

“Earth and sky, woods and fields, lakes and rivers, the mountain and the sea, are excellent schoolmasters and teach some of us more than we can ever learn from books.”

– John Lubbock

PREVIEW

“The period of greatest gain in knowledge and experience is the most difficult period in one’s life.”

– Dalai Lama

PREVIEW

University of Alberta

Interactions between Cattle Grazing and Forestry on Alberta's Public Lands

by

Jillian Kaufmann

A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Science

in

Rangeland and Wildlife Resources

Department of Agricultural, Food and Nutritional Science

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PREVIEW

This thesis is dedicated to the rancher, who despite pressures of urban encroachment, corporate takeover, policy changes, and lobbyist demands, remains a true keeper of the land and provider of wholesome food.

Abstract

The integration of cattle grazing and timber production on forested lands has become a significant resource management issue on Alberta public lands where there is demand to satisfy both uses. This innovative project examined interactions between cattle grazing and forestry operations within rangelands containing recently harvested deciduous and coniferous cut blocks of west-central and south-western Alberta during 2008 and 2009. Two and 3 years following logging, cattle avoided regenerating deciduous and coniferous cut blocks. Cattle forage use was positively associated with greater forage biomass, crude protein concentration, and distance to roads, but was negatively associated with increasing distance to water, and greater elevation, slope gradient, slash accumulation and tree regeneration densities. Cattle-related damage to trees was minimal, yet reflective of stocking rate. Results confirm that cut block reforestation can occur despite cattle presence given sustainable grazing management.

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List of Symbols and Abbreviations

-2 LL – Negative 2 Log Likelihood

AFPA – Alberta Forest Products Association

ADF – Acid Detergent Fibre

AIC – Akaike Information Criterion

AIC_c – Akaike Information Criterion Corrected for Small Sample Size

AIC_{c_i} – Akaike Information Criterion Score for Candidate Model

AIC_{c_{min}} – Minimum Akaike Information Criterion Score

ΔAIC_c – Change in Akaike Information Criterion Score

ANOVA – Analysis of Variance

ASRD – Alberta Sustainable Resource Development

ATS – Advanced Telemetry Systems

AUM – Animal Unit Month

AUM/ha – Animal Unit Month per Hectare (Stocking Rate)

β – Beta Coefficient

C – Carbon

°C – Degrees Celsius

Ca - Calcium

cm – Centimetre

CEC – Cation Exchange Capacity

CP – Crude Protein

DEM – Digital Elevation Model

DU – Distribution Unit

Exp - Exponent

FMA – Forest Management Agreement

GIS - Geographic Information System

GPS – Global Positioning System

Ha – Hectare

K – Number of Parameters

Kg/ha – Kilograms per Hectare

LRT – Likelihood Ratio Test

m – Metre

n – Sample Size

N – Nitrogen

NDF – Neutral Detergent Fibre

PDOP – Positional Dilution of Precision

Proc GLIMMIX – General Linear Mixed Model Statistical Procedure

Proc GLM – General Linear Model Statistical Procedure

Proc MIXED – Mixed Model Statistical Procedure

Proc REG – Regression Statistical Procedure

Proc TTEST – T-test Statistical Procedure

Proc UNIVARIATE – Univariate Statistical Procedure

r – correlation coefficient

R² – Regression goodness of fit measure

RMFR – Rocky Mountain Forest Reserve

RSF – Resource Selection Function

RSPF – Resource Selection Probability Function

SE – Standard Error

Spp - Species

TOL - Tolerance

UTM – Universal Transverse Mercator

VIF – Variance Inflation Factor

ω_i – Model Probability

PREVIEW

1. Integrating Livestock Grazing and Timber Production on Public Land

1.1. Introduction

Alberta Sustainable Resource Development (ASRD) employs and promotes an integrated resource management approach to balance multiple expectations and demands relating to a single land base. Alberta's forested crown lands support several resource uses including timber production, livestock grazing, recreation, and mineral extraction. At times, vested interests associated with forest use conflict due to the sacrifice of one resource for the gain of another (Willoughby 1995). Such can be the case with the integration of cattle grazing and timber production on forested public lands (Clary et al. 1975; Krzic et al. 2001, 2003, 2004).

Forest and livestock industries have a long history in Alberta and are valued contributors to the provincial economy. As of July 1st 2009, Alberta's cattle herd totalled nearly 5.9 million head (Statistics Canada 2009). Pasture for approximately 14 % of these animals is provided by provincial public rangelands, which supplies more than 1.6 million animal unit months (AUMs) of forage and generates over \$4 million in grazing revenue, each year (ASRD 2003). Approximately 2.4 million ha of public land support grazing dispositions in the form of leases and licenses. Long term leases make up the majority of public grazing land in Alberta, while a small portion of grazing licences are granted to cattle producers operating in forested areas that simultaneously support timber production, an area referred to as the green area. Large grazing allotments within the Rocky Mountain Forest Reserve (RMFR) of south western Alberta provide 0.8 million ha of public rangeland. Grazing on public land within the green area is administered under the *Public Lands Act*, while the Rocky Mountain Forest Reserves are managed under the *Forest Reserves Act*.

Alberta's Grazing Lease Stewardship Code of Practice (ASRD 2007) provides leaseholders with guidelines on how to meet provincial expectations for maintaining rangeland ecological health and functionality. Lessees are required to set stocking rates at a sustainable level (25-50% use), manage for appropriate timing, frequency and

duration of grazing, preserve wildlife habitat and watersheds, and accommodate industrial and recreational use of the land. Failure to meet these commitments upon field inspection will result in penalties, or in extreme cases loss of grazing rights.

Forests occupy 57% of the provincial land base or approximately 38 million ha throughout Alberta (ASRD 2009a). In 2007, primary and secondary forest industries in 50 Alberta communities employed a total of 44,000 full time equivalents and generated nearly \$11 billion in revenue, making forestry the third largest economic sector in the province (Alberta Forest Products Association [AFPA] and ASRD 2008).

Forest companies are granted dispositions including timber permits, licences, quotas, and forest management agreements (FMA) issued by the government under the *Forests Act* (ASRD 2001). FMAs represent large tracts of land within the green area that are managed by forest companies, making them accountable for establishing, growing, and harvesting timber using environmentally sustainable practices (ASRD 2001). The development of detailed forest management plans outlining when, where and how trees are harvested and regenerated, along with how other land uses will be accommodated, is a requirement for FMA holders. Forest management plans address social, economic, and ecological aspects of timber production. All forest companies must adhere to timber harvesting planning and operating ground rules relating to harvesting operations, reforestation, watershed, wildlife and fisheries conservation, soil disturbance and erosion, and the consideration of other land uses including grazing.

Less than 1% of Alberta forests are harvested each year to allow timber growth to surpass the amount of forest resources removed. For example, annual growth of crown forests was assessed at 44.5 million m³ in 2007, while the actual amount of wood harvested did not exceed 23 million m³ (AFPA and ASRD 2008); the total annual allowable cut deemed sustainable for the province was determined to be slightly greater than 27 million m³.

Reforestation following harvest has been mandated since 1966, when Alberta was the first province to institute this law (ASRD 2009a). Timber companies are required to reforest harvested areas within 2 years following logging and must report their

regeneration status to be audited by ASRD. Tree establishment and performance surveys are conducted based on procedures listed in the *Regeneration Survey Manual* (ASRD 2008). Establishment surveys are performed 3 to 8 years following harvest and determine whether logged areas are sufficiently stocked and evenly distributed with suitable trees (ASRD 2009a). In the case of inadequate regeneration, amendments to reforestation are required within one year. Performance surveys are done 8 to 14 years following timber removal and assess tree growth (ASRD 2009a); where unsatisfactory, future harvest levels are reduced to account for the lack of production.

Stocking is the key measure used to assess reforestation and is calculated as the proportion of plots (within a grid layout) containing trees of acceptable height, form and vigour (ASRD 2009a). Reforestation is considered successful if stocking meets or exceeds 80%, corresponding to an average of 5700 trees per ha. During the 2007-08 reporting year, 92% of cut blocks surveyed had greater than 80% stocking (ASRD 2009a). Stocking values have progressively increased, suggesting reforestation practices have become more successful with the application of improved knowledge and technology.

In 2003, ASRD was approached by the beef and forest industries to discuss respective issues and opportunities associated with overlapping grazing and timber dispositions on Alberta's crown forests. Alberta ranchers expressed concern over the potential negative outcomes of timber harvest, such as altered vegetation composition and production, decreased forage accessibility due to slash accumulation, and compromise of their implemented grazing systems and infrastructure (Newman et al. 1994; Krzic et al. 2004). Any factor limiting forage production or availability may have a negative impact on cattle stocking rates and production efficiency for ranchers.

Similarly, timber producers were apprehensive about the potential effects of cattle grazing on forest regeneration. From a forest management perspective, the timing, duration, intensity, and frequency of livestock grazing can all have detrimental effects on the regeneration success of tree seedlings (Allen and Bartolome 1989; Pitt et al. 1998; Irving 2001; Dockrill et al. 2004). High levels of browsing, trampling and soil compaction caused by livestock have been associated with conifer seedling mortality