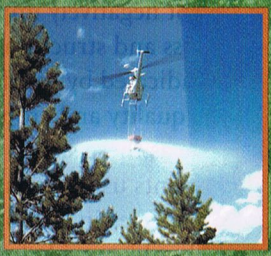
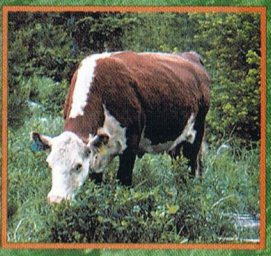
Incremental Silviculture of Lodgepole Pine

Crop Tree Productivity
Stand Structure and Vegetation
Wildlife Habitat
Range Forage





Introduction

Managing and conserving forests for biological diversity has become a major objective for forested landscapes in North America. This objective may be achieved by a combination of practices that provide a variety of forest successional stages (including old-growth), tree species, stand structures and silvicultural treatments in a mosaic of habitats across a landscape. Perhaps the greatest opportunity to diversify forests lies in the vast areas of young second-growth lodgepole pine stands which are amenable to silvicultural practices that accelerate ecosystem development.

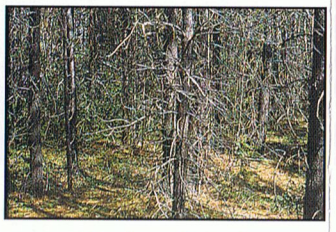
This brochure reports on two ongoing studies:
A – Ten-year results in pre-commercially thinned stands; and B – Five-year results in thinned and fertilized stands.

Study A – Thinned Stands of Lodgepole Pine

Young lodgepole pine stands are currently thinned to within a narrow range of densities in pre-commercial thinning programs (typically 1400 to 1600 stems/ha). Thinning can dramatically alter stand structure and the rate and direction of ecological succession. Hence, diversification of thinning prescriptions could have profound implications for wildlife habitat and biological diversity.

Low density stands can create early successional stages of herb and shrub layers. This provides forage and cover for several wildlife species. In addition, open-grown crop trees can simulate late seral and old-growth conditions. These stands are tailored to large diameter timber and quality products.

Stands of higher density provide important thermal, security and nesting cover for wildlife. Thickets and patches of dense pine provide important habitat for many fur-bearing species and their prey. These stands are well suited for wood volume production (construction lumber).



Unthinned stand

Study A tested the hypotheses that large-scale stand thinning over a range of densities would:

- enhance productivity and old-growth structural features of lodgepole pine
- enhance stand structure attributes
- as a measure of habitat diversity, enhance species richness and diversity of small mammal communities.

Study areas were located near Penticton, Kamloops and Prince George. Each study area had stands thinned to ~500 (low), 1000 (medium), and 2000 (high) stems/ha in 1988, with an unthinned juvenile and old-growth pine stand for comparison. The low-density stands were pruned (3 m lift) in 1992. Stand ages in 1988 were 17 years (Penticton), 23–27 years (Kamloops), and 15–20 years (Prince George).

Pre-commercially Thinned Lodgepole Pine Stands

500 stems/ha – 1988

Ten years later – 1998

1000 stems/ha – 1988

Ten years later – 1998

2000 stems/ha – 1988

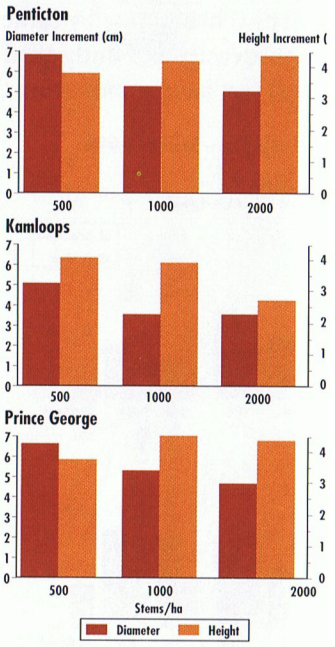
Ten years later – 1998

Old-growth Pine Stand

Growth and Structure

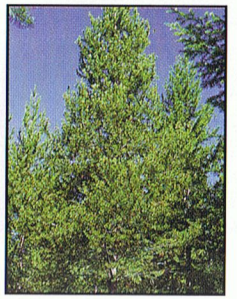
Diameter and Height

- Mean diameter increment highest in low-density stands.
- Mean height increment similar in medium and high-density stands and both higher than low-density stands at Penticton and Prince George.
- Mean height increment similar in low- and medium-density stands, but higher than that in high-density stand at Kamloops.

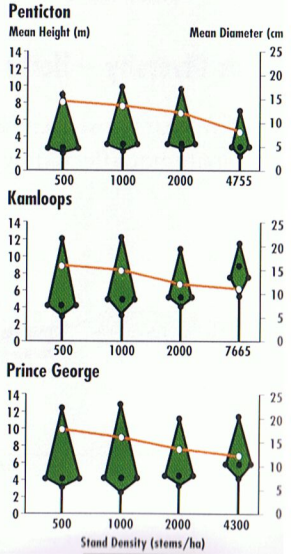


Crown Volume

- Mean crown volume higher in low- and medium-density stands than in high-density and unthinned stands.



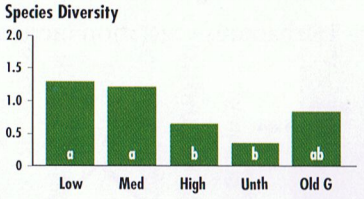
Tree crowns in low-density stand



Coniferous Trees

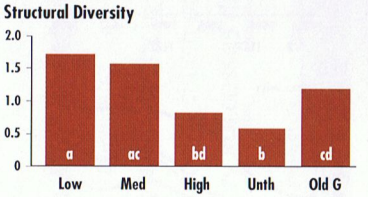
Species Diversity

- More diverse component of coniferous species in low- and medium-density stands than in high-density and unthinned stands.



Structural Diversity

- Greater diversity within coniferous tree layers in low- and medium-density stands than in high-density and unthinned stands.

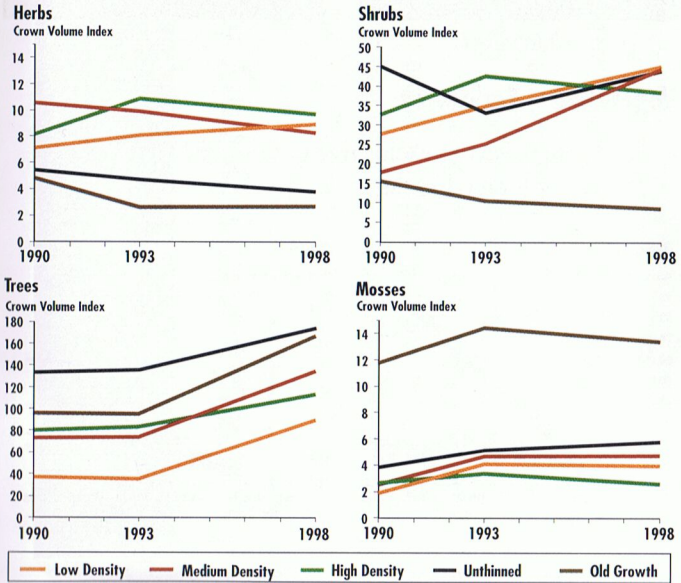


Mean values represented by histograms with different letters are significantly different.

Vegetation

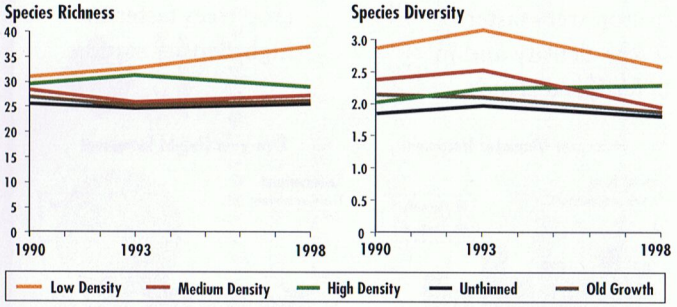
Amount of Vegetation

- Similar herb biomass in 1990 but higher in all three thinned stands than in unthinned and old-growth stands in 1998. No difference in shrubs and trees. Mosses highest in old-growth stands.



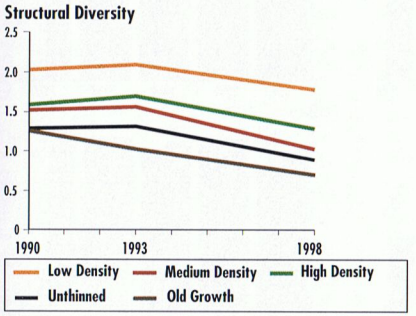
Total Species Diversity

- No difference in number of species but tendency for highest diversity in low-density stands.



Total Structural Diversity

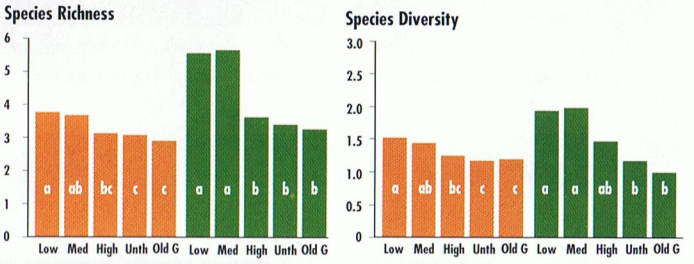
- No difference in number of layers of herbs, shrubs and trees but higher structural diversity in low-density stand than in medium-density, unthinned and old-growth stands in 1998.



Small Mammal Communities

Species Richness and Diversity

- Mean species richness highest in low- and medium-density stands.
- Mean species diversity highest in low- and medium-density stands.



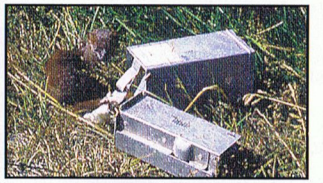
Small Mammals in Studies

Red-backed vole

Deer mouse

Heather vole

Shrew



Short-tailed weasel

Northwestern chipmunk

Long-tailed vole

Meadow vole

Jumping mouse

Study A Conclusions

Ten Years Post-thinning

Low-density stands

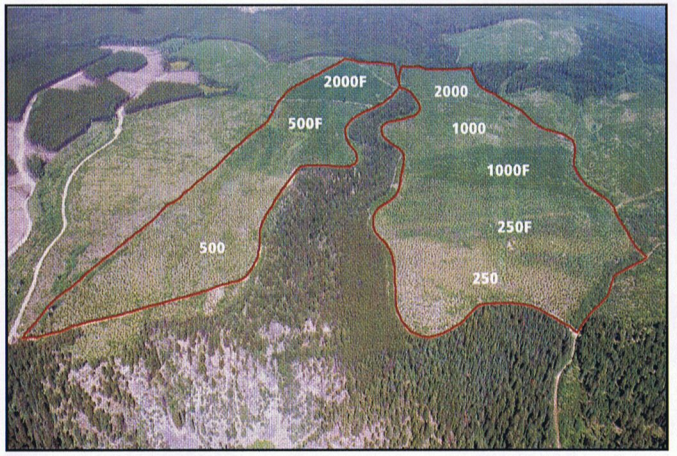
- Diameter growth enhanced
- Crown volume enhanced
- High diversity of conifer species and stand structure
- Small mammal species richness and diversity high
- Old-growth structural features
  - snow interception for ungulate winter range
  - potential habitat for forest carnivores
  - diverse understorey
- Shorter rotations
- Few snags for wildlife
- Reduced wood volume, quality products.

High-density stands

- Height growth enhanced
- More snags for wildlife
- Longer rotations
- High wood volume, sawtimber, pulp.

Study B – Thinned and Fertilized Stands of Lodgepole Pine

Lodgepole pine responds well to conventional fertilization and potentially to optimum nutrition. This latter practice is designed to maximize the productivity of crop trees by adjusting the nutrient supply to the uptake requirements of the stand, thereby maintaining steady state nutrition. Annual nutrient applications gradually increase the nutrient delivery capacity of the soil to a level where the ecosystem is saturated. The ecosystem then cycles the nutrients needed for high production throughout the remainder of the rotation with little additional fertilization. Thinning and fertilization treatments applied over the whole ecosystem have the potential to significantly increase



Overview of study area TFL 49, Riverside Forest Products Ltd.

wood production and enhance stand structure and wildlife habitat diversity over time. This suggests that a continuous and diverse flow of wood products may be coupled with provision of diverse wildlife habitats and may also benefit livestock forage in understorey vegetation.

Study B tested hypotheses that stand thinning and fertilization over a range of densities on large-scale units would enhance:

- Productivity of crop trees
- Stand structure attributes
- Species diversity of small mammal communities
- Relative habitat use by large mammals
- Forage for cattle.

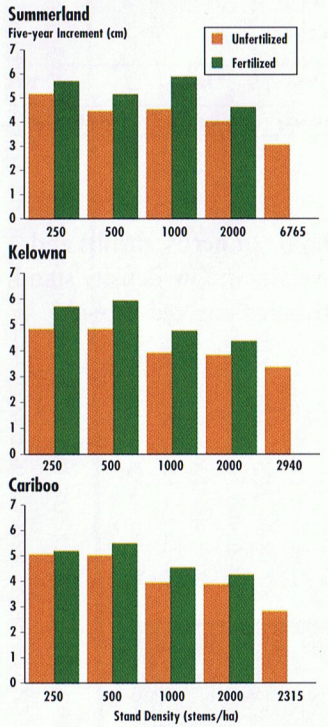
Study areas were located near Summerland, Kelowna and Gavin Lake (Cariboo). Each study area had four sets of paired stands thinned to 250, 500, 1000 and 2000 stems/ha in 1993, with an unthinned pine stand for comparison. Stand ages in 1993 ranged from 12 to 14 years. Fertilization (optimum nutrition) of one stand of each pair was initiated in fall 1994 and repeated in 1996 and 1998. A cattle-proof exclosure was constructed in each stand to provide a measure of vegetation response in the absence of grazing by livestock.

Growth of Crop Trees

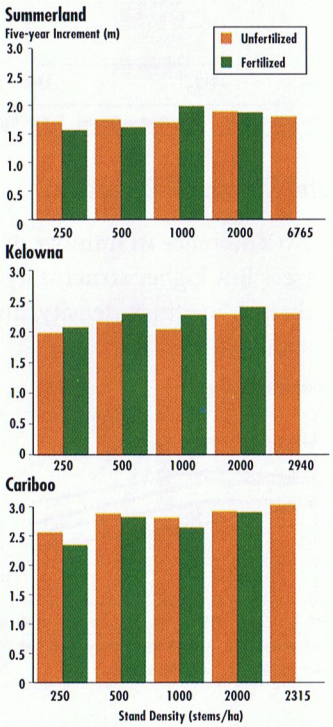
Five-year Height and Diameter Increments

- Diameter growth of crop trees faster in low-density and in fertilized stands.
- Height growth of crop trees faster in high-density stands.

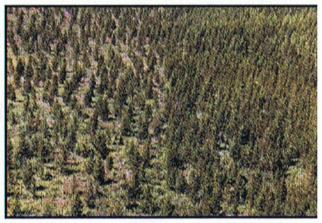
Five-year Diameter Increment



Five-year Height Increment



Fertilized stands of 2000 stems/ha (on left) and 500 stems/ha (on right)

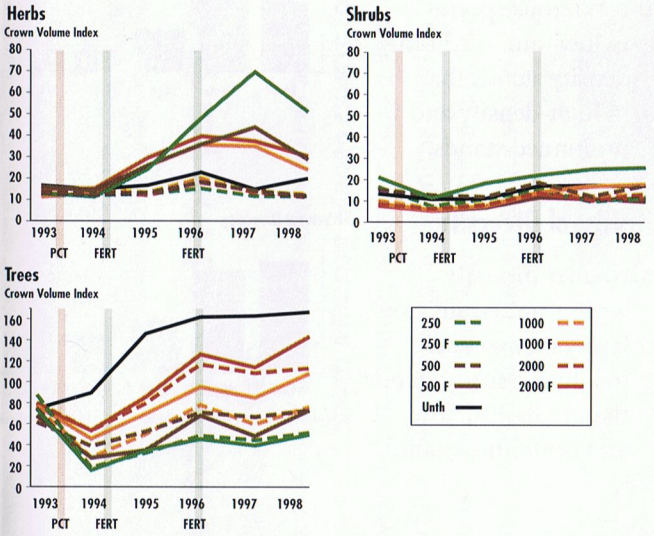


Fertilized stands of 250 stems/ha (on left) and 1000 stems/ha (on right)

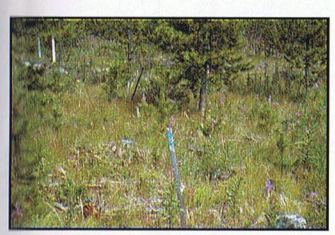
Vegetation

Amount of Vegetation

- Herbaceous vegetation increased in fertilized stands.



Vegetation in 250 stems/ha stands

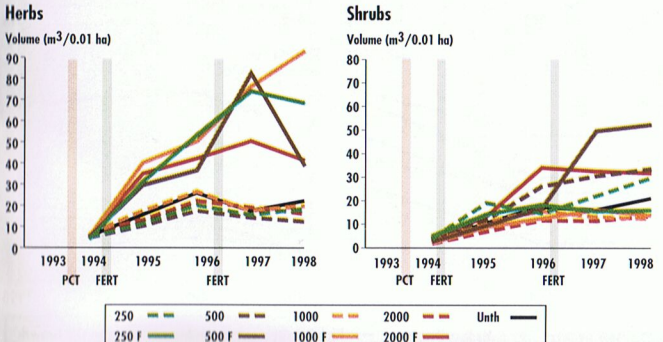


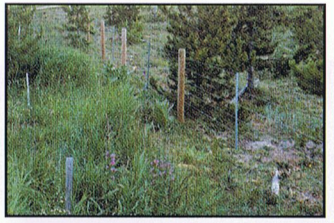
Unfertilized

Fertilized

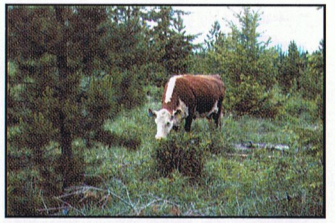
Vegetation – Exclosures

- Herbs increased in exclosures in fertilized stands, providing forage for cattle.





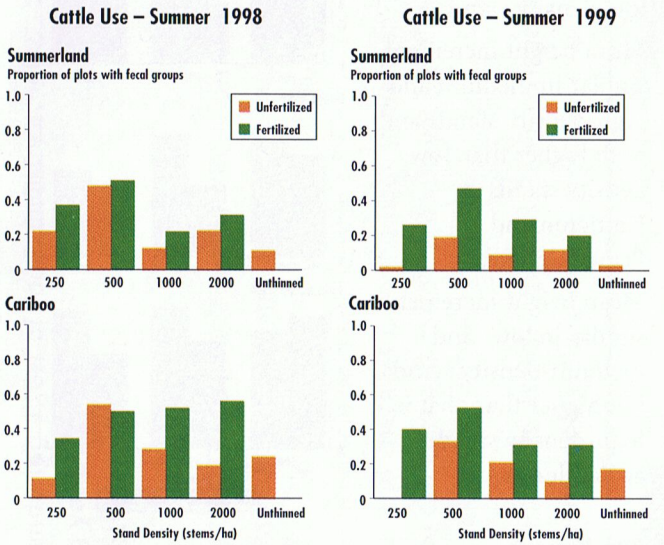
Vegetation inside (left) and outside (right) of a cattle exclosure



Cow foraging in fertilized stand

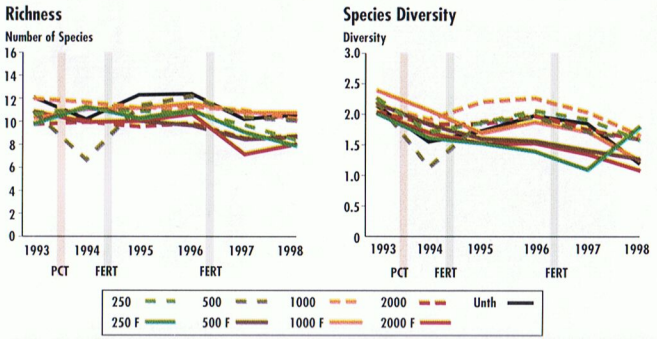
Cattle Use

- Relative habitat use by cattle was greater in the low- than high-density and unthinned stands in 1998. In 1999, cattle used fertilized stands more than unfertilized stands.

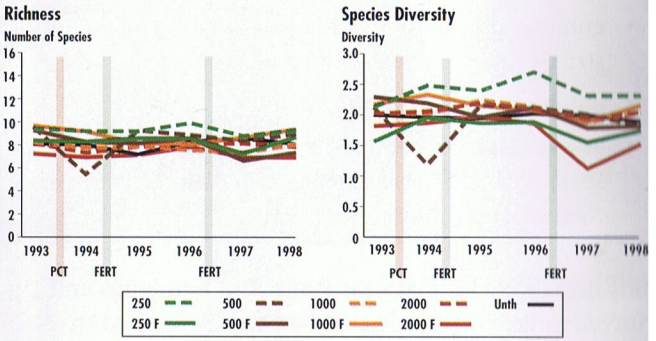


Species Diversity – Herbs

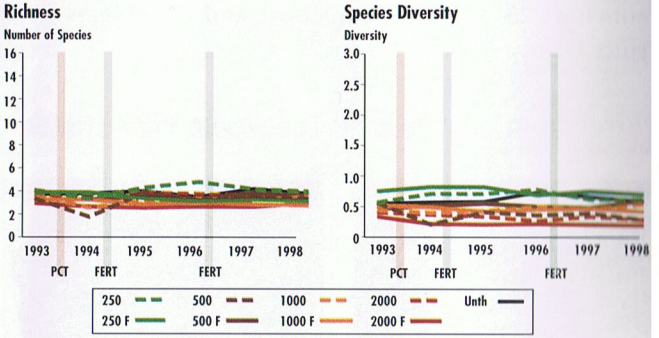
- At five years post-treatment, plant species richness and diversity not affected by stand thinning or fertilization.



Species Diversity – Shrubs

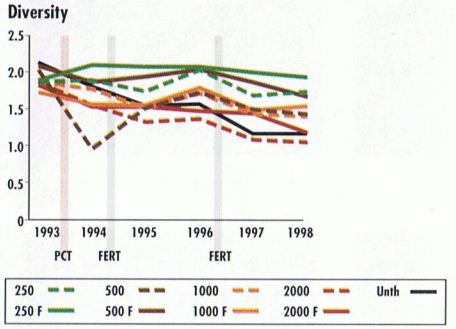


Species Diversity – Trees



Structural Diversity

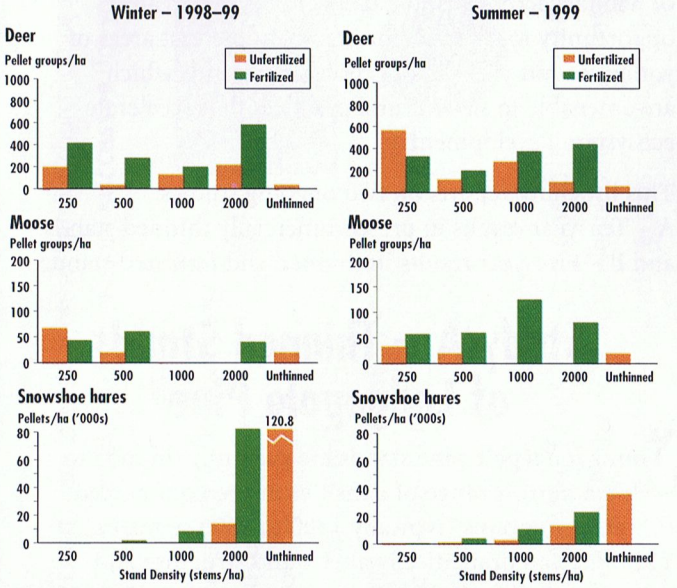
- Diversity of vegetation layers higher in low-density stands.

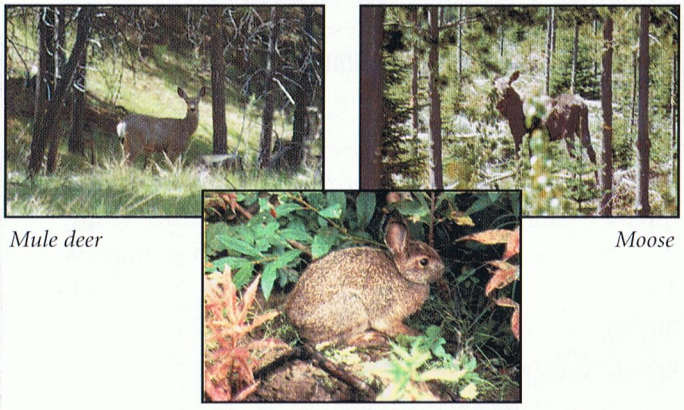


Mammals

Habitat Use – Kelowna

- Relative habitat use by deer was similar across thinned and fertilized stands and tended to be higher than in the unthinned stands. Moose also followed this pattern with use of all fertilized stands in summer 1999. Snowshoe hares preferred the high-density and unthinned stands.



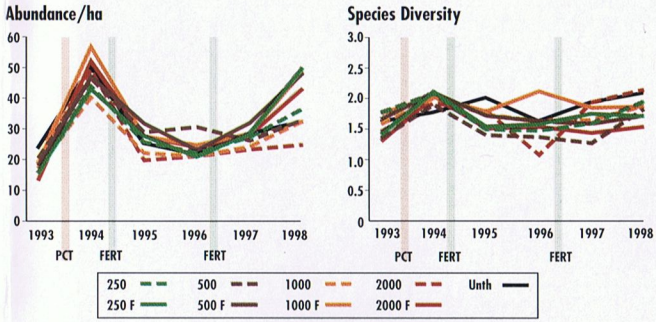


Mule deer *Moose*

Snowshoe hare

Small Mammals

Stand density and fertilization had no effect on mean abundance or species diversity of small mammals up to 1997. Abundance of small mammals peaked in 1994 and again in 1998. Total abundance appeared higher in fertilized than unfertilized stands in 1998.



Five Years Post-treatment

In general, silvicultural treatments such as pre-commercial thinning and fertilization do not negatively impact habitat productivity (vegetation biomass and structural diversity) or mammal communities, as indicated by the data collected in this study. Habitat quality and crop tree productivity will likely improve as these stands develop. A variety of silvicultural treatments using variable stand densities, fertilization and tree species in a "mosaic" of habitats across a "landscape" should provide for natural levels of biodiversity. Each habitat will have various groups of species; many different habitats and species can be expected at the large-scale landscape level. This approach uses "wildlife habitat diversity" as an indicator of biological diversity.

An additional component of this ongoing study is the comparison of biodiversity and sustainability in a mosaic of forest habitats (managed and unmanaged): young plantation, unthinned pine, pine thinned to 1000 stems/ha, pine thinned to 1000 stems/ha and fertilized, mature stand, and old-growth stand versus an unmanaged mosaic of forest habitats (mature and old-growth stands). Wildlife diversity is represented by trees and understorey vegetation (habitat structure), small mammal communities, and habitat use by large mammals.

References

Sullivan, T.P., D.S. Sullivan, and P.M.F. Lindgren. 2000. Influence of various thinning intensities on old-growth attributes, stand structure, and small mammals: 10-year results in young lodgepole pine forest. Ecological Applications (In press).

Sullivan, T.P. and W. Klenner. 2000. Response of northwestern chipmunks (*Tamias amoenus*) to variable habitat structure in young lodgepole pine forest. Canadian Journal of Zoology 78: 283–293.

Sullivan, T.P., D.S. Sullivan, P.M.F. Lindgren, R.P. Brockley, and R. Winter. 2000. Influence of thinning and fertilization on stand productivity, habitat structure, mammal diversity, and range forage: 5-year results in young lodgepole pine forest. (In preparation).

Acknowledgements

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Canada

BC

Partnership Agreement on Forest Resource Development: FRDA II