LOSS OF NUTRIENTS DUE TO LOGGING IN THE LOWER SPANISH FOREST OF CENTRAL ONTARIO

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Introduction

In a recent analysis of timber supply, Clark (1995, pg. 7) stated that, "there are few places [in Canada] where the current timber harvest is sustainable in the long run". One of the primary causes of unsustainable logging practices is the loss of terrestrial nutrients which can lead to a permanent decrease in forest site productivity (Bormann and Likens 1979, Kimmins 1987, Maser 1994). Clearcutting, which is still commonly practiced in the majority of the Lower Spanish Forest (LSF) of central Ontario, is the most disruptive of all logging practices. The need for sustainable forestry (OMNR 1995), observations of intensive clearcutting practices in the LSF, and a lack of scientific information led us to question E.B. Eddy's claim to be practicing "forest management...[for] sustained economic growth and a healthy environment for the benefit of all Canadians" (E.B. Eddy 1990) in the LSF.

Thus, the objective of this study was to determine the effect of logging on nutrient loss through watershed outlet streams in the LSF area of central Ontario. Numerous studies have documented terrestrial nutrient losses through watershed outlet streams in northern temperate forested (NTF) landscapes, however, they (1) have excluded the effect of logging, focussing only on relationships between ecosystem characteristics and stream nutrient concentration (Likens et al. 1967, Martin 1979, LaZert and Dillon 1984, Cronan et al. 1987, Jeffries et al. 1988, Dillon et al. 1991), (2) have focussed on the influence that timber harvesting has on stream nutrient concentration using only a few small watersheds (Likens et al. 1970, Leak and Martin 1975, Vitousek and Reiners 1975, Martin et al. 1985, Martin et al. 1986, Hornbeck et al. 1986, Fuller et al. 1988, Lawrence and Driscoll 1988, Pierce et al. 1993), or (3) have sampled sites that were logged 30 or more years prior to sampling (Vitousek 1977, Rosen et al. 1988).

If the effects of timber harvesting on nutrient loss are to be accurately and fully assessed, samples of watershed outlet stream chemistry must be obtained as soon after logging as possible, preferably within five years (Bormann and Likens 1979), and a large sample size should be obtained in order to capture site variability.

Methods

We collected outlet stream chemistry samples between early June and early July 1994 from 40 streams (first and second order) using the small-watershed approach of Hornbeck and Swank (1992). Of these streams, 21 were logged on average 3.5 years prior to sampling and 19 drained from watersheds with no previous record of logging - these latter streams are referred to as "pristine". The watersheds range in size from 30 to 327 hectares and are located approximately 80 km. northwest of Sudbury, Ontario. This area is ideal for conducting studies using baseline comparisons due to the vast amount of pristine (unlogged) forested landscape (at least 40,000 ha) that provides these baseline reference sites. Shortly after collection, the water samples were taken to the Ontario Ministry of Environment and Energy's Dorset Research

Station for analysis. The means of the stream chemistry variables were compared using the rank sum test (Mann-Whitney U statistic) (Analytical Software 1994). Stream discharge was calculated using Dunne and Leopold (1978).

Table 1. Results of the Rank Sum Test (Mann-Whitney U statistic) for Stream Chemistry Variables Compared Between Pristine (n=19) and Logged (n=21) Watersheds in Ontario's Lower Spanish Forest (p<.05 in bold)

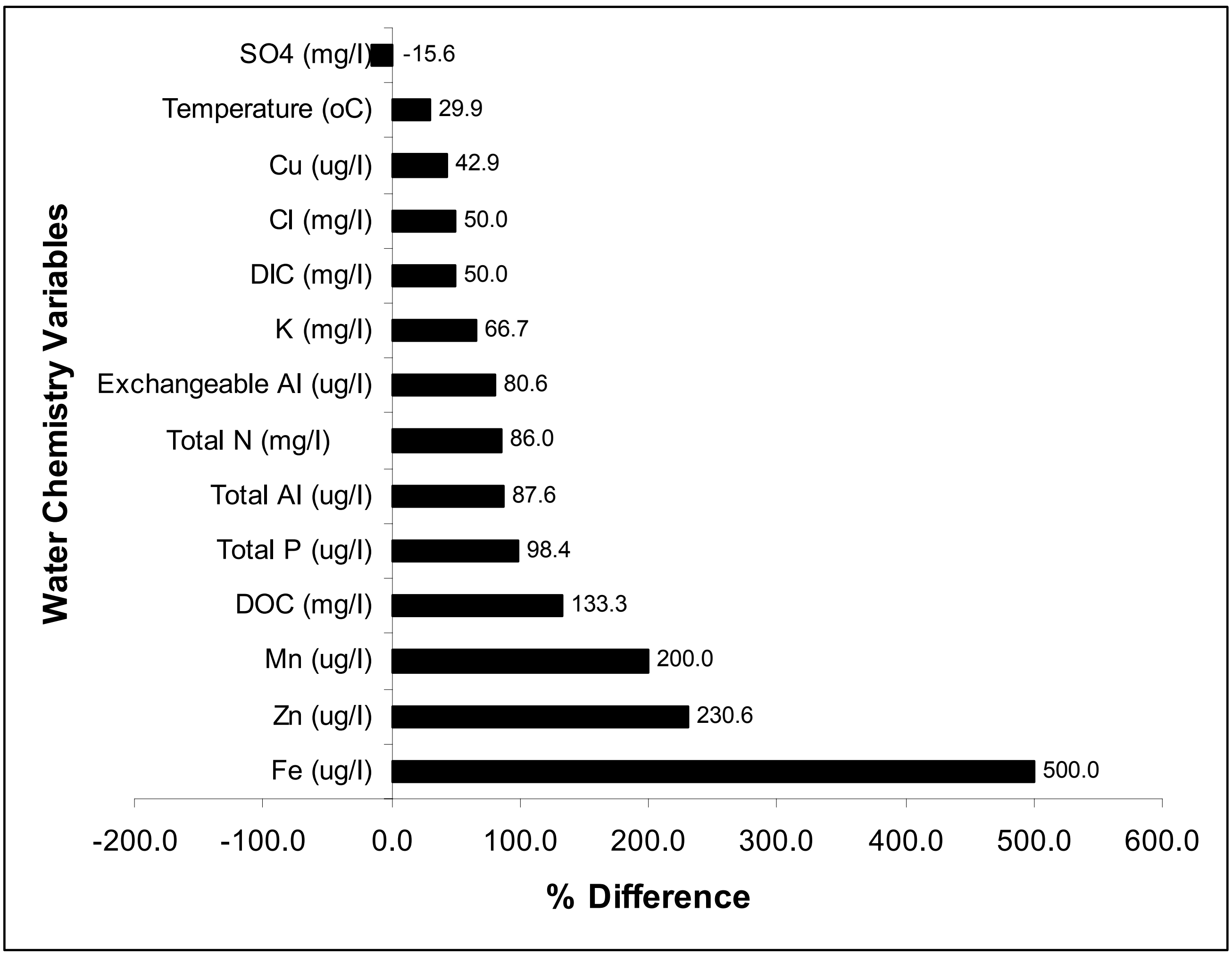
Stream Chemistry Variable	Probability	Mean for Pristine Watersheds	Mean for Logged Watersheds
Exchangeable Al (ug/l)	**.0000**	**28.3**	**51.1**
Total Al (ug/l)	**.0022**	**79.2**	**148.6**
Ca (mg/l)	.3867	2.5	2.8
Cd (ug/l)	.5338	.1	.1
Cl (mg/l)	**.0422**	**.2**	**.3**
Cu (ug/l)	**.0396**	**1.4**	**2.0**
DIC (mg/l)	**.0090**	**1.2**	**1.8**
DOC (mg/l)	**.0000**	**3.3**	**7.7**
Fe (ug/l)	**.0006**	**.07**	**.42**
K (mg/l)	**.0337**	**.24**	**.40**
Mg (mg/l)	.6359	.65	.70
Mn (ug/l)	**.0020**	**.01**	**.03**
NH_4 (ug/l)	.2914	5.4	20.4
NO_3 (ug/l)	.8498	57.5	57.0
Total N (mg/l)	**.0009**	**170.5**	**317.1**
Na (mg/l)	.5518	.95	1.03
Ni (ug/l)	.5979	.0	.3
Total P (ug/l)	**.0373**	**6.3**	**12.5**
Pb (ug/l)	.9892	.0	.0
pH	.6168	6.0	5.9
SiO_3 (mg/l)	.7049	2.1	2.2
SO_4 (mg/l)	**.0106**	**6.4**	**5.4**
Temperature (^oC)	**.0004**	**13.4**	**17.4**
Zn (ug/l)	**.0248**	**6.2**	**20.5**

Results and Discussion

The mean concentrations for 12 stream water nutrients (exchangeable Al, total Al, Cl, Cu, dissolved inorganic carbon, dissolved organic carbon, Fe, K, Mn, total N, total P, and Zn) were significantly higher in the logged watershed outlet streams compared to the pristine watershed outlet streams in the LSF (Table 1). These differences ranged from 42.9% higher for Cu to 500% higher for Fe (Figure 1). In addition, stream water temperature was 29.9% higher in logged streams compared with pristine streams. In general, these results reflect the findings of other watershed-ecosystem studies in the NTF that have examined the influence of timber harvesting on the loss of terrestrial nutrients through outlet streams - that logging causes an increase in nutrient loss (Bormann and Likens 1979, Kimmins 1987).

The results of this study raise serious questions about the sustainability of logging practices in the LSF area of central Ontario. Additional studies are underway to examine the specific characteristics of the 21 logged watersheds (e.g. area logged, distance of logging from streams) included in this study in order to better understand the interactions between logging and nutrient loss through watershed outlet streams. The results from these additional studies will aid in designing field experiments to test hypotheses regarding sustainable logging practices.

Figure 1. Comparison of water chemistry variables for outlet streams in logged and pristine watersheds, Lower Spanish Forest, Ontario (values in percent)



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