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Cording to reduce soil disturbance during timber harvesting

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Background

Soil is much more than particles of sand, clay and silt. In addition to these mineral particles soil consists of organic matter, humus, air, and water. Approximately half of the soil volume is pore space which is filled with air and water and occupied by fine roots, fungal hyphae, bacteria, soil microbes and larger organisms such as insects and earthworms. Soil pores are vital to the physical, biological and chemical processes that maintain soil fertility.

Heavy machinery used in timber harvesting can cause compaction of forest soils which damages soil structure and reduces soil pore space. In the jarrah forest compaction across the harvested area may persist for more than 55 years after timber harvesting. The loss of soil pore space adversely affects soil processes, such as the infiltration and drainage of water in the soil, and soil respiration - the exchange of gases between the soil and atmosphere. These processes are active in soil nutrient cycling. Damaging the soil and soil processes fundamentally threatens the soil vitality which underpins forest health. This impact has been measured in the karri forest where compaction on major extraction tracks used in harvesting mature karri stands caused severe localised suppression of karri regrowth.

Severe soil rutting and compaction caused by machinery operating in wet conditions

The compaction of soil is usually exacerbated by soil moisture, which reduces soil strength and acts like a lubricant, assisting the movement of soil particles past one another. For this reason, timber harvesting in the jarrah and karri forest of WA is restricted to dryer periods defined by the soil trafficability index (TI_{SDI}), a variant of the Soil Dryness Index (SDI). During the higher risk periods, operations that use heavy machinery for log extraction must cease unless special approval is provided. The advent of these restrictions , specified in the Forest Management Plan 2004 – 2013, reduced the period of the year available for timber harvesting.

Cording with unmerchantable material can be used to reduce soil damage during harvesting

Cording or corduroy, is round or split log material that is closely and continuously laid across the extraction tracks (a.k.a. snig tracks) or placed across landings to distribute the machine load over a larger area and reduce soil compaction, mixing, and rutting. Cording was studied as a means of reducing soil disturbance so that harvesting could be extended into the higher risk periods of the year when soils are moist. This study also examined the effects that the gravel content of the soil, and the weight of logs removed from the stand, had on soil compaction.

Findings

1. Timber harvesting under moist soil conditions caused significant compaction of surface soil on primary and secondary extraction tracks.
2. Soil compaction was moderated by the pre-harvest bulk density of the soil (dry soil weight per volume). Soils that were already partly compacted or soils that naturally had an elevated bulk density were more resistant to further compaction than soils that had a low bulk density.
3. Soil compaction was significantly related to the total load of timber hauled over the extraction tracks. Compaction increased as the cumulative load of timber hauled over the track increased.
4. The gravel content of the soil affects the compactability of the soil. Soils with high gravel content were more resistant to compaction than soils with low gravel content. However soil gravel was ineffective at reducing soil compaction in soils with low bulk densities (less than about 0.55 g cm^{-3}), and was most effective at reducing the compaction of soils with moderate to high bulk densities (i.e. bulk densities greater than about 0.7 g cm^{-3}).
5. Cording disperses the load of heavy machinery over an area larger than the footprint of the machine - significantly reducing compaction under the wheels but slightly increasing compaction between the wheels. The resulting nett decrease in severity of compaction was seen as beneficial despite the increased extent. The reduction in severity of soil compaction provided by cording was statistically significant but small; consequently the cost and the potential negative environmental impacts of routinely cording during timber harvesting on moist soil must be weighed against the benefits of cording.
6. Cording provided a substantial reduction in rutting and associated soil mixing. This reduction in rutting and soil mixing is a major benefit of cording, particularly in karri harvesting, and is a substantial improvement over winter harvesting operations in karri where cording was not used.
7. Soil texture and variations in soil moisture content were not accounted for in this study and it is known that both of these factors influence the compactability of soils. Fine textured soils (those with high clay content) are prone to compaction, and compactability generally increases as soil moisture content increases.

Management Implications

Maintaining the biological and chemical processes that underpin soil health is fundamental to sustaining forest productivity and the wider ecosystem processes that are supported by soil. Soil compaction, which impacts soil processes by reducing pore space, is a potential threat to the ecosystem function and productive capacity of forests. Consistent attention to operating standards is required to minimise the impact of this disturbance during timber harvesting.

- Cording can be used to reduce the severity of soil compaction during timber harvesting under moist soil conditions. The cost and negative environmental impacts of routinely cording during timber harvesting on moist soil must be weighed against the benefits of cording.
- All traffic by heavy machinery produces some soil compaction. Focusing all traffic onto as few tracks as possible minimises the area compacted by heavy machinery. Landings should be as small as practical. Old extraction tracks, old landings and other areas that have previously been compacted should be re-used wherever possible.
- Soils with high gravel content resist compaction, particularly when these soils have moderate to high bulk density. Harvesting operations conducted under moist soil conditions should target these soils with moderate to high bulk density. Soils with low bulk density should not be trafficked when the soil is moist, regardless of their gravel content.

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