

Commercial Thinning Specifications and Exceptions Monitoring Protocol for Jack Pine, White Spruce and Black Spruce in Ontario's Boreal Forest

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Overview:

Interest in operational commercial thinning in boreal Ontario (which includes the “semi-commercial thinning” of the Forest Accord) is currently focused on a single-entry, uniform, moderate intensity thinning from below (30-35% of stand basal area removed at immature stand age, in addition to 10% area in extraction trails). This thinning regime is part of a package of regeneration and stand tending techniques used to regulate stand density. By using commercial thinning in conjunction with planting and/or pre-commercial thinning, the growth track of an individual tree can be maintained within the bounds of having adequate neighbour competition to limit excessive branchiness and taper yet having adequate growing space for good growth. If stocking is initially too sparse then wood quality suffers due to poor form and excessive branching; and if stocking becomes too dense then the time to reach the objective piece size is lengthened.

The primary purpose of the above thinning regime is as a stand tending practice to reduce the number of trees in a stand to a density that will produce high quality sawlogs and reach a technical rotation age sooner (grow a big tree faster) thus potentially mitigating future wood supply shortfalls. A secondary benefit is the provision of an immediate source of salable wood, potentially mitigating current wood supply shortfalls. Compared to no thinning, this thinning regime, when properly implemented, does not increase nor reduce total stand volume over a rotation¹. Since the stand volume growth curves for thinned and unthinned stands proceed in parallel (Figure 1; post-thinning parallel yield curve), the standing live volume in thinned stands at the time of harvest (rotation age) is less than that from an unthinned stand. However, the volume of larger diameter crop trees at harvest can be greater with thinning than without.

Even though a multiple entry light intensity commercial thinning regime (e.g., ≥ 3 entries with $\approx 10\%$ removal at each entry with ghost trails² only) has the potential to yield a greater cumulative total volume over a rotation compared to an unthinned stand (post-thinning convergent yield curve), this level of intensive forest management is not currently under consideration for boreal Ontario. The cost of each harvest would be high for small volumes of small wood, and the regime does not grow a big tree faster. Single-entry heavy intensity thinnings ($>35\%$ basal area removal plus 10% area in extraction trails) are also not being considered as this thinning regime will reduce cumulative total volume over a rotation compared to an unthinned stand (post-thinning divergent yield curve), and is associated with greater risks of post-thinning wind and snow damage.

Definition of Commercial Thinning

The definition of commercial thinning in Ontario may be standardized as follows:

Commercial thinning: A stand tending treatment in well stocked, vigorous, immature stands where some portion of the trees removed have reached a merchantable size and where the sale of timber harvested will potentially earn a positive financial return. The primary objective of the treatment is to accelerate the diameter increment of residual trees (relative to no thinning), but the treatment should also, by suitable selection, improve the form, quality and/or value of residual trees. Commercial thinning is differentiated

¹ The cumulative total volume over a rotation that is produced by the thinned stand is the sum of the volume generated through the commercial thinning plus the volume from final harvest at rotation.

² A ghost trail is defined as a trail where the harvester can access trees for removal but tree selection and tree spacing are not compromised.

from a two-stage removal harvest in that the former is a tending treatment, the primary purpose of which is to enhance the growth of residual stems without reducing total stand volume growth.

Specifications for the Application of Commercial Thinning

Based upon a literature review (McKinnon et al 2006), the following interim specifications for the application of commercial thinning are recommended. As additional information applicable to boreal Ontario becomes available, commercial thinning under additional site, stand and/or treatment conditions may be supported.

1. Target fully stocked jack pine and white spruce stands with a history of density regulation (planting and/or pre-commercial thinning); consider fully stocked upland black spruce stands with a history of density regulation; consider fire origin jack pine stands only if the stands meet the site quality, leave tree characteristics and stand uniformity qualities (see bullet points 2-3 below). The literature suggests that jack pine and white spruce closely follow the general principles underlying a growth response to commercial thinning. There are fewer studies specifically on black spruce, and the magnitude of its response to commercial thinning is less clear because of the inherently slow growth and narrow crown morphology of this species. Stands with a history of density regulation are more likely to have more uniform stand conditions necessary for successful implementation of commercial thinning.
2. Target high productivity sites. Commercial thinning should be concentrated on the best sites for the species of interest where piece sizes will be larger at an earlier age, the greatest absolute growth responses will be realized, and the risk of reduction in stand volume growth is lowest. Soil conditions must not pre-dispose residual trees to windthrow.
3. Stands should not be thinned if leave trees have small live crown ratios (<35%), exhibit several years of strongly suppressed diameter growth or have high height/diameter ratios that would increase the risk of post-treatment wind damage. Early density regulation (e.g. planting or precommercial thinning) is needed to reduce height/diameter ratios and to maintain a live crown ratio greater than 35% for leave trees. The growth response of trees with sparse crowns to increased light is minimal.
4. Given that the success of commercial thinning is highly dependent on appropriate site and stand conditions, these conditions must be verified in the field prior to thinning, i.e., determined empirically during a pre-harvest assessment. A higher sampling intensity may be necessary for natural stands to determine if they may meet the conditions for commercial thinning.
5. The timing for commercial thinning should coincide with a point earlier than the culmination of mean annual increment, and no later than the period of active height growth when the opportunity for good crown expansion is lost. On high productivity sites, the recommended age for commercial thinning is prior to: 35 years for jack pine; 40 years for white spruce; and 50 years for upland black spruce. Until more detailed growth and yield data is obtained, existing stand density management diagrams should be used to help determine the timing for stands that have not exceeded these age limits. If thinning occurs too late in the stand's development (in terms of live crown ratio), the individual trees will not be able to respond adequately to opening of the canopy and will also be more prone to wind damage. Consequently, the stand will not reach its volume potential.
6. Only uniform thinning from below with 30-35% basal area removal is recommended at this time. The smallest size classes and poorer quality trees are removed from a stand, leaving the more vigorous, structurally stable and potentially valuable crop trees to continue growing to

operable age. If thinning is too heavy, the trees will not attain canopy closure, thus full site occupancy will not be recovered and the stand will not realize its volume potential.

7. Harvesting equipment and operational practices should be selected to minimize post-treatment area reductions. A maximum of 10% of the treated area should be in extraction trails, and extraction trail width should not exceed the inter-tree spacing required to maintain full canopy closure at harvest (generally less than 3.0 m wide) (Figure 1). If extraction trails are too wide to allow canopy closure, then full site occupancy is not achieved and the yield curve from commercial thinning is somewhat divergent. Extraction trails need to be minimized through the use of small forwarding equipment and purpose-built commercial thinning harvesters equipped with long booms and/or small enough to work off a ghost trail network (see footnote 2).
8. Harvesting equipment and operational practices should be selected to minimize crop tree damage (i.e., damage to the boles, crowns, and/or roots of residual trees) and site disturbance (e.g., compaction, rutting, erosion). The silviculture guide for the Great Lakes-St. Lawrence Region of Ontario (OMNR 1998) provides generalized tree damage standards, as well as suggestions for preventing residual tree damage (or substituting trees for those damaged) for partial harvesting operations. Operations should also be limited during spring and early summer (May-June) during the peak sap flow period to minimize bark damage. Site disturbance can be minimized in part by requiring commercial thinnings to conform to the *Forest Management Guidelines for the Protection of the Physical Environment* (Archibald et al. 1997).
9. Assessment of these interim best management practices must be verified through the use of monitoring programs to verify stand yields (exceptions monitoring) and to ensure operational practices meet the stand quality goals, and minimize crop tree damage and site disturbance (compliance monitoring). Any apparent site disturbance and tree damage should be recorded.

Some FMP Considerations

1. A parallel post-treatment yield curve will apply for modeling stand growth, given that operational commercial thinning in boreal Ontario will be initially limited to a single-entry moderate intensity (30-35% of basal area) removal. The interim application of a parallel post-treatment yield curve in modeling assumes operational practices have not resulted in excessive crop tree damage or exceeded guidelines (10%) for area removals from extraction trails. Although the yield curve from fully stocked stands that are not thinned and the yield curve from stands commercial thinned will eventually converge, the rotation age at which the stand is harvested is much younger than the age of convergence (Figure 2). At rotation age, the curve is still parallel. Thus, the total volume over a rotation from a stand with commercial thinning using a single-entry, moderate intensity removal is equal to the total volume produced by the unthinned fully stocked stand (see footnote 1). However, the temporal distribution of the volume produced by the thinning will result in lower future volumes from the stand at rotation age since the two yield curves are parallel at this point.
2. If deviations from the parallel post-treatment yield curve are to be used in modeling, the deviations must be reflected in actual treatment data and approved through the management plan approval process.
3. FMP forecasts which incorporate sustainable yields from commercial thinning operations to mitigate future wood supplies must be supported by current programs of early stand

density regulation to create stands that are suitable future commercial thinning candidates.

4. Commercial thinning modeled in the Strategic Forest Management Model (SFMM) must be reasonable and feasible, and must be reflected in actual treatments. Identify which and how many stands are suitable/eligible. This work should be completed in consultation with regional planning staff.
5. Until such time as the existing silviculture guides are revised, commercial thinning continues to be viewed as being not recommended for use in Ontario's boreal forests. If this treatment is included in a forest management plan, then it must be identified as an exception and relevant exceptions monitoring conducted. A proposed exceptions monitoring program is described in the appendix.

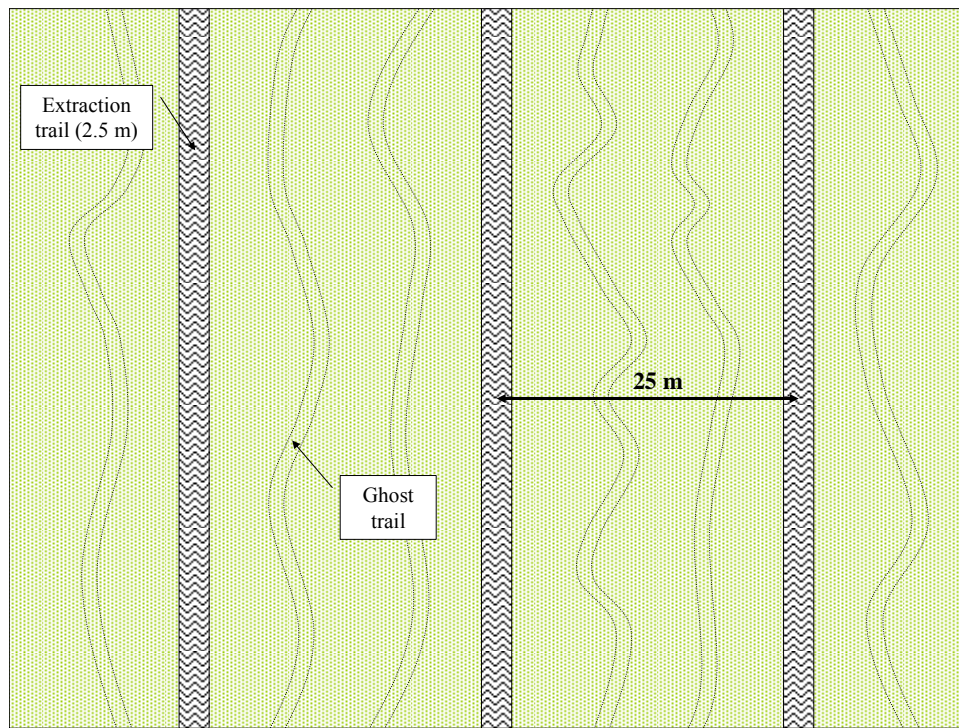


Figure 1. Sample layout of extraction and ghost trails. Trails occupy 10% of the area in this example.

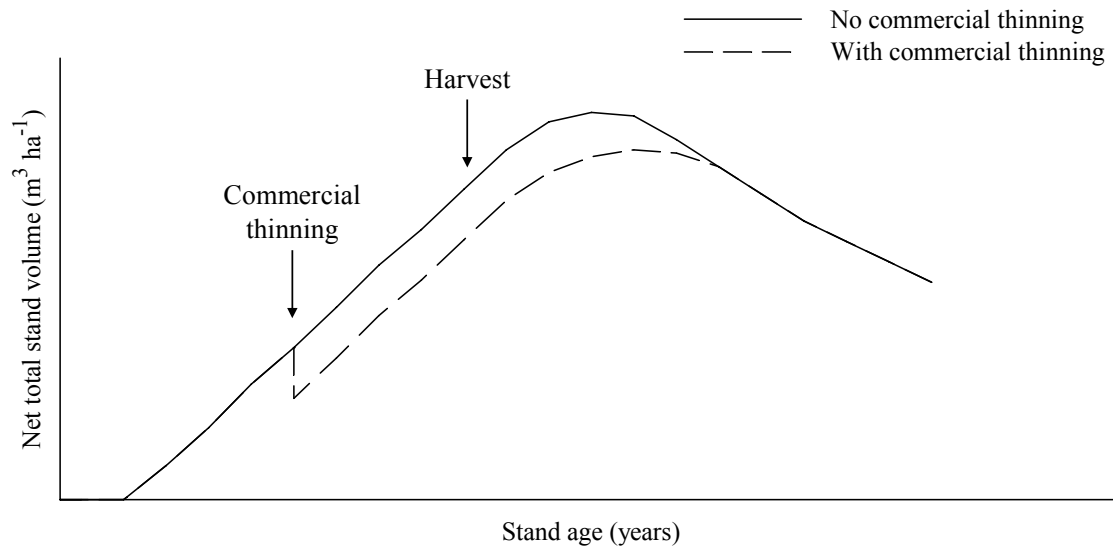


Figure 2. Projected long-term yield curves comparing the yield of a stand without commercial thinning and a stand with a uniform single-entry moderate intensity commercial thinning from below. At the time of harvest (rotation age) the two curves are still parallel, and only eventually converge sometime well past the rotation age. Long term data does not yet exist to determine the point of convergence. However, commercial thinning is an intensive stand management technique so long-term trends past rotation are largely irrelevant.

Source Document:

McKinnon, L.M., G.J. Kayahara, and R.G. White. 2006. Biological framework for commercial thinning even-aged single species stands of jack pine, white spruce, and black spruce in Ontario. Ontario Ministry of Natural Resources, Northeast Science and Information Section, South Porcupine, ON. Technical Report TR046.

Exceptions Monitoring Plan

Silviculture Treatment: The commercial thinning treatment is a single-entry, uniform, moderate intensity thinning from below (30-35% basal area removal, plus 10% area in extraction trails) that follows the commercial thinning specifications of this technical note.

Treatment Purpose: The primary purpose of this thinning regime is as a stand tending practice to reduce the number of trees in a stand to a density that will produce high quality sawlogs and reduce technical rotation ages (grow a big tree faster), thus potentially mitigating future wood supply shortfalls. A secondary benefit is the provision of an immediate source of salable wood, potentially mitigating current wood supply shortfalls.

Monitoring Objectives: Long-term comparisons between areas with early density regulation only and areas with both early density regulation and mid-rotation density regulation (commercial thinning) are required to determine: 1) individual tree growth rates to assess the degree to which we are growing a big tree faster; 2) stand volume growth to assess the degree to which we are utilizing the site after thinning, including the area in extraction trails; and 3) wood quality of trees at final harvest.

Stand and Treatment Information to be Recorded: The following information will be gathered for each stand prior to thinning: 1) silviculture history; 2) site quality, site index; 3) current stand density, species composition, and dbh profile; 4) live crown ratio of target crop trees; and 5) planned harvesting and forwarding equipment. After thinning the following information will be collected: 1) species composition, residual density, and dbh profile of the residual stand; 2) damage to residual trees; and 3) sample plot coordinates.

Sampling Plan: The following protocol for establishing paired (“control” and commercially thinned) sampling plots will be followed for each species-site combination to be thinned and, within each of those combinations, for every 25 ha treated.

Control (Unthinned) PGP

An undisturbed control block (with no thinning) is established that is at least 150 m × 150 m square and representative of the overall area (Figure 3)³. A standard permanent growth plot (PGP; circular, with an 11.28 m radius; see MNR Growth & Yield manual 2006) is then placed in the centre of the control block following MNR growth and yield protocol. The control block thus represents a sample PGP with a 63.72 m buffer (approximately 3 tree lengths). This PGP is used to assess the growth response and future wood quality of a stand with early density regulation but without subsequent commercial thinning.

Thinned PGP

A comparable standard permanent growth plot is also established in the thinned area. This PGP should be centred at the midpoint between two machine extraction trails far enough to the side of the control block that there is at least another 63.72 m buffer of thinned area between this PGP and the edge of the control block (Figure 3). This PGP is used to assess the growth response and future wood quality of a stand with early density regulation and a subsequent commercial thinning. In addition, a rectangular 10 m × 20 m permanent plot is established outside of this PGP so as to sample residual trees on either side of an extraction trail (Figure 4). This latter plot is used to determine to what extent and how fast canopy gaps created by extraction trails are utilized by residual trees.

Information Management: Stand and treatment information, treatment maps, copies of the completed tally sheets and electronic copies of the monitoring data will be forwarded to the NW or NE Science and

³ In some cases, narrow treated areas are operationally planned to accommodate a maximum forwarding distance of 100 m. In this case, a 100m x150m control area would be acceptable.

Information Section office. Planned re-measurements of the PGPs will occur every 5-years until final harvest.

Proposed Analysis: The data collected will be combined with data from similar site/treatment combinations carried out by other SFLs. Data analysis will be lead by MNR science staff.

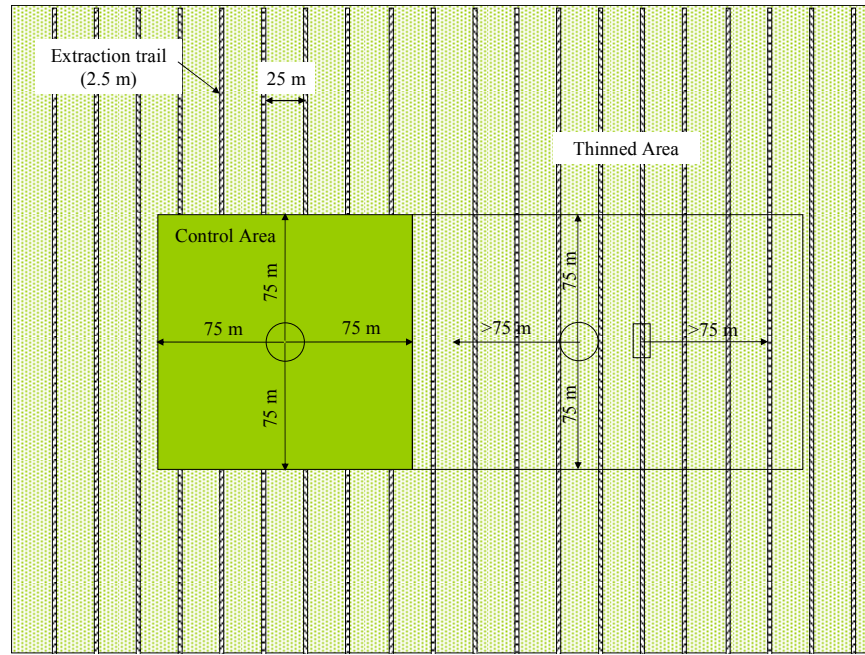


Figure 3. Layout of sample plots. A control block 150×150 m is established in a representative area of the stand with a standard permanent growth plot (PGP; circular, 11.28 m radius) located at its centre. A PGP is also established in the commercial thinned area with its centre at least 75 m from the boundary of the control block. An additional 10 m x 20 m rectangular plot is centred on a machine trail.

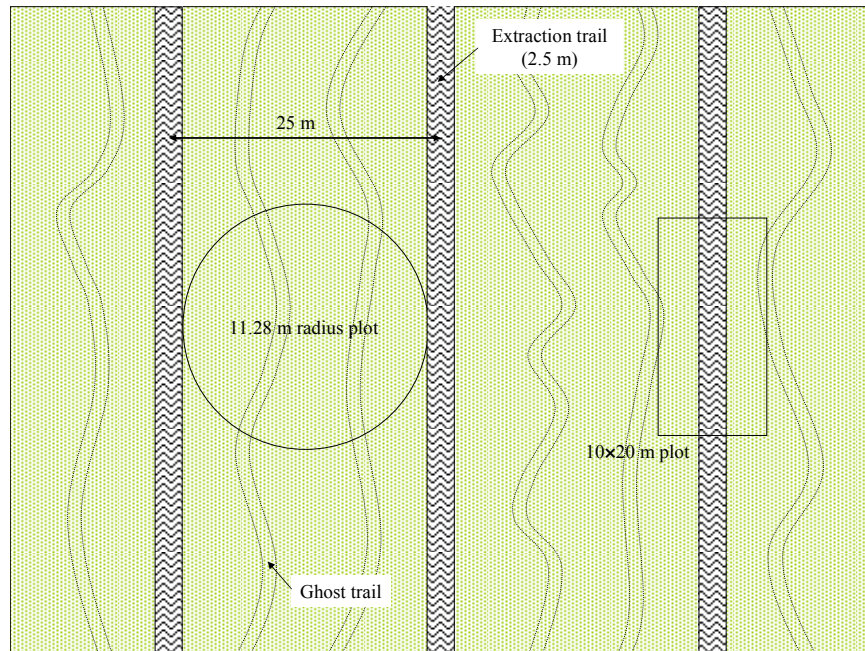


Figure 4. A close-up of sampling plots in the thinned area. In the commercial thinned area, a PGP is centred at the midpoint between machine extraction trails. Since ghost trails are trails where the harvester can access trees for removal but tree selection and tree spacing are not compromised, the PGP can include ghost trails. An additional 10 m × 20 m sample plot is established on the side of the thinned PGP that is furthest from the control block boundary. The centre of the short side of this rectangular plot is established along the midpoint of the extraction trail.