Terrestrial and Riparian Organisms, Lakes and Streams (TROLS)

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ABSTRACT

The Terrestrial and Riparian Organisms, Lakes and Streams Project studied the impacts of forest harvest and riparian buffers on terrestrial and aquatic ecosystems in twelve fish-bearing lakes in the boreal mixed-wood forests of Alberta. Major results are outlined based on forest harvest and buffer effects on the landscape, water quality, and the aquatic ecosystem. Results from this project suggest that forest managers should be flexible in buffer width recommendations and should consider the entire watershed when determining the effects of disturbance due to complexities in the landscape.

RÉSUMÉ

Le Projet d'étude sur les organismes terrestres et riverains des lacs et des cours d'eau (TROLS) portait sur les effets de l'exploitation forestière et des bandes riveraines boisées sur les écosystèmes terrestres et aquatiques de douze lacs poissonneux situés dans les forêts mixtes boréales de l'Alberta. Les principaux résultats sont présentés en fonction de l'exploitation forestière et des effets tampons des bandes riveraines sur le paysage, la qualité de l'eau et l'écosystème aquatique. Les résultats de ce projet suggèrent que les aménagistes forestiers devraient faire preuve de flexibilité dans leurs recommandations sur la largeur des bandes et qu'ils devraient tenir compte de tout le bassin versant pour déterminer les effets des perturbations en raison de la complexité du paysage.

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Twelve fish-bearing lakes surrounded by aspen-dominated boreal mixedwood forests were chosen from three regions in Alberta: Lac La Biche, South Pelican Hills and South Calling Lake (Table 2, Fig. 1). Study lakes were treated with three different riparian forest buffer widths (20 m, 100 m and 200 m) and there was one unharvested reference lake for each region (Prepas *et al.* 2001).

Introduction

The Terrestrial and Riparian Organisms, Lakes and Streams (TROLS) Project was a collaborative research project that ran from 1994 to 2000 and studied the impacts of forest harvest and riparian buffers on terrestrial and aquatic ecosystems (Table 1). The research was conducted in the boreal mixed-wood forests of Alberta because minimal information previously existed on this forest type and Alberta's forestry guidelines of the time were adopted from standards of other provinces (Prepas 2002). The primary objectives of TROLS were to determine the effects of forest harvesting and forested buffers on "various aspects of terrestrial and aquatic ecosystems in the mixedwood forest on the Boreal Plain" (Evans *et al.* 2000, p 61).

Results

Landscape

- Edge effects (lakeshore or buffer edges) were observed up to 40 m into the forest (Harper and Macdonald 2001, 2002).
- Abundance and composition of small mammals and amphibians did not differ among buffer widths post-harvest (Hannon *et al.* 2002)
- Vertebrates that require a much larger habitat range (e.g., raptors, woodpeckers and mammalian carnivores) did not have adequate territory preserved in the 200 m buffer strips (Hannon *et al.* 2002).
- Forest bird diversity decreased in the 20 m and 100 m buffer strips; 200 m buffers were effective reserves for bird diversity (Hannon *et al.* 2002).

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Table 1. Research design and variables measured for the TROLS project

	Research Design
Study type	Before/After; Control/Impact (BACI design)
Treatments	Riparian buffers of varying widths from the lake edge (20, 100, and 200 m) were left unharvested
Controls	Lakes with no harvesting or major disturbances within 800 m
Study duration	1994–2000
Variables measured	Aquatic, terrestrial, and hydrologic conditions: Water quality, soil water and nutrients, mammal tracking, snow surveys, small mammals, songbirds, amphibians, and vegetation sampling

Water quality

- Differences in total phosphorus between pre- and post-harvest were in part due to lake position and hydrologic connectivity to wetlands. Deep surficial glacial deposits and complex groundwater flow systems in the Western Boreal Forest confounded and masked the potential chemical response to disturbance in lakes (Devito *et al.* 2000).
- Differences in total dissolved phosphorus concentration (TDP) in mineral soil (<1.7 m) in cut and uncut subcatchments were not detected. Increases in ground water TDP following harvest are unlikely due to the large adsorption affinity of mineral soils and rapid regeneration of aspen. (Evans *et al.* 2000, Macrae *et al.* 2005).
- High rates of gross ammonification and nitrification were observed in soils of aspen-conifer mixed stands in harvested plots compared to unharvested plots one year following the harvest (Carmosini *et al.* 2002). Conversely, aspen-dominated stands showed no difference in net mineralization or nitrification (Carmosini *et al.* 2003), indicating large immobilization of inorganic nitrogen in both soils of harvested and un-harvested catchments (Macrae *et al.* 2006).
- Winter mineralization and nitrification in soils in aspen-dominated and aspen-conifer mixed stands may cause leaching of nitrogen during spring snowmelt (Carmosini *et al.* 2003, Macrae *et al.* 2006).

Aquatic

- Shallow lakes with mixed or weakly thermally stratified water columns showed the strongest increase in total phosphorus, chlorophyll *a*, cyanobacteria, and cyanotoxins concentrations in the first year after harvest (Prepas *et al.* 2001).
- Decreases were observed in overall zooplankton biomass and abundance post-harvest due to increase in cyanobacteria biomass in weakly or

non-stratified lakes and decrease in edible phytoplankton biomass in stratified lakes (Prepas *et al.* 2001).

- Buffer strip width did not appear to mitigate effects on in-lake responses to harvest (Prepas *et al.* 2001).

Management Implications

- Flexibility in buffer widths is recommended to incorporate lake position, riparian zone function, and local aquatic conditions (Devito *et al.* 2000, Hannon *et al.* 2002, Creed *et al.* 2008).
- When determining the effects of disturbance on water quality and aquatic biota in lakes, the entire watershed should be considered due to complexities in the landscape (Devito *et al.* 2000) and a lack of evidence of buffer strip mitigation (Prepas *et al.* 2001).

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Table 2. Summary of the TROLS project watershed and climatic descriptors.

	Watershed Location Data
Location (descriptive)	Southern portion of Alberta's Boreal Mixedwood Ecoregion
Location (geographic)	Lac La Biche: 55° 08' N 111° 45' W South Calling Lake: 55° 07' N 113° 43' W South Pelican Hills: 55° 23' N 113° 38' W
Biogeoclimatic zone	Boreal Mixedwood Ecoregion
Drainage basin area (range)	Headwater lakes: 455 – 1053 ha; non-headwater lake (SCL200): 5669 ha
Precipitation (mean annual)*	<485 mm
Temperature (mean monthly)**	July: 18 °C January: -17 °C

*Beaudoin *et al.* 2001

**Evans *et al.* 2000

Fig. 1. Location of the 12 TROLS study lakes in the South Pelican Hills (SPH), South Calling Lake (SCL), and Lac La Biche (LLB) regions of north central Alberta. The numbers 20 to 800 indicate the width of buffer treatment following harvesting in the lakes, winter 1997.

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