Water quality in headwater streams following timber harvesting

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Introduction

Headwater streams can account for 65-75 percent of the cumulative length of all stream and river channels in a watershed (Leopold et al 1964). Nevertheless, small headwater streams have often escaped both scientific research and regulatory scrutiny.

In Maine, streams draining watersheds of less than 300 acres have no buffer or shade requirements under state law (Maine Department of Conservation 1999). Our study was conducted to better understand small headwater streams and their sensitivity to water quality changes following commercial timber harvest.

Methods

Design: Before and after controlled experiment

Experimental Units: 15 headwater streams draining watersheds with mature closed-canopy cover forest (>85%) at least 15 m tall forest were located in the industrial forests of western Maine.

Experimental Treatments: In the fall/winter of 2001, 200m x 300m blocks of forest on both sides of the study streams were harvested to the following specifications:

0m buffer: clearcut harvest zone (<6.8m^2/hectare residual basal area) without retention buffers

11m buffer: clearcut harvest zone with 11m buffers on both sides of stream

23m treatment: clearcut harvest zone with 23m buffers on both sides of stream

Partial Harvest: selectively cut harvest zone (> 13.7 m^2/hectare residual basal area) without specified buffers

Control: no harvest

Figure 1 Harvest Layout

Results

- Average pH, conductivity, and dissolved oxygen did not change following the harvest in any treatment group (Figure 2).
- Average turbidity remained below 0.5 NTU in all treatment groups (Figure 2). Turbidity measurements were variable between years with a small post-harvest increase occurring in the 4 of the 5 treatment groups (including the control).
- Stream temperature and diurnal temperature fluctuation within the harvest zone was much greater than in undisturbed forest. (Figure 3a).
- Diurnal fluctuation of dissolved oxygen was larger within the harvest zone than in undisturbed forest, but the average concentration of dissolved oxygen was not reduced (Figure 3a).
- After a large rain event (3 cm), both pH and conductivity dropped sharply, both within and above the harvest zone (Figure 3b).

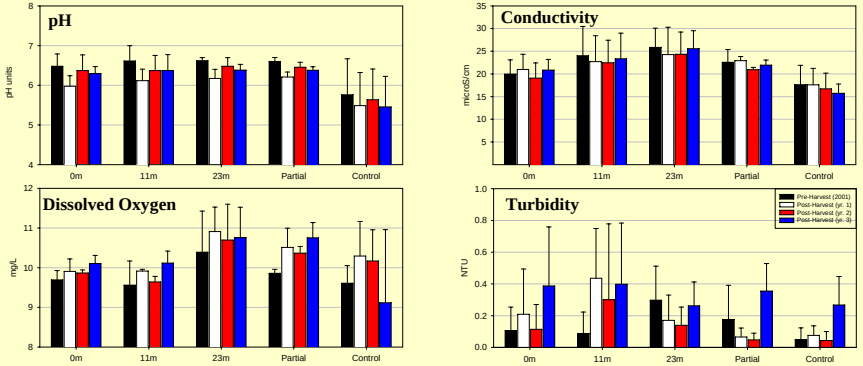

Figure 2 Average spring time water chemistry measurements at the downstream boundary of the harvest zone (100-m station) in the pre-harvest and three post-harvest years. Measurements are an average of three visits that occurred in May and June of each year.

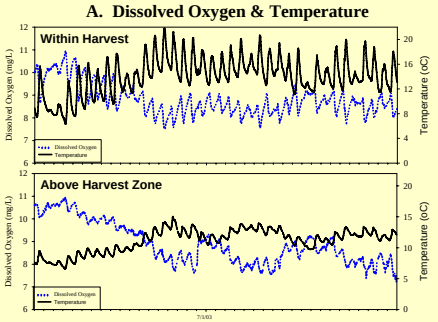

Figure 3a Bi-hourly measurements of water temperature and dissolved oxygen of an unbuffered stream both within (100-m station) and above (400-m station) the harvest zone. Graph shows data from 6/13/03-7/21/03.

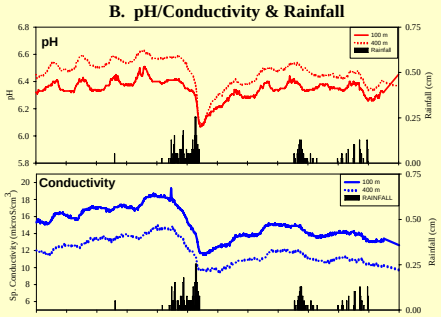

Figure 3b Rainfall and bi-hourly measurements of pH and conductivity of an unbuffered stream both within (100-m station) and above (400-m station) the harvest zone. Graph shows data from 6/7/02-6/19/02.

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Discussion

- pH and dissolved oxygen levels were within the documented range of streams in the eastern U.S. (Binkley and Brown 1993, Hornbeck et al. 1997). Conductivity levels were within or slightly below documented levels for New England streams (Noel et al. 1986).
- Turbidity remained below 0.5 NTU in all years of the study. These levels of turbidity are very low; even below public drinking water standards (EPA 1986).
- Continuous water quality monitoring highlights the strong relationship between stream temperature and dissolved oxygen, the influence of rainfall on pH levels (Hornbeck et al. 1997), and the inverse relationship between discharge and conductivity (Dissmeyer 1994).

Conclusions

- With proper harvest planning and careful adherence to BMPs, buffers are not required to prevent large changes in pH, conductivity, dissolved oxygen, or turbidity.
- However, changes in water quality are linked with near stream soil disturbance. Soil disturbance in our study streams was minimal due to harvest specifications that prohibited machinery within 7.5m of the stream and the timing of the harvests during late fall and winter when the potential for soil disturbance is low.
- Harvests during other times of the year, on special soil types, and adjacent to streams of special management concern may require a buffer to ensure minimal soil disturbance next to the stream channel.

References

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