Effects of grazing on soil compaction and water infiltration in forest plantations in the Interior of British Columbia

KLAAS BROERSMA[*], MAJA KRZIC[†], REG NEWMAN[‡], AND ARTHUR BOMKE[†]

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 effect on the growth of young tree seedlings and on productivity in older plantations. These negative effects 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 in lodgepole pine plantations in the Montane Spruce very dry cool biogeoclimatic subzone. The study was replicated on three sites near Kamloops, B.C.

MATERIALS AND 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 Lake site was rough-piled and track-and-blade-scarified, and the piles were burned after the first snowfall.

All sites were aerially seeded in May 1988 to a forage seed mix of 35% orchardgrass (*Dactylis glomerata* L.), 5% timothy (*Phleum pratense* L.), 40% alsike clover (*Trifolium hybridum* L.), and 20% white clover (*Trifolium repens* L.) by weight. Seed was applied at a rate of 12 kg per hectare and equal areas were left unseeded. One-year-old, container-grown lodgepole pine (*Pinus contorta* Dougl. ex Loud. var. *latifolia* Engelm. ex S. Wats.) seedlings were then planted at a density of 1400 stems per hectare. The sites were fenced into 5-ha pastures.

Grazing was initiated in 1989, the year following planting, and has continued for 8 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 suggest a moderate to high hazard rating for soil compaction and puddling (B.C. Ministry of

Citation —

Broersma, K., M. Krzic, R.F. Newman, and A.A. Bomke. 2000. Effects of grazing on soil compaction and water infiltration in forest plantations in the Interior of British Columbia. *In* Proceedings, From science to management and back: a science forum for southern interior ecosystems of British Columbia. C. Hollstedt, K. Sutherland, and T. Innes (editors). Southern Interior Forest Extension and Research Partnership, Kamloops, B.C., pp. 89–92.

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. Water infiltration rates were measured in 1997 after the 1-month grazing period.

RESULTS AND DISCUSSION

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 8 years (1 month each year since 1989) had higher soil bulk density than ungrazed exclosures (Figure 1). 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 1). This was due to the higher number of cattle used to achieve 50% use of total forage on the seeded compared with the unseeded pastures. Seeded pastures supported greater numbers of cattle because of the 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 exclosure throughout most of the soil profile (Figure 2). Soil penetration resistance was always lower in the ungrazed control. In general, soil penetration resistance readings in the grazed pastures at most depths were not above the levels reported as thresholds of root-restricting conditions.

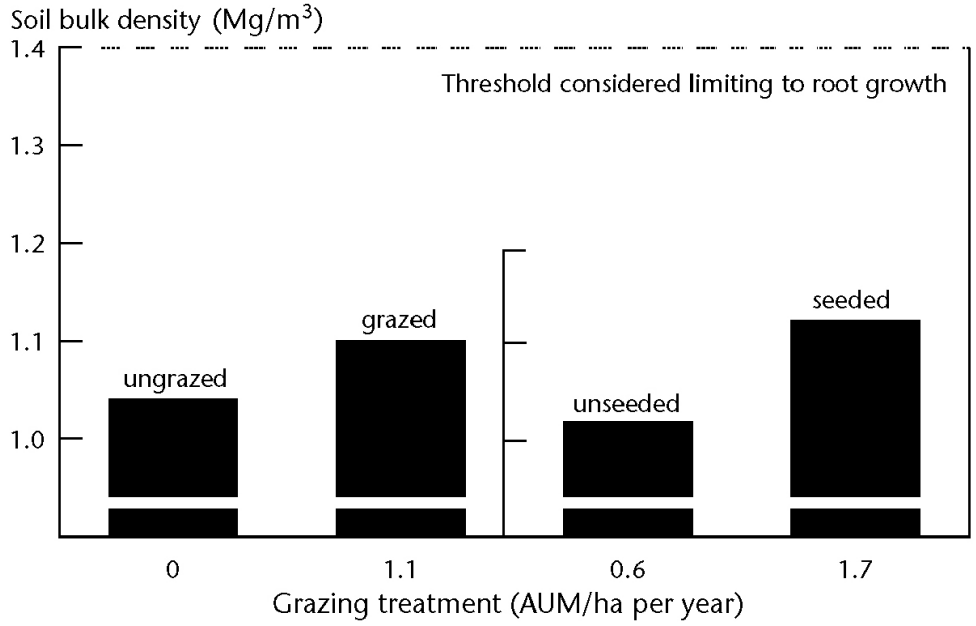

FIGURE 1 *Soil bulk density following cattle grazing for 8 years.*

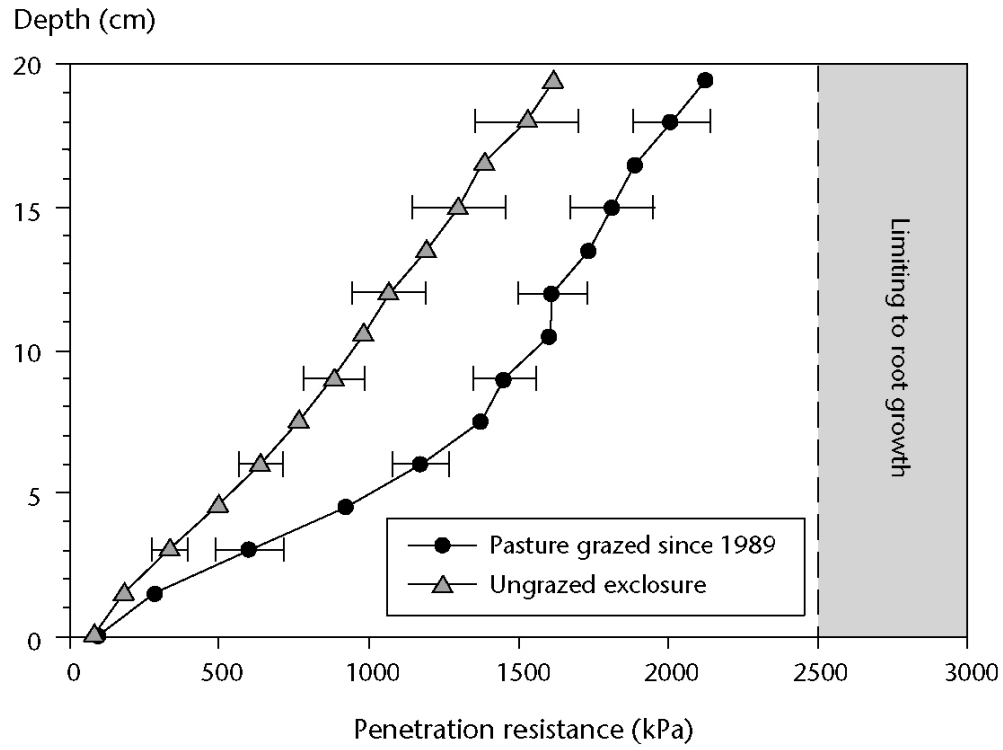

FIGURE 2 *Soil penetration resistance on seeded pastures grazed at 1.7 AUM/ha per year for* 8 *years.*

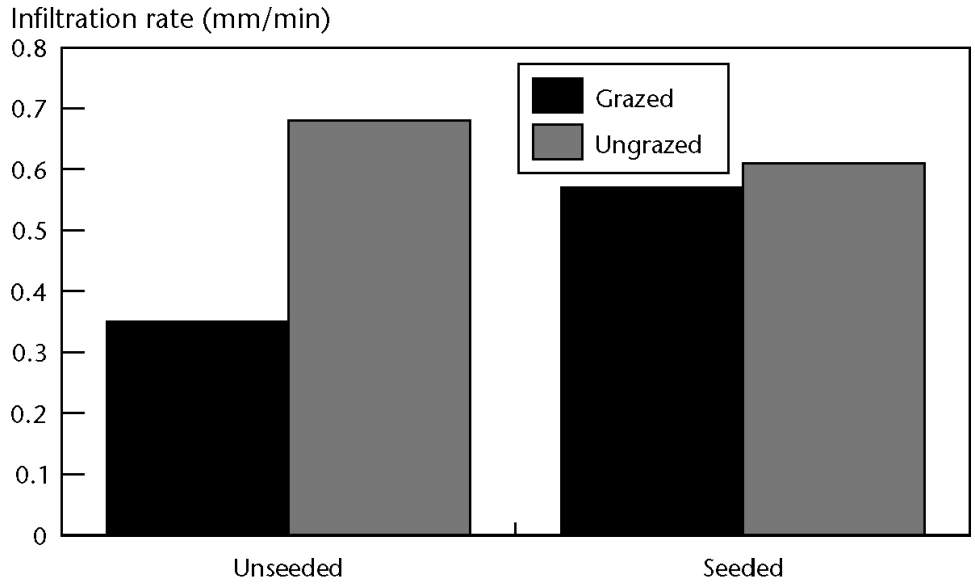

FIGURE 3 *Rate of water infiltration following long-term grazing and seeding to domestic forage species.*

Water Infiltration

Long-term grazing and forage seeding did not affect the rate of water infiltration (Figure 3).

SUMMARY AND CONCLUSIONS

Eight years of cattle grazing increased bulk density by 6% relative to the ungrazed exclosures. Similarly, soil penetration resistance 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 compared to unseeded pastures resulted in greater soil bulk density.

Bulk density and penetration resistance data obtained in this study were well below the critical ranges considered as limiting to root growth (1.4 Mg/m^3 and 2500 kPa, respectively). It is unlikely that long-term cattle grazing at stocking rates from 0.6 to 1.7 AUM/ha per year will lead to root-limiting levels in soil compaction on forest plantations with moderate to high soil compaction hazard ratings.

ACKNOWLEDGEMENTS

Support for this project has been provided by Ainsworth Lumber (1987) Ltd., Savona, B.C.; Aspen Planers Ltd., Merritt, B.C.; Indian Gardens Ranch Ltd., Savona, B.C.; Gardens Creek Ranch Ltd., Savona, B.C.; and Guichon Cattle Co. Ltd., Quilchena, B.C. Financial assistance for this project was provided by Forest Renewal B.C.

REFERENCES

British Columbia Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1995. Hazard assessment keys for evaluating site sensitivity to soil degrading processes guidebook. Forest Practices Code. Victoria, B.C.

AUTHORS

* ***Correspondence to:*** **Klaas Broersma**, Agriculture and Agri-Food Canada, 3015 Ord Road, Kamloops, BC V2B 8A9.

E-mail: broersmak@em.agr.ca

† University of British Columbia

‡ B.C. Ministry of Forests, Research Branch