Monitoring Cumulative Effects of Landscape Change on the Frontenac Axis: A Preliminary Investigation*

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Abstract

Current thinking in conservation recognizes that protected areas are generally too few, too small and too isolated to protect biodiversity and the ecological conditions that sustain it. Planning for conservation must give active consideration to lands beyond park boundaries, and requires an understanding of how changes in land use and land cover affect ecosystem components and processes at a variety of spatial and temporal scales.

This research examines changes in the structure and composition of land cover on the Frontenac Axis in south-central Ontario from the late-1970s to 1996. The Axis harbours a rich diversity of species and has important implications for biodiversity and ecological integrity in Algonquin Park and, potentially, the Adirondacks, New York. The Axis serves as a buffer and a migration linkage for wildlife and provides important opportunities for conservation. To date, no cumulative effects monitoring of landscape change has been undertaken over the full extent of the Axis.

A supervised classification was conducted using PCIWorks on Landsat MSS images from the mid 1970s and TM images from 1996 based on training sites selected from ground truthing, NTS maps, and air photos. Classified images were entered into a Geographic Information System (Arc/Info) and landscape indices for each land cover type will be generated using FragStats. Indices will include total area, patch size and shape, edge density, and core area. Indices will be contrasted and inferences about the cumulative ecological effects of landscape changes will be made. These will be related to habitat requirements for a suite of indicator species. Additional data on population density, road density, and intensity of land use will be compared and correlated with the fragmentation indices. It is hypothesized that forest cover connectivity will have decreased (i.e. fragmentation increased) in areas close to urban centres and transportation corridors while in more remote areas connectivity will have increased due to abandonment of farms and industrial sites.

Introduction

The signing of the Convention on Biological Diversity at the 1992 U. N. Earth Summit reflected a global urgency to address the issues of increasing ecological degradation and rapid declines in species and habitat diversity from human alteration and fragmentation of the landscape. Current thinking in conservation recognizes that protected areas are generally too few, too small and too isolated to protect biodiversity and the ecological conditions that sustain it (Noss and Cooperrider

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1994). Planning for conservation must give active consideration to lands beyond park boundaries and requires monitoring and assessment of ecological characteristics at a variety of spatial and temporal scales including broad landscape and regional scales (Grumbine 1990, Hudson 1991). Monitoring is a frequently underrepresented but essential component of conservation strategies that allows us to assess the cumulative effects of human activities on biodiversity and ecological integrity (Slocombe 1994, Goldsmith 1991)

Within this context, the goal of this research is to examine changes in land use patterns and the structure and composition of land cover on the Frontenac Axis in eastern Ontario to assess their cumulative ecological effects. Despite the rich diversity of species present and its important ecological role for the region, no cumulative effects monitoring of landscape change has been undertaken over the full extent of the Axis. The results of the study will aid our understanding of the linkages between landscape patterns and processes and provide a basis for more informed planning and management in the region.

Study Area

The Frontenac Axis is an extension of the Precambrian Shield which stretches southeast from Ontario's Boreal region and crosses the St. Lawrence river to join the Adirondack Mountains of New York (Figure 1). The land cover is predominantly mixed forest of the Great Lakes-St. Lawrence interspersed by bedrock outcrops. Due to thin soil cover and protruding bedrock, agriculture is limited and settlements are small and sparse. Common land uses in the region include recreation, tourism, and resource extraction. The portion of the Frontenac Axis that is centered on in this research extends south of Algonquin Park to Frontenac Park, and west of

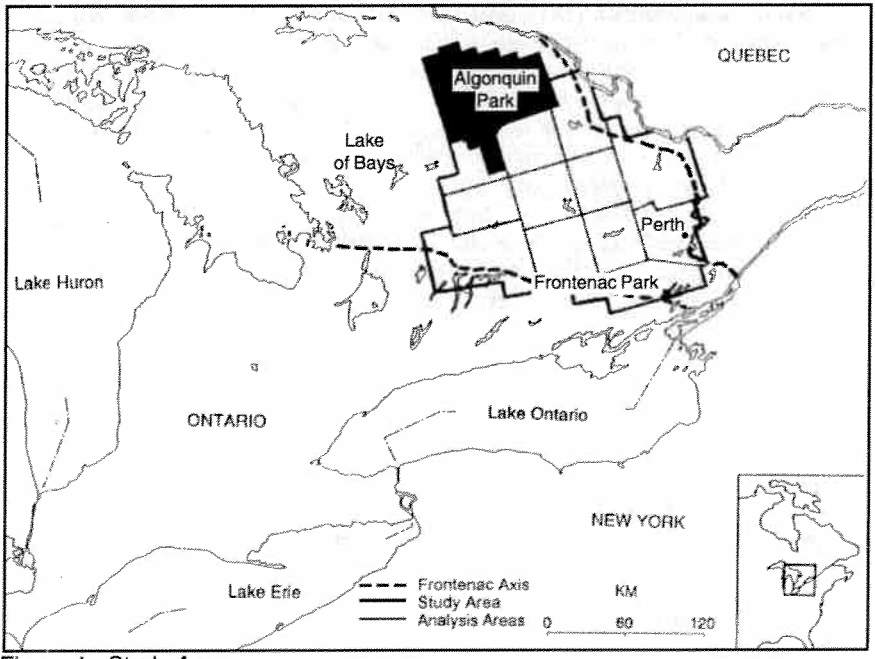

Figure 1: Study Area

the Lake of Bays to Perth in the east. The study area was defined by the largest area of the Axis that could be extracted from the satellite images at hand and still analyzed in a relatively efficient manner. Due to the absence of natural and ecological phenomena that could be used to define the study area, specific boundaries were based on Canada Census Tracts which closely approximated township boundaries.

Study Rationale and Objectives

Many factors contribute to the conservation value of the Frontenac Axis and highlight the need for monitoring changes in the landscape dynamics. Most importantly, this region:

- is ecologically unique because it is the southern most extent of the Canadian Shield and represents a transition between major biotic communities;
- harbours a particularly rich diversity of habitat and species;
- is the most extensive and least degraded north-south linkage across the St. Lawrence River (Keddy 1995);
- has very important implications for the maintenance of ecological integrity in Algonquin Park and other protected areas, and potentially for the Adirondacks in New York, by serving as a buffer and corridor for migrating wildlife;
- remains relatively undeveloped, providing important conservation opportunities;
- is a significant component of the Ontario government's current *Ontario's Living Legacy* land use strategy; and,
- faces growing pressures from development in areas such as recreation, tourism and resource extraction.

The overall objective of the study is to identify the spatial and temporal trends in human use and land cover of the Frontenac Axis from the mid-1970s to the present, and assess their cumulative effects for maintaining biodiversity and natural processes. Specific objectives of the study include:

- determining the direction of change for selected indices including forest fragmentation, road density, land uses, and population densities;
- determining the magnitude of change for the selected indices; and,
- evaluating the cumulative ecological effect of changes in land cover and land use by relating landscape changes to habitat requirements of selected indicator species.

Methods

Phase One

- Conduct literature review.
- Acquire and inspect Landsat Thematic Mapper (TM) data from 1996 and Landsat Multispectral satellite (MSS) data from mid-1970s to develop preliminary land cover classification system for image classification work.

Phase Two

- Conduct preprocessing of TM and MSS data including sub-scene creation and geocorrection using PCI's EASI/PACE software.
- conduct unsupervised classification of TM and MSS data.
- ground truth data through field work, air photos and NTS maps.

- conduct supervised classification, filtering and final editing of TM and MSS data.
- Assess classification accuracy using GPS in field.

Phase Three

- Convert classified satellite data to geographic information system (GIS) data layer and input into ESRI's Arc Info GIS software.
- Divide study area into twelve sub-areas of approximately equal area (Figure 1) for efficient analysis and determination of spatial variation of landscape fragmentation indices for both time periods.
- Generate land cover fragmentation indices for sub-areas from both time periods using FRAGSTATS*ARC (McGarigal 1999). Indices will include area, patch size and shape, edge density, and core area.

Phase Four

- Analyze change in population density and land use intensity between two time periods.
- Digitize road network and analyze change in road density in Arc Info GIS.

Status of Work and Expected Results

At the present time phase three is nearing completion and the remaining work is expected to be completed within two months. It is hypothesized that natural vegetation is regenerating in areas of abandoned farmland and industry but that increasing urban, road and recreational development is resulting in a net loss of forest cover and connectivity.

Research Benefits

This research has the potential to benefit conservation work on the Frontenac Axis in several respects:

- the results will identify areas of high habitat quality and connectivity that could serve as focus areas for furthering conservation planning efforts;
- the results will identify fragmented areas or areas at risk of fragmentation for possible enhanced stewardship or restoration;
- it provides a perspective of landscape functioning on a large geographical scale to complement regional and site-level conservation planning and management;
- it provides a basis for more detailed ecological studies and long-term monitoring; and,
- it provides a value-added product in the form of an up-to-date, digital land cover map.

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