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Soil Compaction on Forest Plantations following Cattle Use

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Introduction

Grazing cattle on forest plantations in the interior of British Columbia is a common practice. Soil compaction can occur following cattle use, although this may vary with stocking rate, vegetation type and age, soil type, soil water content, and climate. Several studies have shown that increased soil compaction can have a negative impact on growth of young tree seedlings and on productivity in older

plantations. These negative impacts result from restricted root development, reduced water and nutrient availability, and reduced soil aeration.

This study evaluated the effects of cattle grazing and domestic forage seeding on soil bulk density and soil penetration resistance (pr) in lodgepole pine plantations in the Montane Spruce very dry cool biogeoclimatic subzone. The study was replicated on three sites near Kamloops, B.C.



figure 1 *Forest grazing near Helmer Lake, BC.*



figure 2 Bulk density corer.



figure 3 Seeded cutblocks support greater numbers of cattle and therefore have greater potential for soil compaction damage.

Methods

The two Tunkwa Lake sites were harvested in November 1986 and were windrowed, burned, and drag-scarified during November 1987. The majority of the Helmer Lake site was harvested in 1985, with an additional 10 ha harvested in October 1987. The Helmer site was rough-piled and track-and-blade-scarified, and the piles were burnt after the first snowfall.

All sites were aerially seeded in May 1988 to a forage seed mix of 35% orchardgrass, 5% timothy, 40% alsike clover, and 20% white Dutch clover. Seed was applied at a rate of 12 kg/ha and equal areas were left unseeded. One-year-old container-grown lodgepole pine seedlings were then planted at a density of 1400 stems/ha. The sites were fenced into 5-ha pastures.

Grazing was initiated in 1989, the year following planting, and has continued for eight years. Grazing was applied at 50% forage use, and a 0.5-ha exclosure was maintained as a control. The grazing period was kept constant at about 30 days. Cattle numbers were modified, depending on forage availability in each year, to achieve 50% use of forage.

The soils are generally Melanic Brunisols, with Luvisols occurring in mesic areas. The soil attributes at the sites (Table 1) suggest a moderate to high hazard rating for soil compaction and puddling (B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks 1995). Soil bulk density and soil penetration resistance were determined in 1996 and 1997, both before and after the 1-month grazing period.

table 1 Soil attributes at the Tunkwa Lake and Helmer Lake sites

	Texture	Coarse fragments (% vol.)	Organic matter content (t/ha)	Moisture regime	Soil compaction hazard rating
Helmer Lake	loam	22	21	Xeric subhygric	high
Tunkwa Lake-1	sandy loam	14	19	Xeric subhygric	moderate
Tunkwa Lake-2	loam	20	22	Xeric subhygric	high

Soil Bulk Density

One month of grazing at an average cattle stocking rate of 0.69 AUM/ha was not sufficient to produce significant changes in soil bulk density. However, pastures grazed for eight years (one month each year since 1989) had higher soil bulk density than ungrazed exclosures (Figure 4).

Eight years of cattle grazing has slightly increased soil bulk density by 6% relative to the ungrazed exclosures.

Pastures seeded to domestic forage species had greater soil bulk density than unseeded pastures (Figure 4). This was due to the higher number of cattle used to achieve 50% use of total forage on seeded than on unseeded

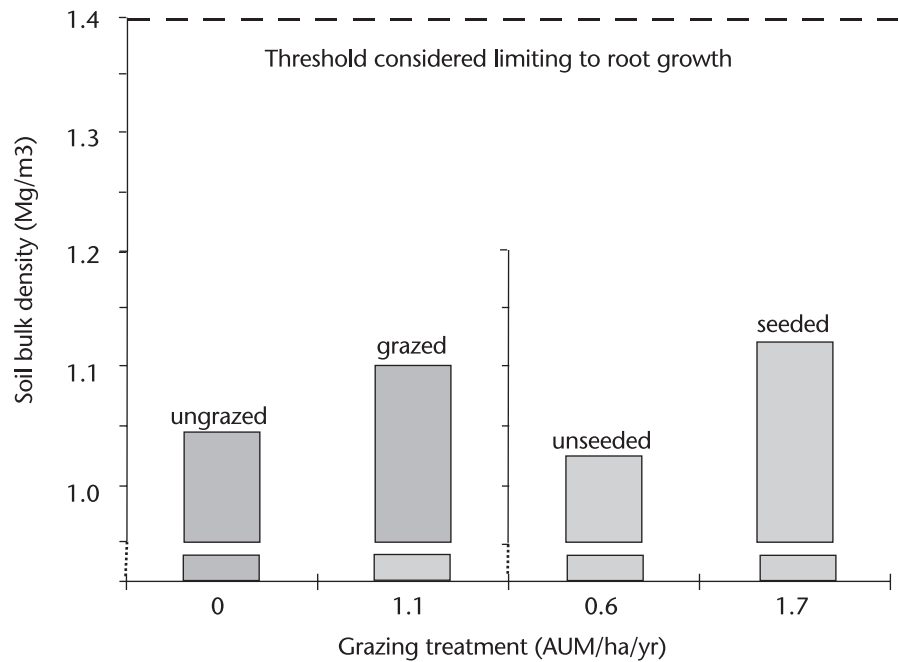


figure 4 Soil bulk density following cattle grazing at 0, 0.6, 1.1, and 1.7 AUM/ha/yr for 8 years at the Tunkwa Lake and Helmer Lake sites.



figure 5 Compaction problems are usually localized on trails and on salting and watering areas. (Photo taken at Poplar Lake, Smithers.)

pastures. Seeded pastures supported greater numbers of cattle due to increased forage production.

The soil bulk densities obtained in the grazed pastures during this study were well below the root-limiting critical range reported in other studies.

Soil Penetration Resistance

Eight years of grazing clearly increased soil penetration resistance relative to the ungrazed enclosure throughout most of the soil profile (Figure 6). Soil pr was always lower in the ungrazed

figure 6 Soil penetration resistance on seeded pastures grazed at 1.7 AUM/ha/yr for eight years.

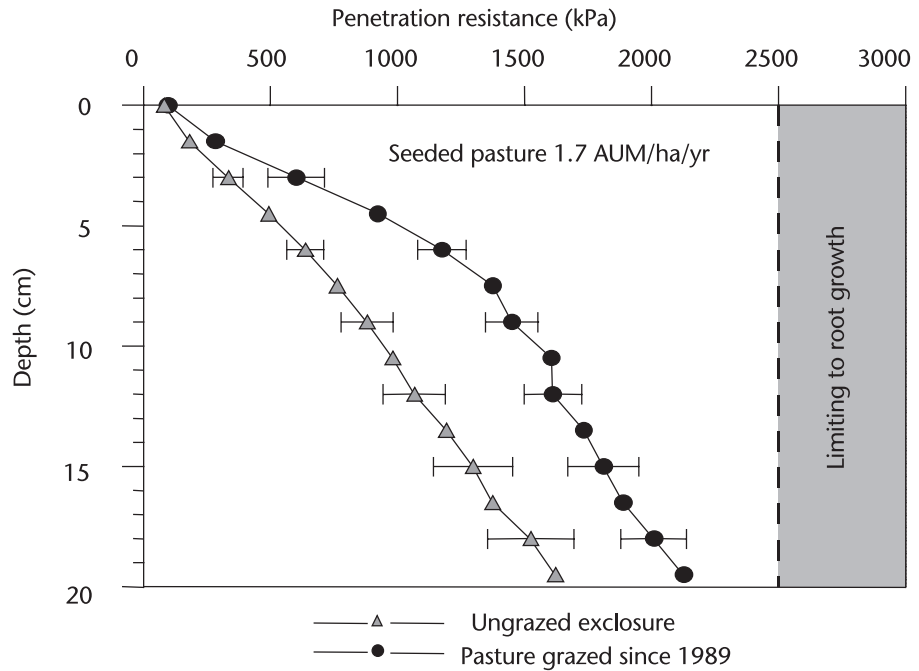


figure 7 Moderate cattle use on plantations with moderate or high soil compaction hazard ratings does not result in negative impacts on tree growth.



figure 8 Penetrometer.

control. In general, soil pr readings in the grazed pastures at most depths were not above the levels reported as thresholds of root-restricting conditions.

Summary

Eight years of cattle grazing increased bulk density by 6% relative to the ungrazed exclosures. Similarly, soil pr is also higher on pastures grazed since 1989 than on ungrazed exclosures. This effect was consistent when measured both before and after the 1-month grazing period and throughout the top portion of the soil profile.

Although it was expected that seeding domestic forages would have an ameliorating effect on soil compaction, this was observed only in ungrazed exclosures. The higher number of cattle used to achieve 50% use of total forage on seeded than on unseeded pastures resulted in greater soil bulk density.

Conclusions

Bulk density and pr data observed in this study were well below the critical ranges considered to be limiting to root growth (1.4 Mg/m³ and 2500 kPa, respectively). It is unlikely that long-term cattle grazing at stocking rates from 0.6 to 1.7 AUM/ha/yr will lead to root-limiting levels in soil compaction on forest plantations with moderate to high soil compaction hazard ratings.

References

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