No longer is a wise human one that plants a tree whose shade they will never sit under. We are not planting trees for an unknown future, rather we are planting trees for a cut in less than 45 years, in some areas closer to 30 years. This is within the time period of your next license renewal.

Step 1: Planting

Regardless of the future stand tending treatments, you should plant. Natural ingress will happen, but planting gives you three management advantages.

> The first is that planting usually consists of stock that is breed for growth and is Class A seed. This has a genetic gain with equates to a higher growth, which gives you a higher annual allowable cut (AAC) when the inventory gets updated. Even if your planting stock isn't Class A seed, planting results in a higher AAC then naturally restocked stands.
>
> The second advantage is that the trees have a more even spacing, which means each tree gets similar resources to grow and have more space to grow into before they need to start competing with their neighbour.
>
> Third, the trees are a year old when they are planted, giving them a head start over brush and natural ingress.

The same strategy applies in Finland as it would in B.C. Target planting between 1600 and 2200 stems per ha. More trees means that branches won't develop into large knots and if there is disease there are more spacing options. Deciduous is an import component of the stand. It increases forage and diversity. Let them grow.

Step 2: Brushing and Spacing

Here is where we are likely going to economize the Finnish model, one treatment instead of two. Not only will this reduce costs, spacing a younger stand will utilize brush saws rather than chainsaws. At some point the plantation is going to fill in enough that the crop trees will start to compete with each other and deciduous trees. This stage is important to identify. Leaving a stand too long pushes the stand into a zone of slowed growth and once the stand is spaced, the trees need to 'release'. Some trees may not have the resources to release or it take too many years to get back to their full growth potential. Here are some signs that your stand is ready for a brushing and spacing treatment, these may not all apply to your ecotype. Use your discretion.

- Crop trees are starting to grow in the influence of other crop trees. Branches might be touching or there may be clumps of trees growing together. Some trees might be getting damaged from their neighbours. There might be rub marks or broken leaders.
- Crop trees are between 2-4 metres tall. Smaller trees are easier to cut down and when required cut up so they are on the ground and not tangled in their neighbours branches.
- Brush is starting to be a concern. Crop trees have brush that is overtopping or will be overtopping them in the next couple years. Walking through the stand is a struggle due to brush and stocking.
- Pine are losing needles off their bole. Needles are how blister rusts enter the tree. Once the needles on the bole fall off, the tree is unlikely to be infected anywhere but on branches, which won't impact quality or increase mortality.

Treating too early can result in brush overtopping crop trees in the future and requiring another treatment. However, too late will result in a delayed growth response, increased cost of the treatment, a higher likelihood of damage from the treatment and longer timeframe to effectively commercial thin.

The treatment targets will depend on the ecotype's moisture and nutrient regime. Here are a few topics to consider when prescribing a brushing/spacing regimes.

- Drier sites should have lower stocking as the limiting resource is water.
- Pests and pathogen populations will require more species diversity including deciduous. For example, spruce do better with more deciduous in areas with high leader weevil incidence. Consider your area's pests and pathogens.
- Wildlife objectives might require road screening. Maintaining more deciduous and brush along roadways reduces lines of site.
- Riparian areas may also require a different brushing and spacing regime to increase shading and coarse woody debris.
- Alder and willow are important to the ecosystem. Alder fixes nitrogen, which in the Prince George area is limited in the forest soils. Alder and willow top out in height, so limit how much they are bushed. Perhaps only remove the portion of the plant that is damaging the crop tree.
- If wildlife forage is an objective, cutting down a tall willow regenerates it to a height ungulates can consume it at. Perhaps cut some tall willow back to regenerate forage, but leave some tall for birds.

As always, consider previous experience and look at untended stands in your area. Why is growth slowing down and are there disease concerns? If you need to brush before free growing, consider

using that opportunity to remove crop trees that are damaged, growing in clumps or being out competed.

The final crop tree stocking post spacing should be somewhere between 1400-1800 sph. This is still considerable stocking which will encourage straight boles and small branches and/or early self-pruning.

Maintaining deciduous trees within the stand is very important. They should be maintained spaced through your stand and in clumps. Diversity is best as it increases stand resilience. Deciduous also keep crop trees growing straight towards the sun and reduces branching. This is important with conifers that epicormic branch (can grow new shoots through bark of the bole).

CONTRACT EXAMPLES

Appendix A has a Contract Schedule A that was used by the MoF in 2012. Although old, it has a sound structure and requirements. Whether or not you have an official contract with your stand tending contractor, there is a list of topics that should be clearly identified on paper prior to beginning a treatment.

Crop Tree Definition

- Crop Tree Species
- Priority of species. For example, you may want to keep all your Douglas fir, so this would be the tree that the contractor would space off of when selecting subsequent trees. List species in order of priority.
- Spacing from another crop tree (minimum inter-tree distance)

Work Plan

A work plan would define how choices are made when selecting the trees to cut and those to maintain. These decisions will impact your future stand and should be clear and well understood by the contractor. As an example:

> Where any of the following is not specified in a treatment prescription or treatment plan for Spacing it must be specified by Treatment Unit in a work plan:
>
> (a) the crop tree species to be retained, in the order of preference;
> (b) the target number of crop trees per hectare to be retained;
> (c) the minimum and maximum number of crop trees per hectare to be retained;
> (d) a minimum cutting height below which trees are not required to be cut;
> (e) the Minimum Inter-tree Distance between crop trees;
> (f) a description of any leave trees and any circumstances when they are not to be cut; and

(f) the locations and widths of any Slash Removal and No Treatment Zones.

Evaluating a Crop Tree for Selection

Detailing how you want the spacing contract to choose the healthiest tree is another aspect. The largest tree is not always the best tree. Here are points to use to evaluate a crop tree:

(a) free of unacceptable insect damage, injury or disease;
(b) healthy live crown of good colour;
(c) straight stem with no forks or multiple tops;
(d) a sturdy stem in relation to height, suited to resisting potential wind and snow damage after spacing;
(e) small branch diameters; and
(f) good terminal leader growth.

Cutting Specifications

It is also important to discuss how the tree should be cut. A low stump height and stump angle reduces damage to wildlife, livestock and field workers. The example contract states that unless otherwise specified, a tree that is cut must be cut so that:

(a) it is cut completely through (i.e., must not be hinged);
(b) the stump is not higher than 15 cm from the point of germination;
(c) no live limbs remain on the stump;
(d) the stump cut angle is not greater than 30^{o} (thirty degrees) from the horizontal;
(e) it does not lean against a standing tree; and
(f) it does not fall onto a fence or into a stream.

WOODLOT EXAMPLE

There are many examples of woodlots that have juvenile spaced stands that now exceed the volume that were harvested off the original stands. This example is in the Nadina Forest District, located just south of the Community of Burns Lake on private land. The land was purchased for the woodlot program. It was failed ag lease (i.e. it was an ag lease that was logged and then never cleared for pasture or fields). It reforested naturally to almost 100% pine. When the woodlot licensee took ownership, it was stocked. In 2000 they hired two 18-year-olds, bought two brush saws and put them to work spacing. The trees were between 2-4 metres tall and the stand was clumpy.

In 2025, the site was walked for potential commercial thinning opportunities. The site is SBS dk with a site index of 19.5 according to SIBEC. Site index is how tall the tree is at 50 years old. For this stand to have a site index of 19.5, at 50 years old, the dominate trees would be 19.5 metres tall.

Here are the stand specifications:

- The current age of the stand is around 45 years old.
- The diameter at breast height (DBH) is between 18-20 cm.
- The height of the pine is between 20-22 metres tall.
- There was very little stem abnormalities.
- The Basal Area was between 25-30m^2
- The crown was between 40 and 50% of the bole and the core from the increment borer showed that the stand growth was not slowing down.
- Rough volume estimates using basal area and heights indicated that the volume is between 280 and 300m^3 per ha. Pre-beetle, the average of cruises was 278m3/ha in the Lakes TSA.

The stand still had the stumps from the spaced trees and many of the selected trees had a stump touching their bole. This stand is set up to be commercially thinned. Areas where the trees were larger, the crowns were lifted closer to 30% and areas where the trees were smaller, the crown was closer to 50%.

This spring, the stand will be cruised and this section will be updated with more statistically valid information.

Tip:

Trees can be measured accurately and then calculated without a vertex, diameter tap or prisms. Here are some user-friendly options.

Collecting heights, diameter and basal area:

Arboreal Forest is a Swedish App: https://arboreal.se/en/arboreal-forest There is a subscription, but it can be paid by the week and when cancelled data can still be accessed.

Use a 3.99 or a 5.64 m plot cord and measure the DBH of all the trees in the plot. Use this page: https://www.omnicalculator.com/biology/basal-area and fill in the DBH for each tree with the area the plot covers. A 3.99 m plot cord is $50m^2$ and a 5.64m plot cord is $100m^2$. It will calculate the basal area by ha.

Calculating volumes:

https://apps-scf-cfs.rncan.gc.ca/calc/en/volume-calculator

Note: Limit needs to be filled in. Use diameter (cm) and use the minimum top size.

https://www.spikevm.com/calculators/logging/standing-tree.php

STAND TENDING CONCLUSION

Regardless of the location, there are only so many nutrients, litres of water and sunlight hours available on that site. More trees means that less resources are available for each individual resulting in smaller individuals. Less trees means more resources per tree and that tree then can grow larger.

The caretaker of plantations has the opportunity to envision the stand management pathway through the rotation. Stand tending as a tool has shown in multiple research platforms and models that it impacts growth on a stand. Planting, brushing, spacing and then commercial thinning all impact the final quality and volume of the stand.

Stand tending also allows caretakers to influence biodiversity and habitat. Pine monocultures in a landscape of even aged pine stands left over from the reforestation event of the early 2000's has opened up an opportunity. These stands are ready for thinning. Tending stands that were planted with high quality seedlings sets these stands on a course towards commercial thinning.

It is time to look at plantations through a new lens. Woodlots are area-based tenures and investment back into the plantations increases quality and yield. Perhaps more importantly, it reduces the age to harvest. Large trees are not just important for timber objectives, they are also important features on the landscape for a variety of wildlife.

Run the volume of the woodlot example in the tools provided. Look at the plantations near your woodlot. Consider disease, age of crop trees, diversity of the stand, water and nutrient availability and current growth. No longer should we consider free growing the end goal. It might be for some stands. In others, stand tending may create stands with more diversity, growing larger, higher quality trees that impacts the long term AAC.

Forestry is an Art as much as a Science. The references below demonstrate that stand tending is important to consider. That is the science. A walk in the woods is the final brush stroke to the art of forestry.

REFERENCES

Binkley, C. S., & MacDonald, J. D. (2014). An economic perspective on intensive forest management: The case of British Columbia. *Forest Ecology and Management, 324*, 163–173. https://doi.org/10.1016/j.foreco.2014.02.021

Government of British Columbia. (2025, July 24). Stand Tending. https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/silviculture/stand-tending#spacing

Government of British Columbia, Forest Renewal B.C. (1997). *Stand Density Management Diagram: Yield predictions for a spacing prescription*. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/stand-tending/sdmd_yld.pdf

Government of British Columbia, Forest Renewal BC. Spacing to Increase Diversity within Stands. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/stand-tending/sp_div.pdf

Government of British Columbia. (1999) *Developing Stand Density Management Regimes.* https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/silviculture/developingstanddensitymanagementregimes.pdf

Lieffers, V. J., Pinno, B. D., Johnson, A., Hossain, K. L., & Gooding, T. (2023). Intensive management increases flexibility in managing wood supply. *Canadian Journal of Forest Research, 53*(6), 691–699. https://cdnsciencepub.com/doi/10.1139/cjfr-2022-0317

Metsakeskus Forest Centre (2025) *Tending of seedling stands*. https://www.metsakeskus.fi/en/forest-use-and-ownership/forest-management-and-fellings/tending-of-seedling-stands

Pinno, B. D., Hossain, K. L., Gooding, T., & Lieffers, V. J. (2021). Opportunities and challenges for intensive silviculture in Alberta, Canada. *Forests, 12*(6), 791. https://www.mdpi.com/1999-4907/12/6/791

Prescott, C, deMontigny, L and Harper, G. (2020, January 7). Eighteen-year growth responses to thinning and fertilization of a height-repressed lodgepole pine stand in interior of British Columbia. *The Forestry Chronicle, Volume 92*. https://pubs.cif-ifc.org/doi/10.5558/tfc2019-029

Rantala, Satu et al. (2011). *Finnish forestry practice and management* (p. 94 to 102). Metsakoulu.

APPENDIX 1

JUVENILE SPACING CONTRACT EXAMPLE

Ministry of Forests

Schedule A
Spacing Standards
Effective April 15, 2012

These standards apply, in addition to the General Standards for Ministry Funded Programs (FS 1001) or FS1000 for internal Ministry contracts, to all juvenile spacing activities carried out under Ministry Funded Programs.

CONTENTS

ARTICLE 1: DEFINITIONS

Definitions

1.1 In this document, the following words shall have the following meanings unless alternative definitions are approved by the Ministry Representative in a treatment prescription, a treatment plan or a work plan.

1.2 **"Approved Spacing Quality Inspection System"** means the Ministry of Forests' current Juvenile Spacing Quality Inspection system http://www.for.gov.bc.ca/isb/forms/lib/fs251.pdf in effect immediately prior to the commencement of Work **or** another similar system approved in writing by the Ministry Representative prior to the commencement of Work. References to specifications contained in a stand management prescription in the Juvenile Spacing Quality Inspection system shall be interpreted to mean specifications in a treatment prescription, treatment plan or work plan.

"Crop Tree" means a tree that is:

(a) Specified as a preferred or acceptable species;

(b) equal to or greater than the Minimum Inter-tree Distance from any other Crop Tree

(c) equal to or greater than a Specified minimum cutting height;

(d) selected from among adjacent trees in accordance with the specifications required under this standard;

(e) not damaged by the Contractor to the extent it would be a non-reworkable error; and

(f) is not a Leave Tree, unless the Leave Tree is actually a Crop Tree because it satisfies paragraphs (a) to (e) above (*i.e. Pw are to be retained on the South Coast and a Pw is retained as a Crop tree*).

"Inter-tree Distance" means the horizontal distance between two trees on a centre to centre basis, calculated or measured to the nearest 1/10th of a metre unless otherwise Specified.

"Leave Tree" means a tree other than a Crop Tree that is Specified as not to be cut.

"Ministry Representative:" means

(a) a person appointed as a Ministry Representative pursuant to the Recipient Agreement,

(b) a person who is authorized through an implementation contract to act on behalf of the Ministry Representative for purposes of these Spacing Standards, or

(c) a Ministry of Forests employee who is appointed to act as the Ministry Representative for purposes of these Spacing Standards.

The person who will be the Ministry Representative for purposes of these Spacing Standards must be identified to the Recipient and the spacing contractor prior to the commencement of Work.

"**Minimum Inter-tree Distance**" means a Specified Minimum Inter-tree Distance that must exist between Crop Trees.

"**Natural Opening**" means an area in the original stand that has no trees above the Specified minimum cutting height, and has an average diameter greater than twice the Target Inter-tree Distance.

"**No Treatment Zone**" means an area within which no Spacing takes place.

"Over Cutting" means when, Spacing has reduced the number of Crop Trees within a plot to less than the target number of Crop Trees per plot.

"**Slash Removal Zone**" means an area within which slash created as a result of the Work is removed.

"**Spacing**" means the reduction of the number of trees per hectare of the original stand within the Treatment Area to within a Specified range of post-spacing densities.

"**Spaced Stand**" means the portion of the Work Area on which Spacing took place.

"Specified" means, as the context so requires, specified in this standard, another applicable standard, a treatment prescription, treatment plan, work plan or a map attached to a prescription or plan.

"**Target Inter-tree Distance**" means, unless otherwise Specified, the target distance between Crop Trees as determined by the formula:

$$\sqrt{\frac{11{,}547}{\text{Target \# of Crop Trees/ha}}}$$

"**Void**" means an area within a Spaced Stand that, as a result of Over Cutting, has no Crop Trees within the Target Inter-tree Distance measured in a circle around the stump of a Crop Tree that was cut.

ARTICLE 2: SPACING STANDARDS

General Requirements

2.1 Despite any requirement that is Specified on a per hectare basis, all spacing and density requirements must be met throughout the entire Treatment Area, so that Crop Trees are as well distributed as possible.

2.2 Motorized tracked or wheeled thinning machinery must not be used without the prior written approval of the Ministry Representative.

Work Plans

2.3 Where any of the following is not specified in a treatment prescription or treatment plan for Spacing it must be specified by Treatment Unit in a work plan:

(a) the Crop Tree species to be retained, in the order of preference;

(b) the Target number of Crop Trees per hectare to be retained;

(c) the minimum and maximum number of Crop Trees per hectare to be retained;

(d) a minimum cutting height below which trees are not required to be cut;

(e) the Minimum Inter-tree Distance between Crop Trees;

(f) a description of any Leave Trees and any circumstances when they are not to be cut; and

(f) the locations and widths of any Slash Removal and No Treatment Zones.

[Notes: In naturally regenerated stands in the interior, the Minimum Inter-tree Distance could be as low as zero (0) centimetres to maximize the retention of the largest, healthiest Crop Trees within clumps and to facilitate the retention of sufficient Crop Trees around openings.

Section 51(3)(c) of the Forest Planning and Practices Regulation prohibits juvenile spacing in the riparian reserve zone of a stream, wetland or lake.]

Selection of Crop Trees

2.4 The average number of Crop Trees per hectare retained in the Spaced Stand must be:

(a) as near as is possible to the Target number of Crop Trees per Hectare to be retained;

(b) not less than the Specified minimum number of Crop Trees per hectare to be retained; and

(c) not more than the Specified maximum number of Crop Trees per hectare to be retained.

2.5 When Spacing adjacent to a boundary of a Treatment Area, the Spaced Stand must not have a Crop Tree that is closer than the minimum Inter-tree Distance to a tree above a Specified minimum cutting height that is within a No Treatment Zone or just outside the boundary of a Treatment Area.

2.6 Crop Trees must be selected that are as close as possible to the Target Inter-tree Distance from each other, but the distance between Crop Trees must be varied within allowable spacing criteria so as to select those trees having the best overall possible combination of:

(a) Crop Tree species in the Specified order of preference; and

(b) the tallest trees having good form and vigour and which can be expected to continue exhibiting superior growth in comparison to adjacent trees.

[**Note**: Consistently selecting Crop Trees that are close to the Minimum Inter-tree Distance will likely result in exceeding a Specified maximum number of trees per hectare to be retained, whereas consistently selecting trees that are further apart than the Target Inter-tree Distance risks not achieving the Specified minimum tree retention requirement.]

2.7 When evaluating Crop Trees for good form and vigour the selected trees must optimize as many of the following characteristics as possible:

(a) free of unacceptable insect damage, injury or disease;

(b) healthy live crown of good colour;

(c) straight stem with no forks or multiple tops;

(d) a sturdy stem in relation to height, suited to resisting potential wind and snow damage after spacing;

(e) small branch diameters; and

(f) good terminal leader growth.

Additional Crop Trees Around Natural Openings

2.8 Additional Crop Trees must be left uncut around the edge of a Natural Opening equivalent to the number of trees that the opening could accommodate at the Target Inter-tree Distance. The distance between such Crop Trees must not be less than the minimum Inter-tree Distance.

Trees Not to be Cut (Leave Trees)

2.9 Except to provide worker safety, the following trees must not be cut or damaged:

(a) a tree within a Natural Opening;

(b) a Wildlife Tree;

(c) a tree larger than a Specified maximum cutting diameter, if one has been established;

(d) a pacific yew tree or another Specified tree species; or

(e) other Specified trees which meet Specified criteria.

2.10 A tree within a Treatment Area that is Specified as not to be cut in the preceding section may be less than the minimum Inter-tree Distance to a Crop Tree.

Trees Not Required to be Cut

2.11 The following trees are not required to be cut:

(a) a tree less than a Specified minimum cutting height; or

(b) a tree that is not a Crop Tree that is more than the Target Inter-tree Distance from a Crop Tree.

2.12 If a tree that is not required to be cut is cut, it must be cut to the specifications contained herein.

Trees to be Cut or Girdled

2.13 All trees in a Work Area that are not Crop Trees, Leave Trees, or trees Specified as not required to be cut, must be cut.

2.14 Subject to section 2.18, a tree that is required to be cut must be girdled if it cannot be cut without damaging a Crop Tree or a Leave Tree.

Cutting Specifications

2.15 Unless otherwise Specified, a tree that is cut must be cut so that:

(a) it is cut completely through (i.e., must not be hinged);

(b) the stump is not higher than 15 cm from the point of germination;

(c) no live limbs remain on the stump;

(d) the stump cut angle is not greater than 30^{o} (thirty degrees) from the horizontal;

(e) it does not lean against a standing tree; and

(f) it does not fall onto a fence or into a stream.

2.16 A forked or multiple-stemmed tree selected as a Crop Tree must not have any of the stems cut.

Girdling Specifications

2.17 Unless otherwise Specified, if trees are girdled, the girdle must

(a) be located below the lowest live limb, and

(b) consist of a single, continuous girdle band around the entire tree trunk that is a minimum of 1.5 cm in vertical width and that completely severs the bark and cambium over its entire width.

2.18 Despite any other requirement herein, unless otherwise Specified, a tree must not be girdled if it is within one tree length of a road or trail that provides vehicle access or is frequented by hikers.

Treatment of Slash

2. 19 Unless otherwise Specified, slash or debris must be removed and redistributed within the Spaced Stand if, as a result of the Work, it occupies:

(a) a Slash Removal Zone;

(b) a road, road-bank, stream, ditch, or fireguard;

(c) a cattle or game trail; or

(d) adjacent standing timber.

ARTICLE 3: INSPECTION AND ACCEPTANCE

Spacing Quality Inspection

3.1 All Work must be inspected by a person (the “Inspector”) who is:

(a) the Registered Professional Forester (RPF), or operates under the direction of the RPF, who will sign and professionally seal reports for the Work;

(b) experienced and competent in conducting inspections of spacing operations;

(c) familiar with the treatment prescriptions, treatment plans or work plans for the Work Areas; and

(d) not engaged in the direct conduct of the spacing operations.

3.2 An Inspector must inspect the Work in accordance with an Approved Spacing Quality Inspection System in a timely manner to ensure all Work is performed to the Standards.

Determination of Satisfactory Treatment

3.3 An area may be declared satisfactorily treated when:

(a) the average performance quality of all plots is 85% or higher;

(b) the number of Crop Trees per hectare does not exceed the Specified maximum and is equal to or greater than the Specified minimum number of trees per hectare to be retained;

(c) unless otherwise Specified by the Ministry Representative, there are no contiguous areas greater than one tenth (1/10) hectare that do not meet the performance quality and density requirements.

Requirement to Notify the Ministry Representative

3.4 Further to the notification requirements contained in the General Standards for Ministry Funded Programs (FS 1001), a Recipient must immediately notify the Ministry Representative whenever an inspection reveals on any contiguous area greater than one-tenth (1/10) hectare (or larger minimum area that may be Specified by the Ministry Representative):

(a) performance quality to be less than the minimum acceptable standard of eighty-five percent (85%), and the nature and extent of the errors are such that performance quality cannot be raised to at least 85%; or

(b) the Specified minimum number of Crop Trees per hectare to be retained has not been retained.

Ministry of Forests

Schedule C
Additional Specifications

File: 10005-40/xxxxxxxxxx

Attachment to the Agreement with _____ for **Pre-Commercial Thinning**

Treatment Unit A: Stand structure targets are to retain an average target density of 1800 well-spaced stems/ha.

The overall objective of manual spacing treatments in overstocked dry-belt fir stands is to improve health and vigour of the residual stems by reducing stand density with the goal of producing a commercial timber harvest at an earlier age as compared with no treatment. Spacing treatments can also target diseased and damaged trees for removal so that overall stand resilience and quality is improved.

The treatment strategy is to retain the biggest and best crop trees (Fd, Sx, P1) trees with good form and vigour to achieve a target density of approximately 1800 sph. This target will be achieved by manually cutting L2 and L3 trees with brushsaws or small chainsaws. Fir Veterans will not contribute to the target crop tree density.

Treatment Unit A:

Treatment Plan Area Summary

Stratum	Treatment Unit	Gross Area (ha)	Non Mapped NP Nat (ha)	Non Mapped NP Unnat (ha)	Net Treatment Area (ha)	Treatment Type
A					0.00	Pre-Commercial Thinning

Retention and Cutting Specifications

Refer to Prescription (FS770) for Treatment Parameters & Specifications.

Priority 1:
Outside of danger trees, there is no cutting of LI trees.

Priority 2:
Fd trees of good form and vigour should be selected for retention as crop trees. If trees are distributed across the treatment unit in clumps, then the cutters should choose the best crop trees in the clump and work their way outwards. This way, cutters ensure they are choosing the biggest and best trees first, and then work down in size and quality.

Priority 3:
Sx trees of good form and vigour should then be selected.

Priority 4: Pl trees of good form and vigour should then be selected. Superior PI trees that are 2x the height and clean of pests and disease may take precedence over Fd and Sx upon thorough examination.

Target Density: The target residual stand is a regular spaced stand with average densities of approximately 1800 sph. For the purposes of determining quality, minimum density is 1400 sph and maximum density is 2000 sph.

Inter-Tree Spacing (meters): Target triangular spacing to achieve 1800 sph is 2.5 m.

Minimum Inter-tree Spacing (m): To ensure that the largest, healthiest trees are retained, minimum inter-tree spacing is 1.5m.

Target Trees for Retention: Primary choice is the largest, healthiest trees with good form and vigour that are free from significant damage and disease and have greater than or equal to 50% live crown. In addition, trees should have good leader growth and have room for the crown to expand. There is no cutting of LI trees. Secondary choice is the Sx trees. Third choice is Pl trees. Pl trees that are 2x the height & clean of pests/disease may take precedence over Fd and Sx. Py are considered Ghost Trees and are not to be cut.

Do not cut Layer 4 stems unless unavoidable when cutting as per priorities described above.

Minimum cutting height = 1.0m in Height

All deciduous tree / shrub species (alder, willow) will be retained.

Target trees for Removal:

- Damaged trees with poor form and vigour including forked, crooked, and scarred stems and trees with <20% live crown.
- Pli trees are a low priority species in this stand and should only be retained if they are healthy, have good form and vigour and if no other suitable Fd/Sx crop tree is available.
- Trees growing within the drip line of larger layer I trees.
- Western Spruce Budworm infected trees that have significantly reduced live crown
- Trees with animal damage or mechanical damage.

Cutting shall be carried out in such a way that stem damage to residual trees does not occur and live limb loss is minimized.

All stumps will be left no higher than 15cm and cut parallel to the ground (stump angle must be <30° from horizontal). If rocks or other obstacles prevent cutters from leaving stumps <15cm, then stumps can cut be flush with the height of the obstacle.

All cut trees must lie parallel to the ground surface at a depth not exceeding 60cm. Additional bucking of felled stems will be required to achieve decomposition.

No Treatment Zones: Where No Treatment Zones exist within the treatment units, the zones are ribboned in the field. There is no cutting within the No Treatment Zones.

Where cattle trails and/or fence lines exist, they will be kept free of any slash.

Danger tree assessment and treatment must be completed prior to the spacing treatment of the unit.

If any cultural or heritage materials are noticed during spacing operations, then activities will cease in the vicinity and the Archaeological and Heritage Branch will be notified.