

Lesson 5

Compliance Issues

Ensuring commercial thinning complies with the Forest Practices Code

90 minutes

Objectives:

1. Participants will be aware of the major compliance issues specific to commercial thinning and partial cutting.
2. Participants will be aware of the compliance assessment procedures, the associated standards, and the potential penalties for non-compliance.
3. Participants will discuss approaches to ensure compliance for the major commercial thinning issues.

Equipment Needs:

- ▲ overhead projector
- ▲ flip chart
- ▲ associated references

Method:

Several large and small group discussions will explore the key compliance issues that are specific to commercial thinning. Several case studies will be used to provide some depth for these discussions. Small lecturettes will help to round out the discussions with background and further information on compliance assessment procedures and related issues.

The participants and the facilitator will together brainstorm ideas to ensure compliance for the major issues noted.

Compliance inspections



- ▲ MoF enforcement officers
- ▲ Post-harvest as a minimum

Criteria (SP and logging plan):

- ▲ seasonal constraints
- ▲ logging methods
- ▲ utilization standards
- ▲ opening size/configuration
- ▲ protected/reserve area commitments

- ▲ deactivation/rehabilitation
- ▲ limits for soil conservation
- ▲ leave tree characteristics and stand damage

- ▲ other special commitments

Overhead: Criteria for compliance inspections

Facilitator:

Key Points:

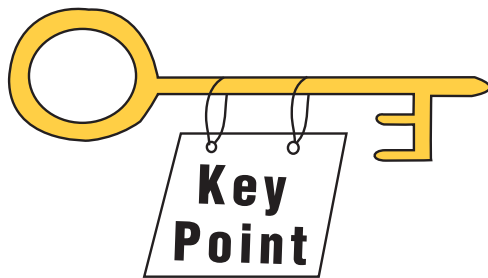
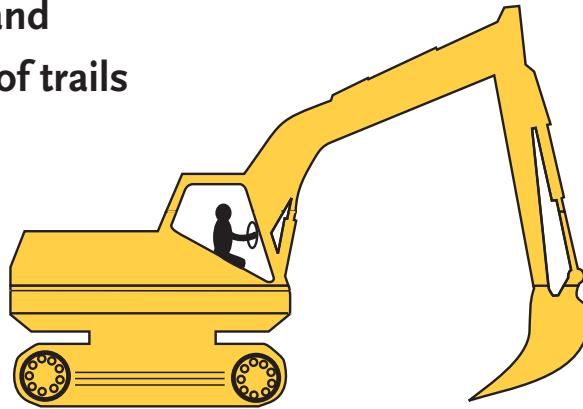
- ▲ Compliance inspections will be done by enforcement officers with the Ministry of Forests.
- ▲ These inspections may be done concurrently with harvesting, but as a minimum, harvesting will be inspected upon completion.
- ▲ The inspector will be looking for compliance with the SP (and the associated logging plan) based on the following criteria:
 - seasonal constraints
 - permissible logging methods
 - utilization standards
 - opening size/configuration
 - protected/reserved areas (including riparian zones)
 - **deactivation/rehabilitation activities**
 - **limits for soil disturbance**
 - **leave tree characteristics and stand damage protection**
 - other special commitments

While many of these criteria are no different than for other harvesting operations, there are some special considerations for the three highlighted criteria. For this reason we will expand on these issues, discussing how they will be assessed, relevant regulations, ministry policy and interpretations, and measures you can take to avoid non-compliance situations.

.....

Commercial thinning: Soil conservation compliance issues

- 1. Deactivation and rehabilitation of trails



Potential Soil Disturbance
Categories in the SP:

A large, empty rectangular box with a thin black border and a light gray drop shadow, intended for handwritten notes or a list of categories.

Overhead: Thinning/Soil conservation compliance issues

1. Deactivation and rehabilitation of logging trails in the stand.

Facilitator: Ask the participants how this should be handled for commercial thinning? What is the key point to remember?

Key Point:

- ▲ No rehabilitation of skidding trails or yarding corridors within the stand should occur in commercial thinning areas.
 - Excavated or bladed trails **should be avoided** as much as possible.
 - Unbladed logging trails (and corridors) within the stand **should not** be designated as temporary access, which is required to be rehabbed after logging.
 - Why? – damage to roots may occur as soil is decompacted while being rehabilitated.
 - The trails may be deactivated by waterbarring and grass-seeding where erosion concerns exist (usually on a slope).

Ask: What does this mean when you develop your SP and associated logging plan? How do you designate these trails for soil disturbance?

- ▲ These trails and corridors must be designated and dealt with under either of the following categories:
 - permanent access, or
 - dispersed disturbance in the net area to be reforested (NAR)

Note:

- ▲ On areas with a moderate to high likelihood of landslides, excavated or bladed trails will only be allowed if a geotech. (or similarly qualified person) has determined that the trails will not contribute to unstable terrain.
- ▲ On areas within community watersheds with a high or very high soil erosion hazard, or a moderate to high risk of sediment delivery in streams, excavated or bladed trails will not be allowed.

Commercial thinning:
Soil conservation compliance issues

2. Closely-timed harvesting events



A yellow key icon is positioned horizontally. A tag hangs from the key's shaft, containing the text "Key Point". To the right of the key is a large, empty rectangular box with a black border, intended for notes or discussion.

Overhead: Thinning/Soil conservation compliance issues

2. Closely timed harvesting events (15–50 years)

Facilitator: Ask the participants how this should be handled for commercial thinning?
What is the key point to remember?

Key Point:

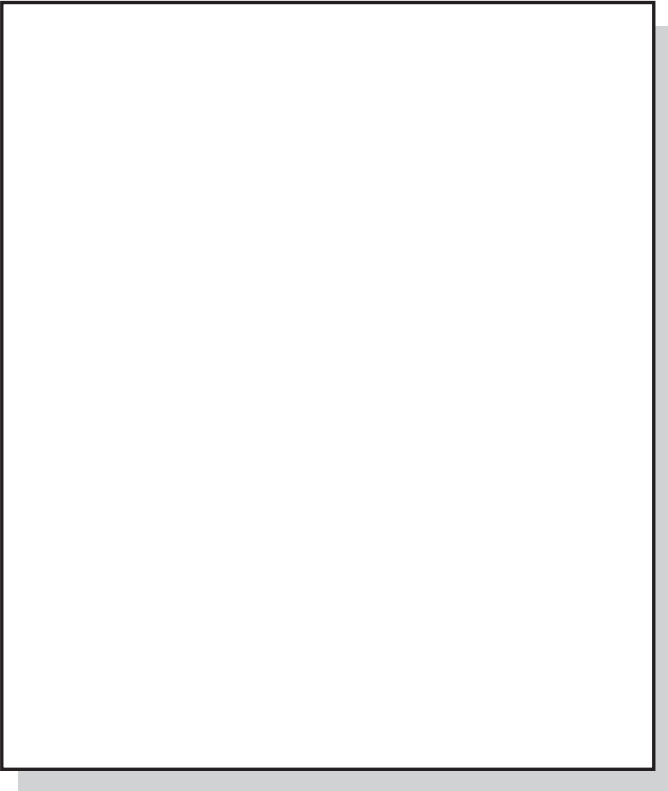
- ▲ Disturbance from repeated harvesting events should be concentrated on the same trail/corridor network as much as possible.
- ▲ Trails with a potential to be re-used must be mapped on the logging plan, so they can be tracked through time.



Commercial thinning: Soil conservation compliance issues

3. Cosely-spaced unbladed logging trails

Case study #1



Overhead: Thinning/Soil conservation compliance issues

3. Closely-spaced, unbladed logging trails

Facilitator: Turn to your neighbour exercise – Allow the participants time to read the case study and discuss the attached question.

15 minutes

▲ Tell them that we are going to explore this issue through several case studies.

Flip chart: Debrief the case study being sure to touch on the key points below, placing key points on the flip chart.

Key Points:

Question #1:

▲ In this scenario the intent will be continuous use of the trails on an uneven-aged basis with no intent to ever regenerate the area they occupy. Therefore, it would not make sense to call them anything other than permanent access.

▲ The *Soil Conservation Guidebook* supports this designation. Show them overhead 6.5.

Question #2:

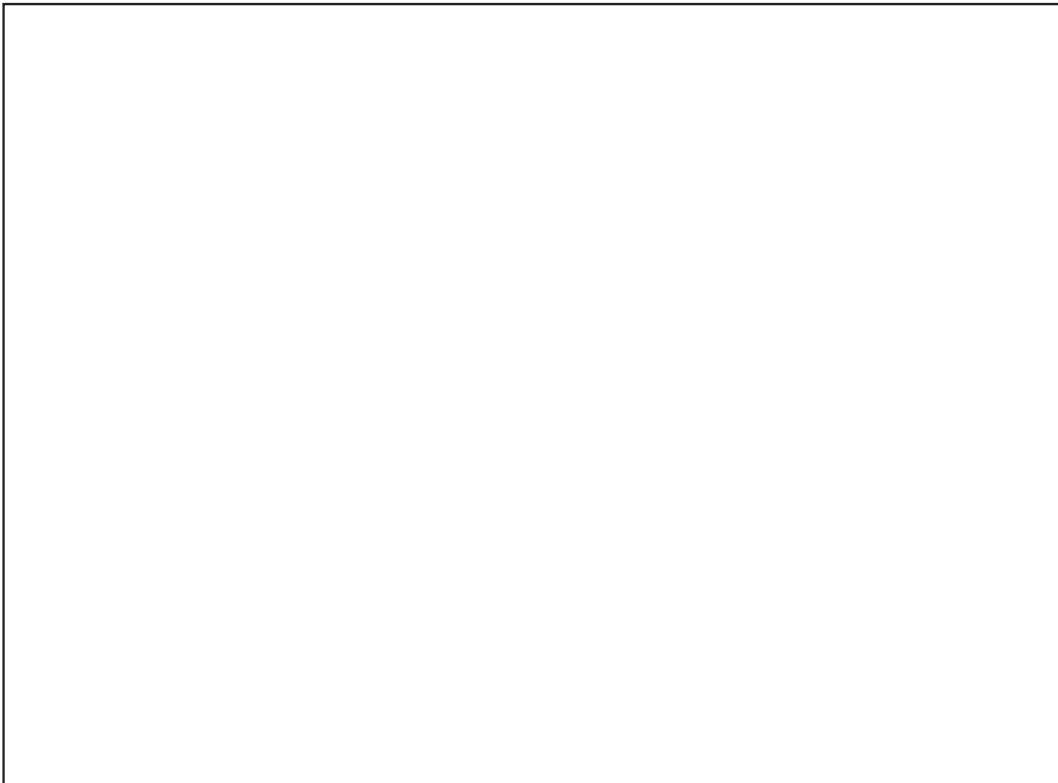
▲ Since countable soil disturbance on the trail network is only at 2.0%, it would make more sense to include the trails in the dispersed NAR disturbance.

▲ A formal compliance survey would yield 2.5% permanent access and 2% dispersed NAR disturbance — well within the allowable limits.

▲ It is critical in this situation that these unbladed trails still be mapped in the logging plan so that they can be found and used in the next entry (on the coast understory vegetation can obscure these trails within 5–10 years).

– This mapping requirement is over and above the *Operational Planning Regulation* and the *Logging Plan Guidebook*, which only ask that permanent and temporary access structures be mapped.

Soil conservation issues:



Roads, landings and skid trails

Roads/ landings (% total area)	Skid trails (% total area)	Countable soil disturbance on the skid trails (% total area)		
		Impressions	Extensive uniform compaction	Total
2.5	7.2	0.6	1.4	2.0

Note: No soil disturbance was counted between the trails.

Overhead: Commercial thinning soil conservation Case study #1

Background Information:

This area is in the ICHmw2 (Interior Cedar/Hemlock – moist warm subzone), east of Vernon, BC. The stand here originated from a large fire near the turn of the century. As with the portions of this block that were logged earlier, this area had an overstory mixture of mostly Douglas-fir and larch, with minor components of spruce and white pine depending on site drainage. The understory had a fairly uniform stocking of redcedar, with minor amounts of hemlock and spruce. Original stand volume was about 300 m³/ha on 45 m²/ha of basal area. This two-storied stand was very dense, with vigour declining in many overstory stems.

Soils are well-drained deep loams to sandy loams and slopes throughout the area range from 0 to 15%.

The *Soil Conservation Guidebook* recommends:

Permanent access maximum – 7%

Dispersed NAR disturbance maximum – 10%

The Commercial Thinning Treatment

The area to the south of the middle road was commercially thinned as a preparatory cutting last year. The intent is to enter the stand several times over the next 30–40 years to commercial thin and then eventually create small openings to encourage an uneven-aged structure. This first preparatory cutting was intended to improve the vigour and height to diameter ratios of the leave trees so that they will be much more resistant to windthrow in future cuttings (a low thinning).

The thinning reduced basal area, between the skidtrails, to about 30 m² on 1100 dominant and co-dominant Douglas-fir and larch per hectare. Diameters of these trees range from 12.5 to 32 cm while heights range from 13 to 17 m.

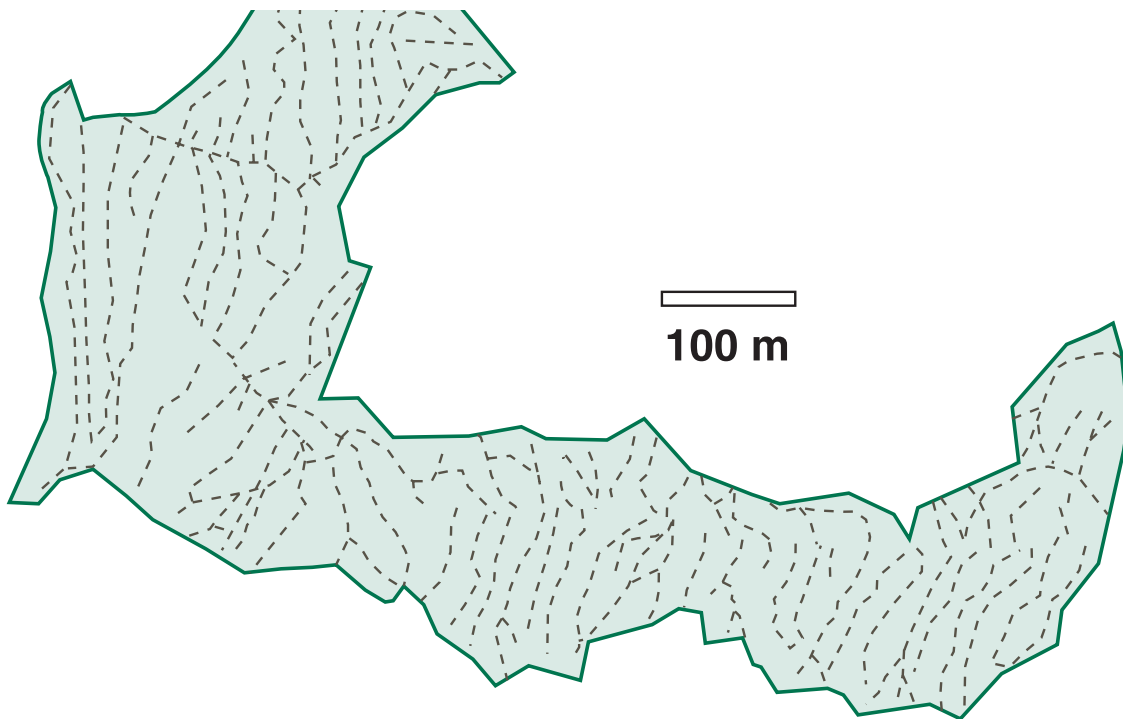
The skidtrails were prelocated at roughly a 30 m spacing (see aerial photo below). Skidding equipment were restricted to use on the skidtrails. Trees were felled directionally at an angle to the trails and then winched to the trail for skidding.

.....

Commercial thinning: Soil conservation compliance issues

4. Closely-spaced unbladed logging trails:

Case Study #2



Overhead: **Thinning/Soil disturbance**
Case study #2

Facilitator: Turn to your neighbour exercise – Allow the participants time to read the case study and discuss the attached questions.

10 minutes

Flip chart:

1. Debrief the case studies being sure to touch on the key points below, placing key points on the flip chart. Use the overhead with the map of the trails to help illustrate points.

Key Points:

Case #2

- ▲ Any potential “heavy impact” trail that will be used in the next entry for skidding could be designated as permanent access. This would include main speed trails used by grapple skidders, when horses or excavators bring the wood to the trail, or any other situations where main trails are used.
- ▲ The permanent access designation could be changed to temporary access in the next entry (if a clearcut), and rehabbed after logging.
- ▲ The secondary trails should be designated as dispersed NAR disturbance due to their low impact. Also, the next harvest (final harvest) may not necessarily utilize these trails. Likely the final harvesting will be done using fewer trails and will probably utilize different logging technology to address the larger timber (e.g., hoe forwarding).

Commercial thinning soil conservation – Case study #2

Background Information:

This area is in the CWHxm (Coastal Western Hemlock — very dry maritime variant), west of Duncan, B.C. This second growth Douglas-fir stand is 60 years old originating from natural regeneration after the original harvest. Preharvest stand volumes averaged about 1000 m³/ha over about 80 m²/ha basal area on 950 stems/ha.

Soils are well drained deep sandy loams and slopes throughout the area range from 0 to 20%.

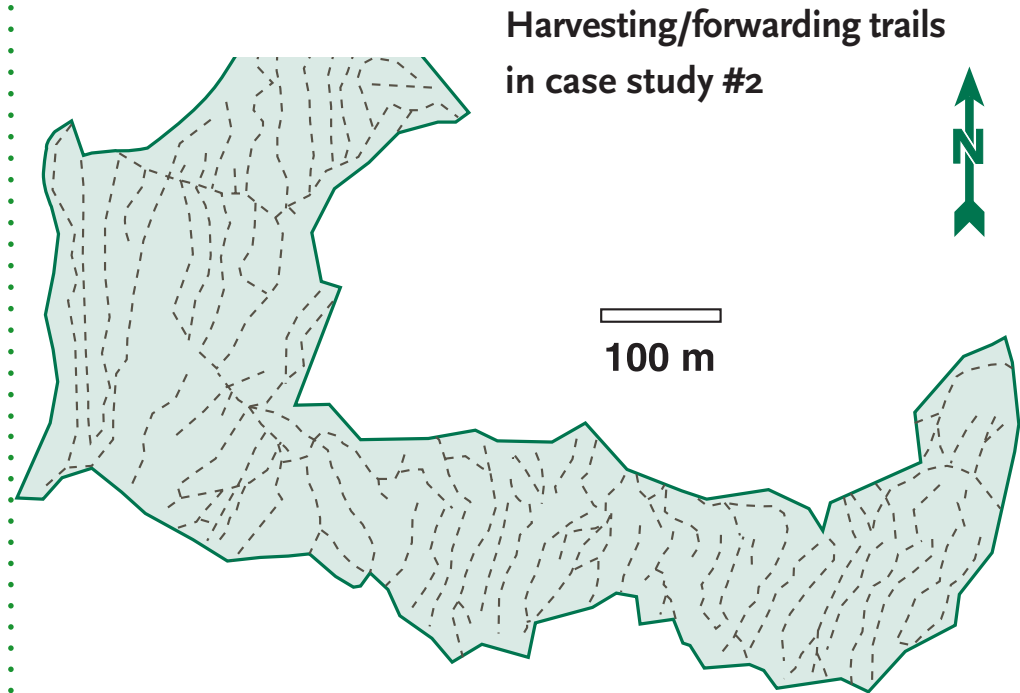
The Commercial Thinning Treatment

The area was thinned from below concentrating on cutting intermediates and smaller co-dominants less than 30 cm in diameter using a single-grip harvester/forwarder combination.

The thinning reduced basal area to 50–55 m²/ha on 350 stems/ha, leaving 700 m³/ha of volume on-site.

Trails were located and cut by the harvester operator based on the reach of the boom, and by operator preference. Trails were spaced at 15–20 m apart (see map) which is typical for this type of equipment in a commercial thinning operation. Trees were felled, delimited and bucked to length using the single-grip head on the harvester. Wherever convenient, stems were processed on the trail in front of the machine to provide a slash mat for the machine to travel on. Logs were piled to the side of the trail to be picked up by the self-loading forwarder. The forwarder can pivot the cab 180 degrees to allow the machine to be easily backed into the stand empty and driven forward out of the stand loaded.

Soil Conservation Issues



The total area covered by the harvesting/forwarding trails totaled 22%. However, note that only a small percentage of the secondary forwarding trails showed impact from the machinery. Only 25% of these secondary trails were affected according to the categories of disturbance outlined in the *Soil Conservation Guidebook*. On the main forwarding trails, most of the trails were heavily affected. However, only a small percentage of the trails qualified as main speed trails.

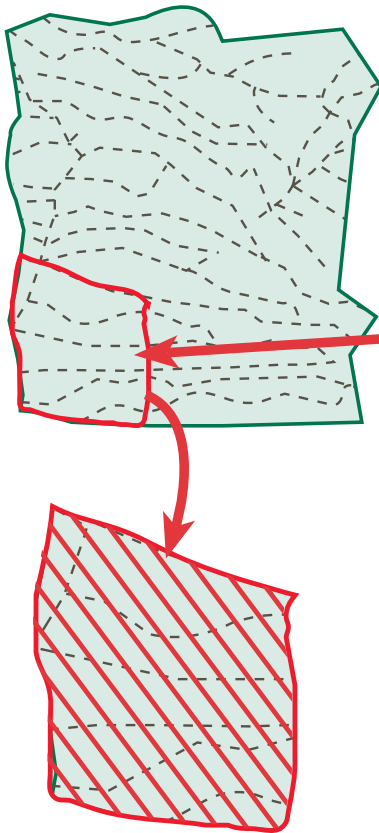
Questions:

1. Based on the above discussion how should the trails be designated in terms of permanent or dispersed disturbance? Explain your rationale.
2. Based on your answers to question #1, do you have any additional *rules of thumb* that can be applied when making decisions about the designation of permanent access for unbladed skidtrails?

Compliance assessment procedures for soil conservation



1. Permanent access structures
 - ▲ Inspection to compare with LP and SP
 - ▲ Formal survey if required
 - absolute measurement of area



2. Dispersed NAR disturbance
 - ▲ Visual inspection
 - ID questionable areas
 - ▲ Questionable areas stratified
 - min. 1.0 ha stratum
 - ▲ Formal compliance survey
 - gridpoint systematic sampling

Overhead: Compliance assessments for soil conservation

Facilitator: Review the main points quickly

Key Points:

- ▲ Compliance will be assessed for soil conservation in commercial thinning using all of the same methods and procedures as for other harvesting operations. The procedure is as follows:

Permanent Access:

- ▲ The enforcement officer inspects the permanent access structures looking for more area in access than is indicated on the logging plan. He may make some measurements here.
- ▲ A formal compliance assessment would measure these structures in detail to determine the absolute disturbance. This would be done if the enforcement officer suspects that permanent access is greater than the SP standard.

Dispersed NAR Disturbance:

- ▲ Enforcement officer inspects harvested block looking for areas that appear marginal in terms of dispersed NAR disturbance.
- ▲ These areas would likely include:
 - unbladed trails that are on the logging plan as NAR disturbance, but appear heavily impacted.
 - other disturbance — unbladed trails that are not on the logging plan or disturbance between trails.
- ▲ If marginal areas of 1.0 ha or greater exist, a full compliance survey will be ordered on these areas. Note: these disturbed strata cannot just follow the skidtrails. They would have to include at least several skidtrails and the area between them.
- ▲ A certified soil disturbance surveyor will assess those areas (or the entire block) where compliance is questionable using the standard assessment procedures outlined in the *Soil Conservation Surveys Guidebook*.
- ▲ These procedures will include a gridpoint systematic sampling on uniformly spaced transects that are run perpendicular to the logging trails. This assessment will have a statistical analysis of data attached and will be submitted to the DM for determination of appropriate administrative remedies, where appropriate.

.....

How can we ensure compliance with SP standards for soil conservation?



Overhead: How can we ensure compliance?

Facilitator: Review the main points quickly

Key Points:

- ▲ Prelocate your trails carefully and GPS them for mapping on the logging plan.
- ▲ Keep the equipment on the trails.
- ▲ Minimize disturbance on the trails by:
 - using the right equipment at the right time (season). Small light-weight equipment is generally best. If soils are especially sensitive or slopes are steeper, consider a small skyline.
 - top and limb on the trails as much as you can (at least for the timber that is felled to the trails). Skidding or forwarding on this slash will reduce impacts.
 - do not blade off any rotten wood deposits. Try to smooth it out and skid over it, using it as a protective mat.
 - use puncheon or rubber mats on significant persistently moist sections of trails.

Overhead: Leave tree characteristics and stand damage issues

Facilitator: There are three key issues that compliance assessments will try to address:

1. Insufficient leave trees.
2. Poor leave tree selection.
3. Excessive stand damage.

The legislative basis for these inspections is mainly:

The Silviculture Practices Regulations – Sec. 12. (1):

A person must ensure that sufficient trees remain standing and undamaged to meet the resource management objectives for the area specified in any higher level plans, if the person carries out a commercial thinning treatment under a silviculture prescription.

Sanctions: Administrative penalty up to \$5000 per tree

How will leave tree characteristics be assessed for compliance?



1. Visual inspection
 - ▲ noting general condition
2. Establish plots
 - ▲ where densities or characteristics appear marginal
 - ▲ leave trees must meet SP criteria for characteristics and density

Note: If density is too low...

- ▲ the stratum may be considered NSR
- ▲ penalty plus new SP to reforest the area

Overhead: How will leave tree characteristics be assessed for compliance? See Appendix 3 in the *Commercial Thinning Guidebook*

Facilitator:

Leave tree characteristics:

- ▲ The enforcement officer will walk through the stand assessing its general condition and the number of stems per ha. Where necessary, plots may be established to get a rough estimate of densities, etc.
- ▲ Where final densities or leave tree selections appear marginal, sample plots will be established similarly to the Thinning Quality Plots.
- ▲ Final leave tree density will be expected to be above the minimum suggested in the SP. Leave tree characteristics should also fall within the ranges specified in the SP.
- ▲ The enforcement officer may stratify out an area within the block where leave tree selection appears marginal. Such areas will be a minimum of 1 ha in size.

Note:

- ▲ If density is too low, the block or stratum will also be considered NSR.
- ▲ In addition to penalties assessed for insufficient leave trees, a new SP to reforest the area will be required.

.....

The conceptual basis for stand damage concerns



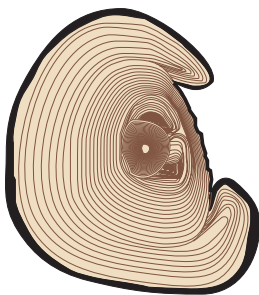
Wounds occur as a result of:

- ▲ falling
- ▲ skidding, yarding and forwarding
- ▲ windthrow and snow breakage



The problems:

- ▲ pathway for decay fungi to enter
- ▲ stress increases the activity of existing decay fungi
- ▲ wound and decay lowers value of log



Reaction:

- ▲ compartmentalization to create a barrier
- ▲ chemical barriers – resins in conifers
- ▲ cover wound with new tissue

Overhead: The conceptual basis for stand damage concerns?

Facilitator: What about assessing stand damage? We should back up a bit and first discuss why we are concerned about damage.

Read:

Read pages 25–27 In the *Commercial Thinning Guidebook* to get an overview of the effects of tree wounding.

Wounding can occur as a result of:

- ▲ falling
- ▲ skidding
- ▲ associated windthrow and/or snow press afterwards

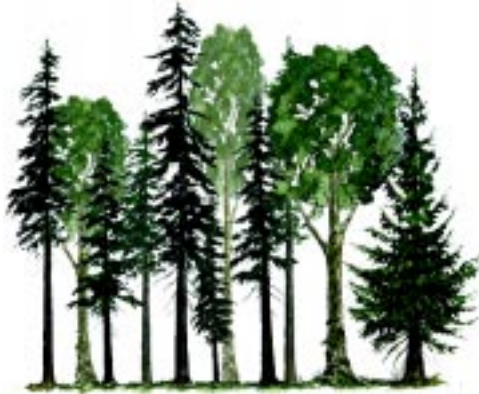
Wounding during commercial thinning creates two problems for a tree:

- ▲ Wounds provide a pathway for some decay fungi to enter the tree.
- ▲ Wounds may allow decay fungi to become more active as the stress of trying to recover from injury diverts internal resources away from tree defenses.

Reaction to wounding:

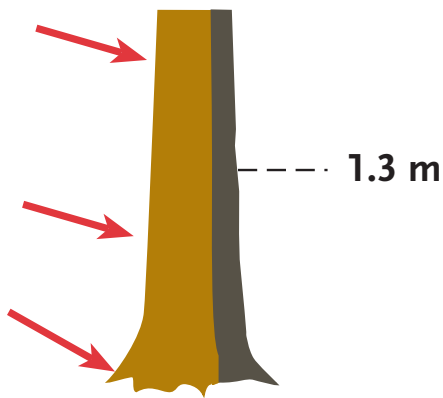
- ▲ Trees do not heal wounds – they compartmentalize the damage to create barriers to resist colonization by decay fungi.
- ▲ New tissue must cover the wound. This will take time, although the cambium is generally more active around the wound than in other parts of the tree.
- ▲ The longer wounds remain open, the more opportunities there are to colonize the tree.

Factors affecting decay development



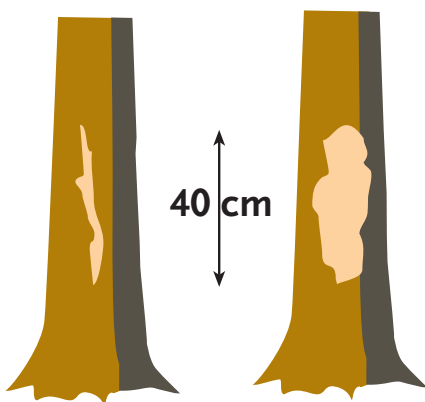
1. Tree species

- ▲ resinous wood?
- ▲ bark thickness



2. Wound location

- ▲ height above or below dbh
- ▲ proximity to soil



3. Size and type of wound

- ▲ total size
- ▲ width
- ▲ scar or gouge

Overhead: Factors affecting decay development in wounds

Facilitator:

Tree Species: (see page 26 in the *Commercial Thinning Guidebook*)

- ▲ Thin-barked species with non-resinous wood, such as true firs, spruce and hemlocks are more readily infected through wounds than thick-barked species with resinous wood (Douglas-fir).
 - The resins are transported to the site of a wound, discoloring it and making the wood somewhat toxic for microorganisms and more or less impervious to water. Over time decay fungi may still be able to grow through this.
- ▲ Resinous species like lodgepole pine, even though they are thin-barked, are still much more resistant than non-resinous species.

Location of Injury:

- ▲ Wounds below breast height are more likely to become infected possibly due to microclimatic effects.
- ▲ Incidence of decay declines with increasing height, although some species (like larch) more frequently become infected through broken tops and branches than through basal scarring (this is most likely related to the bark thickness and its resistance to scarring).
- ▲ Root wounds and stem wounds contacting soil nearly always become infected, regardless of size, and they have faster decay rates.

Size and Type of Injury:

- ▲ Probably the most important characteristic.
- ▲ In wounds greater than 900 cm², between 60–80% of western hemlock, spruce and true firs become infected.
- ▲ Wide scars tend to have twice the decay loss as narrow scars.
- ▲ Gouges (deep or splintered wounds into the xylem) have more decay losses than smooth wounds (scars where only the bark is removed).

Factors affecting decay development

4. Age of injury

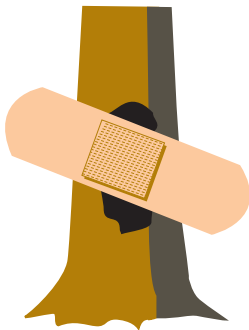


▲ how long before you are harvesting again?



5. Season of harvesting

▲ avoid spring sap-flow period



6. Wound dressings?

▲ generally no benefit

Overhead: Factors affecting decay development in wounds

Facilitator:

Age of Injury:

- ▲ Wounds less than 10 years old generally have no decay as insufficient time has passed to allow proper development.

Season of Injury:

- ▲ Generally, avoid the spring sap-flow period as the bark tends to be loose and more easily damaged. Although there is conflicting reports about the success of decay colonization at this time, you should generally avoid this season since wounding tends to increase along with wound size (all other things being equal).

Wound Dressings:

- ▲ Benefits are highly questionable. Most European studies (where they have used this) indicate that even dressings with systemic fungicides only offer up to one year protection, and even this protection is limited. Infections after a year in a German study indicated 40–70% infection. As these dressings crack and peel over time the entry for decay becomes even more easily facilitated.
- ▲ Generally treatment benefits do not outweigh treatment costs.
- ▲ Has been done for years in urban areas, but may be mostly for “window dressing” – the appearance of something protective.

Impact of wounding decay

Wounding and decay can cause or contribute to mortality

- ▲ lower tree vigour – much more susceptible to other damaging agents

Decay can significantly degrade log value

- ▲ decay associated with large wounds may double every 10 years – hemlock and true fir

Wound along may degrade value

- ▲ especially in butt logs



***Overhead:* Direct impact of wounds**

Facilitator:

Wounding can directly cause or contribute to mortality.

- ▲ It may lower tree vigour to the point where it is much more susceptible to other damaging agents (insects, disease, etc.).

Decay can significantly degrade log value.

- ▲ Beginning 3 years after injury, decay in hemlock and true firs can double every 10 years in wounds larger than 900 cm².
- ▲ Eight years after wounding, decay volumes in wounds larger than 900 cm² in Sitka spruce may double every 3 years.

Just the wound can degrade the butt log significantly.

- ▲ If the wound is severe enough. Remember, the butt log potentially has the highest value.

Minimum damage standards

Maximum individual scar size

- ▲ 400 cm² (20 cm x 20 cm), OR
- ▲ 1/3 tree circumference

Maximum cumulative scars per tree

- ▲ 900 cm²

Supporting root >2 cm

- ▲ no scars <100 cm from base of stem

Small scars

- ▲ no more than 10% of leave trees to have scars 400 cm²

Gouges

- ▲ no gouges on stem or major

Crown damage

- ▲ no reduction in crown mass of >25%



Overhead: Minimum damage standards

- ▲ What constitutes significant damage to a tree?

Facilitator:

As you can see, some damage will be viewed as insignificant, because of size, etc. The question then becomes “What will the Ministry view as significant or countable damage?”

These are considered faults in a thinning operation – they are summarized on page 46 in the *Commercial Thinning Guidebook*.

Minimum damage standards have been set to designate damaged trees as follows:

- ▲ Individual wound size should not exceed 400 cm² (20 × 20 cm) or be greater in width than 1/3 the circumference of the tree.
- ▲ Cumulative wound size per tree – applies to multiple scarring situations. Acceptable up to 900 cm².
- ▲ Wounding on a supporting root (>2 cm) should not occur less than 100 cm from the base of the stem (outside bark).
 - This includes a wound of any size (exposed xylem will qualify).
- ▲ Gouges (damage into the cambium) should not occur anywhere on the tree.
- ▲ Wounding (all types – including less than 400 cm) should not affect more than 10% of all leave trees.
- ▲ Live crown mass should not be decreased by more than 25%. This is a highly subjective ocular estimate.

Less than 10% of the crop trees with scars of less than 400 cm² – this is determined by surveying the entire stratum or block (see page 70 of the *Commercial Thinning Guidebook*).

Compliance inspections for stand damage



Target = Zero Damage



1. Visual inspection

- ▲ identify concentrations of damage
- ▲ absolute tally of all damaged

2. Inspection plots

- ▲ damage trees tallied in plots to determine leave trees

3. Determining compliance

- ▲ non-compliance will result when:

$$\text{acceptable leave trees/ha} - \text{damaged trees/ha are} < \text{minimum density of leave trees in SP}$$

Overhead: Compliance inspections for stand damage

Facilitator:

▲ The goal of the Ministry of Forests is to have “zero stand damage.” However, it is recognized that some logging damage is likely inevitable and often it will be insignificant relative to the ability of the stand to meet the management objectives set.

Procedure:

1. **Visual Assessment Method** – the inspector will walk through the area and identify any concentrations of damage (usually along skidtrails).

▲ These areas may be stratified out with an absolute assessment and tally of all damaged trees conducted.

2. **Formal Plots** – Stand damage will also be assessed as a percentage of the total trees in any formal inspection plots.

3. In your SP you will designate the minimum number of acceptable leave trees (trees with no faults). The way to determine if you have met the objective is by using the formula:

Acceptable leave trees/ha – damaged trees/ha > min density of leave trees specified in the SP (as per page 44 of the *Commercial Thinning Guidebook*). If this condition is met, you are within the tolerance identified in the prescription. If not, you are subject to an administrative penalty.



How do we make it work?

Small group exercise – 15 minutes

Consider:

- ▲ choice of equipment, operator, season, etc.
- ▲ preplanning – the SP, layout, logging plan, harvesting contracts, etc.
- ▲ harvesting operations
- ▲ monitoring

Overhead: How do we make it work?

Facilitator:

1. **Small Group Exercise:** Allow the participants in groups of three or four to consider the question in light of the various considerations and provide some suggestions (15 min).
2. Debrief the suggestions with the flip chart
3. **OPTION: IF TIME** – one group presents findings under each category.

Key Points:

Choice of equipment, operator, season of logging, etc.

- ▲ Equipment must match the site, the stand and the stand structural objectives in the prescription.
- ▲ Operators are professional too! Walking the ground before the layout (and even the development of the SP) may allow you and the operator to develop a strategy together to achieve your objectives.
- ▲ The operator must be made aware of all of your objectives and constraints (obligations for compliance under the Code).
- ▲ Choose an appropriate operator (if you have that flexibility). There is no room for highball operators in a partial cutting situation. Cautious, careful operators who are very concerned about quality of work are best suited for this work.
- ▲ Remember, most operators are used to clearcutting where production or the amount of wood in a landing was what counted at the end of the day. Now you must turn that focus around to the leave trees and the residual stand condition.
- ▲ Generally the best season will be outside of the spring sap-flow period, when ground conditions are suitable with respect to your soil conservation objectives. This will depend on the site and the equipment being used.
- ▲ Winter in the interior is often favoured to reduce impacts on soil. Remember however, that under very cold weather crown branches are quite brittle, breaking much more easily.

Pre-planning – the SP, layout and the logging plan

- ▲ The SP should state a range of densities that allow for some choices and damage.
- ▲ Trails and corridors should be spaced close enough to keep the stand damage low (although you must also consider soil conservation).
- ▲ Generally speaking, this spacing should be 20–40 m, depending on the equipment used (single-grip harvesters need 20 m spacing), and the stand (interior stands tend to have higher residual densities with smaller timber so trails tend to be closer together).
- ▲ As a general rule it is best to enter the stand for the fewest entries you can get away with, but this will also depend on your objectives.
 - Often due to windthrow hazard and or management objectives, you may have to open up the stand through several entries over time rather than one.
- ▲ Trails and/or corridors must be laid out to consider the equipment capabilities.
- ▲ Trails should be as straight as possible.
- ▲ Trails should converge or intersect at an angle.
- ▲ Designate rub trees along trails and corridors, marking them to be left until the end of the skidding or yarding operation.
- ▲ Yarding corridors should be established perpendicular to contours, with adequate deflection and length for good log control.

Falling and harvesting

- ▲ Directionally fall trees herringbone style to the skidtrail to facilitate easy winching.
- ▲ Fallers should watch for trees damaged during falling and substitute similar leave trees where damaged trees were supposed to be left.
- ▲ Fallers should maintain enough leave trees to remain significantly above the minimum leave tree density (but not over the maximum) to allow some extra leave trees to compensate for losses due to damage.
- ▲ Top, limb and buck to length at the stump.
- ▲ Where an unanticipated rub tree develops, leave it until the end of skidding on that trail.

- ▲ Where leave trees appear very vulnerable, use slash, logs, or artificial protection devices (tires, culverts, tires, rubber mats) to protect the bole and major roots from damage.
- ▲ Remove damaged trees along trails (or between trails) at the end of the skidding on that trail. This can become more difficult and costly along corridors in skyline operations as you must shut down the yarder while falling occurs.

Monitoring

- ▲ It is critical to specify clearly the expectations for densities of leave trees, and damage standards to the fallers during the pre-work conference at the start of the project.
- ▲ Walk a bit of the area and discuss strategies to reduce damage before the project starts.
- ▲ **Monitor very closely, especially inexperienced operators at the beginning of a project. Subsequent monitoring will depend on their performance. Make sure that the logger is consistently above the minimum allowed density to allow for some damage.**
- ▲ Walk all of the trails during the project to ensure that damaged trees are removed.