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Best Management Practices for Soil Conservation in Mountain Pine Beetle Salvage Operations

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Introduction

In December 2005, the Chief Forester released guidance on landscape- and stand-level structural retention in large-scale mountain pine beetle (MPB) salvage operations (Snetsinger 2005). Soil conservation was included in elements of that guidance, for instance:

- retain areas with live trees as a first priority in order to maximize the potential to move water from the soil through evapotranspiration
- maintain stand-level retention for the rotation [which addressed the fact that] these retention areas provide an important source of dead wood, standing and down structure, and intact forest floor, which assists with hydrologic stability and provides biodiversity and habitat value throughout the stand rotation—potentially "lifeboating" species until the newly regenerated stand matures sufficiently and provides higher levels of biological diversity.

However, this guidance did not directly address aspects of soil conservation within the cutblock, specifically with respect to the altered soil conditions resulting from MPB attack and how these soil conditions affect seasonal windows of operability.

Accordingly, this document provides additional guidance on harvest planning and operations in MPB salvage to conserve soil productivity. We summarize the factors affecting soils and operability that differ between the harvest of living and dead stands and provide specific guidance on how to avoid or minimize detrimental soil disturbance when harvesting MPB-affected stands.

Background and Issue

The MPB epidemic is changing British Columbia forests and watersheds at the landscape scale. Watersheds with pine-leading stands experience dramatic changes in their water balance when the pine dies (Winkler et al. 2008). Because they have little or no foliage or fine branches, stands of dead trees intercept less snow and therefore accumulate more snow on the ground than live stands (Boon 2007). Dead and dying trees also transpire less than live trees as physiological processes (other than those associated with decomposing organisms) have slowed or ceased. With less interception and evapotranspiration (evaporation and transpiration), more precipitation reaches the forest soil and less water is removed from it. The soils under stands of dead trees are, therefore, generally wetter than soils under stands of live trees through much of the snow-free season.

This is similar to the situation in recent cutblocks during normal forest operations, where soils are generally wetter than in uncut forests (Spittlehouse 2007). In both cutblocks and MPB-killed stands, wetter soil conditions persist until the growing vegetation begins to make significant contributions to evapotranspiration. However, in stark contrast to normal forest operations, because the wetter soil conditions pre-date timber harvesting, they can therefore dramatically affect operability.

Wet soils are more susceptible than dry soils to soil disturbance, especially soil compaction, rutting, and puddling. Some forest licensees have reported that during months when ground-based forestry operations could normally proceed with few constraints, dry, firm soil (typical of summer ground) has been replaced by wetter, less firm soil (once usually restricted to winter operations). This makes the operation of ground equipment more difficult or impossible until sufficient snowfall or freeze-up renders the ground firm enough to be operable.

Rex and Dubé (2008) are studying the hydrologic effects of MPB infestation on soil water conditions and are developing a risk-based assessment model for predicting which areas are most likely to be too wet for normal summer operations. They have determined that the most effective indicators for predicting the risk of wet ground at the watershed level are overstorey lodgepole pine percent composition and mortality, amount of understorey, density of drainage and topography, and sensitivity of soils.

Percent composition of lodgepole pine (and of other tree species that are not susceptible to the beetle and therefore not killed) determines how much living overstorey remains. The amount of living overstorey directly affects the amount of interception and evapotranspiration and the subsequent soil water content. Similarly, the amount of live understorey, including advanced regeneration and other vegetation, contributes to the total amount of living vegetation and therefore the amount of evapotranspiration and the resulting soil water content.

Density of drainage and topography refers to the number of surface channels and the watershed slope gradient and length. These factors directly relate to how quickly surface and subsurface water is removed from a site and from the soil. Toe-receiving areas, for instance, are often wet, so salvage operations and site preparation activities on them should be avoided during spring, summer, and fall months.

Sensitivity of soils refers to soil properties that affect internal soil drainage, such as soil texture and structure. Increasing sand and gravel content means that soils generally drain more quickly. However, soil disturbance can occur on all soil textures if conditions are unsuitable for ground-based harvesting.

In general, the sites at greatest risk of being wetter than expected and therefore of the soil being detrimentally disturbed if harvested at any time except under snowpack are lodgepole pine dominated with little understorey, in gently sloping or flat receiving (toe-slope) positions, and on fine- to medium-textured soils.

Season of operation and precipitation are also critical factors. Frozen ground or sufficiently deep snowpacks (Curran 1999) protect the soil from harvesting disturbance. Because such conditions are now more rarely seen in most of the province, the operating window for conventional logging is therefore reduced. Snowmelt and rain events make the soil wetter and more at risk of harvesting disturbance.

Guidance for Soil Conservation Planning and Operations

Operations planning is essential to logging success. It will determine how the harvesting system can match site sensitivity by recognizing inherent soil constraints to salvage logging. Guidance on selecting strategies to minimize soil disturbance during MPB salvage essentially fall into one of the four groupings outlined by Lewis and Timber Harvesting Subcommittee (1991): scheduling and season of harvest; choice of equipment; on-the-ground strategies; and rehabilitation options.

Scheduling and season of harvest

1. Plan operations, including time of harvest, based on the sensitivities of all soils in the harvest unit regardless of the size of the standard unit against which excessive soil disturbance is measured. Even in areas of apparent uniform sensitivity, small wet drainages and draws should be recognized and avoided so that natural surface drainage patterns are not impeded. Consider soil moisture conditions at the time of harvest because of continuous changes in soil water conditions within MPB areas as trees die, road networks increase, and areas of salvage logging increase. Consider harvesting low-sensitivity soils in wetter periods and the most sensitive soils only once the soil dries or in winter under sufficient snowpack.
2. Focus harvesting on winter months but do not extend past spring

shutdown (snowmelt and beyond) when soils are saturated and easily disturbed. Soils in the Interior are generally unfrozen under a snowpack (warm wet snow, if deep enough, is the most protective of the soil), and during periods of low snowpack, wet, unfrozen soils will be highly susceptible to soil disturbance.

3. Avoid spring and wet summer or fall harvesting, especially on toe-slope positions and in wetter (sub-hygric to hygric) sites or portions of a harvesting unit. This includes sites where soils have restricting layers that can impede drainage. When salvage logging must be hurried under these conditions, pre-harvest activities such as forest drainage could be carried out to reduce soil moisture. Drainage is not a panacea, and the potentially negative long-term impacts of altering natural drainage of a site must be weighed against the possible short-term benefits of improved operability. In drier areas of the province, including the Southern Interior, wet soils may not be a concern under normal summer and fall precipitation, except on the most sensitive sites.
4. Early identification of green-attack stands, especially those without advanced regeneration, reduces the risk of on-site moisture problems because harvesting can be carried out before the stand dies.
5. When harvesting red- and grey-attack trees, take the time to let the soils properly dry before beginning ground-based harvesting because soils take longer to drain excess moisture under dead stands.

Choice of equipment

6. If harvesting under unfavourable soil moisture conditions is unavoidable, consider using innovative or non-conventional harvesting strategies (e.g., hoe chucking, designated trails, or low ground pressure equipment).

On-the-ground strategies

7. When harvesting during the snow-free season, weather-related shut-down may need to occur more rapidly than normal because of higher soil moisture contents.
8. Retain areas with live trees as a first priority in order to maximize the potential to remove water from the soil through evapotranspiration.
9. Retain advanced regeneration and understorey vegetation during salvage operations whenever practicable to maximize the potential to remove water from the soil through evapotranspiration.
10. During the growing season, do not cut trees too far in advance of skidding and bucking. This ensures that any live trees continue to transpire and reduce soil moisture levels until immediately before skidding, the most risky ground-based operation.
11. Construct, inspect, and maintain roads to ensure that natural surface and shallow subsurface drainage remain intact both during and after salvage (Winkler et al. 2008).
12. Upgrade drainage networks on permanent roads before salvage logging as necessary to accommodate expected increases in peak flows (Winkler et al. 2008).

Rehabilitation options

13. Plan for rehabilitation of main trails, roadside work areas, and so on if high soil moisture contents during harvesting are expected. Causing soil disturbance that must be rehabilitated is a less desired approach than delaying harvest until the soil dries. When a disturbed area requires rehabilitation, soil moisture conditions at the time of rehabilitation will be an important consideration for success. Soils that respond well to treatment in dry conditions may be further damaged if treated when too wet.

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