# Living on the Edge: Spatial Pattern Implications of the Current Mountain Pine Beetle Epidemic

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## Abstract

The current mountain pine beetle epidemic in British Columbia is causing large scale disturbances to the spatial structure of the forest. The focus of this project is to quantify the nature of these changes from 2000 to 2006 using landscape metrics and local measures of spatial autocorrelation. The forest/non-forest structure, in 2000 and 2006, will be evaluated using local measures of spatial autocorrelation for categorical data. Landscape metrics, as traditionally used in landscape ecology, will be calculated and a comparison between years will be used to relate forest pattern changes to mountain pine beetle damage. The results will demonstrate the spatial relationships of the current mountain pine beetle epidemic. Increased fragmentation in the spatial pattern of the forest structure is expected. These results will provide valuable information for forest and wildlife managers to incorporate into mountain pine beetle planning and management efforts

## Background and Relevance

Currently, mountain pine beetle infestations are causing large scale disturbance of mature lodgepole pine forests in central British Columbia. This epidemic is the largest on record, and is expected to continue causing mortality in 80% of lodgepole pine before it subsides (Eng *et al.*, 2005). These disturbances, via beetle kill or subsequent salvage logging, are causing widespread loss of forest and altering the forest structure of the region. The effects of forest loss cannot simply be measured in terms of quantity of forest lost, and indicators that incorporate the effects of spatial pattern are necessary (Franklin & Forman, 1987). Landscape metrics have been identified as a useful tool for quantifying the link between landscape patterns and ecological and environmental processes (Frohn, 1998). Quantification of landscape properties is required when attempting to identify significant changes through time and when relating spatial patterns to ecological functions (Turner, 1989). The goal of this research is to quantify the nature of the spatial pattern change to the forest, as a result of the current mountain pine beetle epidemic in British Columbia.

## Methods and Data

Landsat 7 ETM+ imagery was acquired for the core infested region in central British Columbia. All imagery is from the summer of 2006, and minimal cloud cover occurs in most images. Data from 2000 has been provided by the Pacific Forestry Centre, for comparison analysis. A study site will be classified using similar methods to that of the Earth Observation and Sustainable Development of Forests (EOSD) program used for deriving Canadian land cover from Landsat imagery (Wood *et al.*, 2002; Wulder *et al.*, 2003; Wulder & Nelson, 2001). Duplication of methods will allow for an accurate comparison of this work to previous studies that were part of the EOSD program. From the EOSD classification hierarchy (Wulder & Nelson, 2001), a classification level will be chosen that fits the needs of this project. From this the Landsat image can be easily aggregated into a forest/non-forest classification for analysis. Mountain pine beetle has been a significant factor in altering the forest structure of this region, and this work focuses on the link between observed changes and mountain pine beetle processes.

The spatial pattern of the forest/non-forest landscape will be characterized using local measures of spatial autocorrelation and landscape metrics. Spatial autocorrelation refers to the non-random arrangement of values across the study region (Boots, 2002). Local measures of spatial autocorrelation can be used to determine areas of positive and negative local spatial autocorrelation (Boots, 2002; Getis & Ord, 1992). Novel methods for quantifying the nature of spatial autocorrelation in categorical data (Boots, 2003, 2006) will be employed. These methods enable a statistical comparison with random expectations to determine if spatial pattern could exist by chance. Landscape metrics are commonly used in the field of landscape ecology as a means for measuring landscape heterogeneity (Li *et al.*, 2005). They will also be used to provide a quantitative value which measures a component of the spatial configuration of a landscape (Li *et al.*, 2005).

Previously, a similar study by the Pacific Forestry Centre calculated landscape metrics for the entire region in 2000. These results will enable change comparison analysis to occur between 2000 and 2006, a time period which covers the current mountain pine beetle epidemic. Individual metrics will facilitate answers to questions such as: has the mountain pine beetle epidemic caused an increase in forest edge habitat from the year 2000 to the year 2006. The results of this comparative analysis will be useful to forest and wildlife managers, and will aid in determining the effect that the current mountain pine beetle epidemic is having on the spatial structure of the landscape and wildlife habitat. This will allow for a quantitative inventory of the spatial pattern of mountain pine beetle related landscape change.

## Results and Conclusions

The results of this study will show how the forest/non-forest structure of British Columbia has changed during the current mountain pine beetle epidemic. Output will include a classified image of forest cover, an aggregated forest/non-

forest map, and several maps showing the spatial configuration of the forest. The fact that metrics are quantitative will allow the calculation of observable changes between 2000 and 2006. It is anticipated that local measures of spatial autocorrelation will reveal that spatial dependence is an important characteristic of the current mountain pine beetle epidemic. It is expected that the extensive loss of forest from mountain pine beetle kill will have significant effects on both the quantity and spatial pattern of the forest structure. This study will form the foundation for future work aimed at exploring the impacts, that mountain pine beetle related change to the forest configuration, will have on differing wildlife species' habitat.

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