Changes in Female Grizzly Bear (*Ursus Arctos*) Homerange Configuration in the Multi-use Albertan Rocky Mountain Foothills, Canada.

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Introduction

Grizzly bear populations in Alberta, Canada are under tremendous pressure from land use changes related to development of the province's vast forest, agriculture, and petroleum resources. For example, Alberta contains roughly 70% of Canada's oil and gas reserves, and is forecasting annual production increases of 5% over the next decade (CAPP 2005). Understanding the impacts of these changes, and providing resource managers with the knowledge and planning tools necessary to ensure the long-term conservation of Alberta's grizzly bears has been the goal of The Foothills Model Forest Grizzly Bear Research Program (FMFBGRP) since 1999. In this paper, we report on a research project designed to quantify the impacts of human-induced landscape change on grizzly bear home ranges using parsimonious metrics of landscape structure (Linke and Franklin 2006), as observed through annual satellite imagery covering the years 1999 through 2003. The work is part of a broader initiative designed to understand the impacts of resource development on grizzly bear health and habitat selection.

Methods

A series of six annual Landsat 5 TM and Landsat 7 ETM+ images covering the time frame 1998-2003 were orthorectified and radiometrically normalized over a 7450 km^2 study area southeast of Hinton, Alberta, Canada. The enhanced wetness differencing index (EWDI) of Franklin *et al.* (2001) was used to produce 5 layers of *unlabelled* annual change. We then used an object-oriented image processing package (Definiens Professional 5.0), to segment the change pixels into identifiable objects, and applied a series of logical decision rules to classify change objects into landuse/disturbance categories, including wellsites, cutblocks, natural burns, and mine sites. Additional disturbance layers that were not captured by the automated change detection process, such as roads and small disturbance features, were digitized manually with the help of supplemental imagery such as IRS, SPOT and aerial orthophotos. Once assembled, we used these layers of *labelled* annual change to update a 10-class landcover map (circa 2003) of the study area produced by McDermid *et al.* (2007). A second set of decision rules were used to reclassify the change features to the appropriate landcover class, and backdate the 10-class map to each of the years 1998 through 2003. We used the updated annual landcover maps to calculate four landscape-level metrics with Fragstats 3.3 in six female minimum convex polygon (MCP) home ranges with low (G004, G016), medium (G011, G027), and high (G020, G023) exposure to human use (Linke *et al.* 2005).

Results/Conclusions

The overall study area experienced land use changes every year, with forestry, road construction, and well sites contributing the most dominant disturbance features (Table 1). However, changes varied spatially across the study area, affecting the landcover structure of the six home ranges to varying degrees, with two MCPs (G004, G016) remaining unchanged.

Annual changes in metrics were observed for the remaining four MCPs, with the overall largest magnitudes being recorded in home ranges with originally medium exposure to human use (Figure 1). In conclusion, landscape metrics derived from annual maps of landcover from remote sensing are shown to be effective tools for capturing and summarizing changes in landscape structure caused by human development. The techniques presented here have been used to quantify a broad spectrum of human-induced changes to grizzly bear home ranges on multi-use lands in Alberta, Canada. The work establishes a strong foundation for on-going monitoring activities, and further investigations into wildlife habitat inferences frequently drawn from multi-temporal wildlife data sets.

Table 1. Annual extents of land uses/disturbances as derived from Landsat image change detection in the 7450 km^2 grizzly bear foothills study area between 1999 and 2003.

Disturbance Feature	1999	2000	2001	2002	2003
Forestry Cutblocks (km^2)	32.5	34.0	34.1	42.7	44.1
Mining (km^2)	2.1	0.0	2.2	2.2	0.0
Burns/Forest Fires (km^2)	0.4	0.0	0.0	0.0	0.2
Wellsites (#, km^2)	117,1.9	113, 2.1	96, 1.6	65, 1.3	68, 1.1
Roads (km)	94.4	152.5	136.2	87.8	82.3

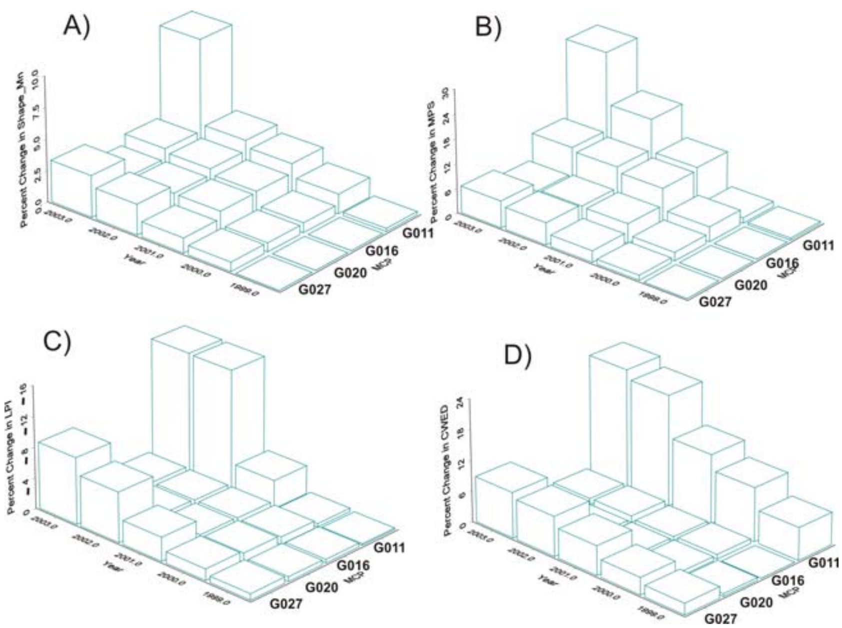

Figure 1. Percent annual cumulative changes in four female grizzly bear homeranges with medium and high exposure to human use between 1999 and 2003 as measured in relation to landcover structure in 1998 with A) mean shape index, B) mean patch size, C) largest patch index, and D) contrast weighted edge density.

References

Canadian Association of Petroleum Producers (CAPP). 2007. Canadian crude oil production and supply forecast 2005-2015. Calgary, Alberta, Canada. Retrieved on Jan. 29, 2007, from http://www.capp.ca/default.asp?V_DOC_ID=6

Franklin, S.E., Lavigne, M.B., Moskal, L.M., Wulder, M.A. and T.M. McCaffery. 2001. Interpretation of Forest Harvest Conditions in New Brunswick Using Landsat TM Enhanced Wetness Difference Imagery (EWDI). *Canadian Journal of Remote Sensing*, *27*, 118-128.

Linke, J. and S.E. Franklin. 2006. Interpretation of landscape structure gradients based on satellite image classification of land cover. Can. Journal of Remote Sensing 32(6): in press

Linke, J., S.E. Franklin, F. Huettmann and G.B. Stenhouse. 2005. Seismic cutlines, changing landscape metrics and grizzly bear landscape use in Alberta. Landscape Ecology 20: 811-826.