

**Effects of managed buffer zones on fauna and habitat
associated with a headwater stream in the Indian Bay watershed
located in northeast Newfoundland**

By

Jacquelyn M. Wells

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Abstract

The effectiveness of managed buffer zones in protecting an aquatic ecosystem during forest harvesting was studied for a two year period on a small headwater stream in northeastern Newfoundland, Canada. The findings of this study will provide forest managers within the Province with region specific data upon which forest management practices can be made. The study consisted of several components: abiotic (water temperature and sedimentation) and biotic (macroinvertebrates and salmonids). These components were studied pre- and post-harvest to determine the impact of the following riparian management schemes: 20 m buffer; 20 m buffer with 30 % of the basal area harvested; 30-50 m buffer with 30 % of the basal area harvested; and a no harvest 'control' site. Sedimentation was significantly increased for both size classes (greater than and less than 1 mm for the 20 m buffer with selective harvesting. Water temperature was slightly impacted within the optimum temperature class only for brook trout (*Salvelinus fontinalis*) with a significant increase in the 30-50 m buffer with selective harvesting and a significant decrease in the 20 m buffer with selective harvesting. The stress and lethal temperature classes were not significantly different between pre- and post-harvest observations. The effects of selective harvesting on aquatic macroinvertebrates varied depending on the index and taxon. The number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) divided by the number of Diptera index was not significantly affected by the interaction term site and year. However, the number of total EPT,

Ephemeroptera, Plecoptera, Trichoptera, Diptera (excluding Chironomidae) and Chironomidae were all significantly affected by the interaction term site and year. The most notable difference between pre- and post-harvest occurred within the 20 m buffer, where a large increase in *Oxythira* sp., an algal consumer, was observed. This might indicate a possible increase in primary production possibly from an increase in nutrient input. The number of species observed for each of the sites was slightly greater post-harvest, however the difference was not significant for any of the study sites. Salmonid (brook trout and Atlantic salmon (*Salmo salar*) population estimates significantly increased for all three experimental sites except for brook trout within the 20 m buffer site. The biomass of brook trout significantly increased within the 20 m buffer with selective harvesting, while all other differences for brook trout and Atlantic salmon biomass were not significant.

Overall, the 30-50 m buffer with selective harvesting appeared to be the least impacted, specifically in terms of sedimentation and invertebrate community changes.

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Chapter 6

General Discussion

6.1 Buffers and blowdown

One of the major problems with the longevity of a buffer is the amount of rot within the stand. Root and butt rot decay fungi kill the lateral root systems and decay the structural heartwood in the major roots and butt section of living trees resulting in growth loss, tree mortality and windthrow. As wind moves across an opening such as a clear cut, and then comes into contact with a forest, the upper portion of the wind profiles continues unimpeded above the forest crown.

However, the lower portion of the wind profile meets with the branches and stems resulting in a great deal of stress for the trees that have recently been exposed to such wind speeds for the first time and do not have the root systems established to withstand the wind. To determine the amount of rot (or the susceptibility of the buffer to blowdown) a pre- and post-harvest rot assessment was conducted with the assistance of Dr. Gary Warren (Canadian Forest Service). For the pre-harvest assessment four sample plots within the experimental buffer area were chosen to represent each of the four dominant stand types (bs442, bs441, bs542), each plot being 1/100th ha. The number of trees with rot present was calculated for each of the experimental sites. To confirm the percentage of rot, a post-harvest assessment was conducted for the three experimental buffers. A post-harvest assessment was conducted by recording the presence of rot of all merchantable trees (10 cm or greater stump

diameter) within the buffer. As shown Figure 6.1, the amount of rot for all diameter classes is very low for the 20 m buffer site. The 20 m buffer with

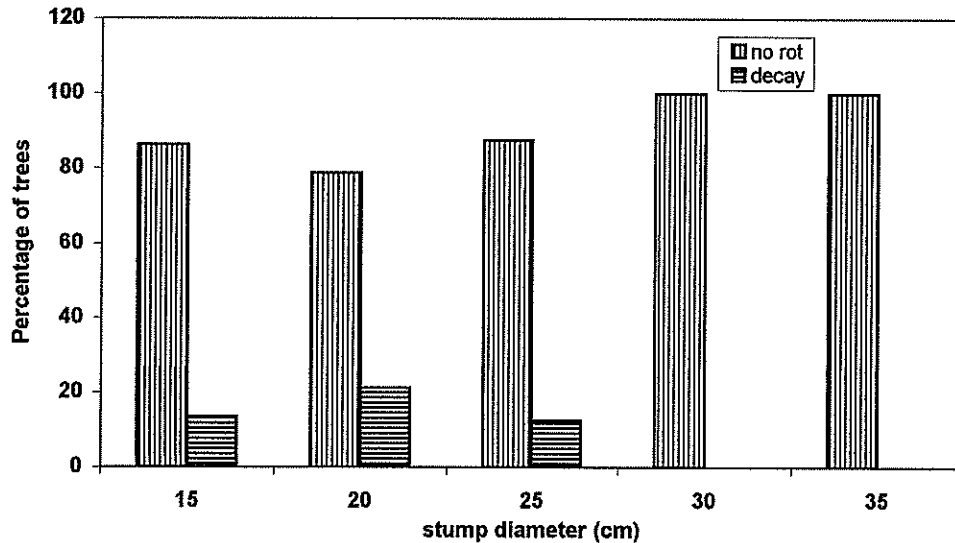


Figure 6.1. Percentage of rot decay in black spruce for various tree diameter classes within the 20 m site.

harvesting shows a greater amount of rot within the stand, thus increasing its susceptibility to blowdown (Figure 6.2). The 30-50 m buffer with harvesting at first glance appears to have a high percentage of rot, however the majority of a stand of this forest type (bs442) has a diameter at breast height at the lower end of Figure 6.3, but since this figure is showing the percentage of trees within the site with rot present, it at first glance appears misleading.

However, a one year post-harvest assessment of the buffer edge indicated a

very low percentage of blowdown (less than 5%, pers. obs.) within each of the experimental buffers with no difference between the treatments. The longevity of the buffer to withstand blowdown will be determined within the next five to ten years, with consideration given to the percentage of rot within each of the sites.

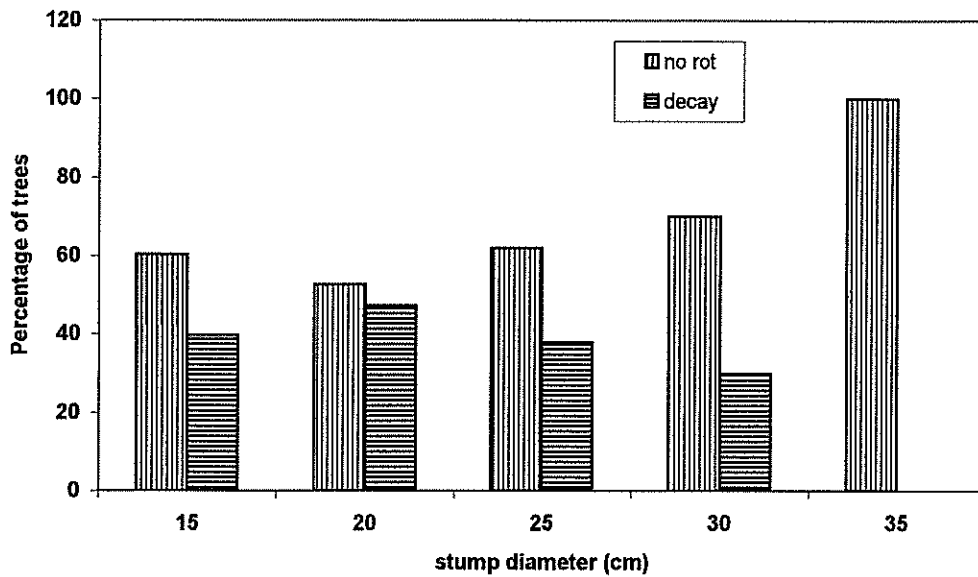


Figure 6.2. Percentage of rot decay in black spruce for various tree diameter classes within the 20 m with harvesting.

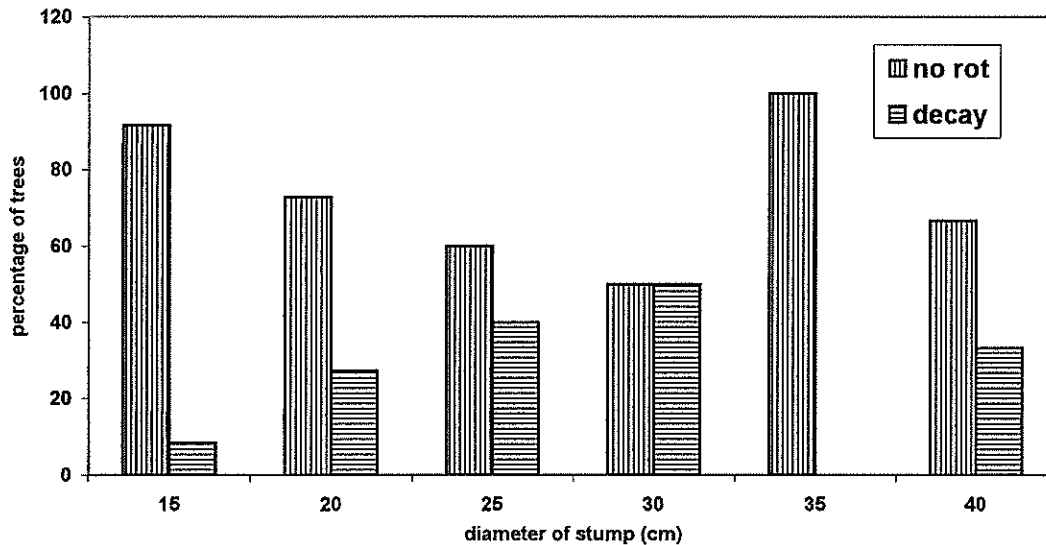


Figure 6.3. Percentage of rot decay in black spruce for various tree diameter classes within the 30-50 m with harvesting.

6.2 Overview of the impact of harvesting with managed buffer zones

Riparian vegetation plays a large role in determining the health of the associated aquatic community. The ecological processes of a stream are intimately related to those of the surrounding terrestrial ecosystem (Garman and Moring 1991).

Therefore, a compromise has to be reached that permits the retrieval of natural resources without reducing the ecological integrity of the area; a delicate balance. The primary purpose of this research project was to determine whether harvesting within buffer zones resulted in adverse effects to aquatic fauna and habitat. The results from the various components of the study yielded varied results from the impact of the harvesting.

Sediment deposition within the 20 m buffer with selective harvesting was significantly affected, however the 30-50 m buffer with selective harvesting did not appear to have been affected, as indicated by a very slight change between pre- and post-harvest. In the 20 m buffer with selective harvesting the increase in sediment was 14.5 times greater post-harvest. The implication of this increase within this site could adversely affect the aquatic habitat and fauna through various means. Sediment is known to affect the productivity of an aquatic environment through various trophic levels.

The effect of this large increase in sedimentation within the 20 m with selective harvesting site was not conclusive. The number of Plecopterans, known as indicators of water quality, decreased the greatest within both 20 m buffers, while the 30-50 m with selective harvesting increased similarly to the no harvest. Plecoptera are typically intolerant to pollution and their presence indicates good water quality (Lydy et al. 2000). This suggests the 20 m buffers are not sufficient to maintain the macroinvertebrate community which is composed of pollution intolerant taxa. However, the 30-50 m buffer with selective harvesting appeared to provided sufficient protection for the pollution intolerant taxa.

Conversely, the number of Diptera exhibited a large increase within the 20 m buffer with selective harvesting, much greater than the other experimental sites. Slaney, Halsey, and Smith (1977) found that Dipterans increased with

sedimentation, therefore one could postulate that the increase in Dipterans observed in Hungry Brook was the result of increased sedimentation.

Moreover, the other significant change within the macroinvertebrate community was a 52 times greater number of *Oxythira* sp. post-harvest compared with pre-harvest observations. This genus is an algal consumer. It could be hypothesized that this increase indicated an increase in nutrient input from increased nutrient runoff as observed by Bormann et al. (1968).

The impact of this increased sedimentation on salmonids appeared to have been negligible. Increases in brook trout and Atlantic salmon population estimates were significant for all three experimental sites except for brook trout within the 20 m buffer site. The biomass of brook trout did not appear to be negatively affected by the increased sedimentation for any of the experimental sites. The biomass of Atlantic salmon did exhibit a decrease within the 20 m buffer, however it was not significant.

The impact the changes within the macroinvertebrate community will have on the salmonids may not be evident until 2002, therefore caution is warranted in drawing conclusions as to the impact on the salmonid populations. However, thus far these changes appear to have no impact on the salmonid productivity during the two year time frame of this study.

Water temperature is an important determinant for various aquatic fauna (Gordon et al. 1992). Within this study, emphasis was placed upon the impact of water temperature regimes on brook trout. Changes in water temperature and other water quality parameters have restricted brook trout within headwater streams (MacCrimmon and Campbell 1969), and therefore were addressed within this project since several studies on the effects of timber harvesting on stream temperature have shown significant maximum stream temperature changes during the summer months (Brown and Krygier 1967; Lynch et al. 1984; Scruton et al. 1998).

The results of this study do not suggest any adverse effects to water temperature regimes. The number of hours within various water temperature classes, defined by brook trout thermal requirements, significantly changed only in the optimum category with a decrease for the 20 m buffer with selective harvesting and an increase in the 30-50 m buffer with selective harvesting. The most notable observation was the lethal and stress temperature classes that were not significantly affected. A slightly better growth potential would be expected within the 30-50 m buffer with selective harvesting due to the increase in the number of hours for the optimum class, and on the contrary, for the 20 m buffer with selective harvesting a slight decrease in growth potential would be expected. The growth potential would be expected to effect the biomass, however the

biomass of brook trout increased in both of these sites, with the significant increase observed for the 20 m buffer with selective harvesting.

6.3 Future research

Further research on the effects of timber harvesting need to focus on two areas: the impact of forwarding and nutrient runoff. Firstly, the impact of forwarding on soil compaction, and subsequently sub-surface hydrological characteristics needs to be investigated further since field observations from this study suggest this may be causing long term damage and possibly the principal source of sedimentation. The increase in algal consuming Trichoptera in the 20 m buffer site may indicate an increase in nutrient runoff. This study did not investigate the nutrient levels within the experimental buffers, however it needs to be investigated to determine whether there could be an increase in primary production from increased nutrient runoff. And if there is an increase, to what extent could the nutrient input increase primary production, with consideration to possible eutrophication of waterbodies.

6.4 Recommendations

For this study, a six wheel drive Fabtek forwarder was used with "Eco-tracks" to enclose the two rear wheels on each side. This machine was supposedly more "ecologically sound", I use this term loosely. It was observed that compaction and rutting was minimal when the forwarder drove over the slash beds left by the harvester. However, compaction and rutting were severe in numerous areas as

a result of the machine making numerous passes over the same area. In these established paths, large ruts were evident. Also, unacceptable rutting was very noticeable in the areas that had wetter terrain. Whenever the machine did not make repetitive passes over the same area, and when wetter terrain were avoided, the effect was minimal.

These deep ruts, in excess of 0.50 m resulted in water becoming channeled and confined to these paths, and following repeated passes created very turbid water with high concentrations of suspended sediment. The channeled water eventually would overflow these ruts and the result was suspended sediment flowing across the slash covered cutover, and ultimately entering the stream. Throughout the landscape there are numerous small tributaries entering headwaters streams, and it was observed that some of these tributaries become 'feeder' tributaries for these large ruts. These ruts then become "artificial streams" that begin to dominate the landscape.

My recommendation to ameliorate these negative impacts includes altering forwarding schedules to minimize soil disturbance. Winter harvesting in areas near waterbodies could result in negligible soil disturbance. Furthermore, by forwarding during winter months, frozen soil conditions would minimize the impact that forwarder ruts and soil compaction had when conditions were wet. The findings and observations of this study suggest that concentrated forwarding

within watersheds should be a concern. Subsequent rutting and siltation were observed as problems even when they were in excess of 200 m from Hungry Brook. Frequently used forwarding trails with mineral soils exposed in the ruts appeared to be the major problem particularly on sustained slopes of stream valleys. This leads to the suggestion that sustained forwarding should be restricted to areas greater than 200 meters from a waterbody. Exceptions could be made for operations conducted under winter condition with frozen terrain.

With respect to the different experimental buffers for this study, overall the 30-50 m buffer with selective harvesting appeared to have had the least impact, specifically in terms of sedimentation and invertebrate community changes. The 20 m buffer and the 20 m buffer with selective harvesting observed a decrease in the number of Plecoptera, possibly indicating a decrease in water quality. To further this point, the 20 m buffer with selective harvesting site exhibited a large increase in sedimentation.

The term ecoforestry is based on the understanding that there are thousands of life forms which form complex communities and who live within forests, or are intimately dependent on forests such as aquatic ecosystems, and these life forms have intrinsic value which needs to be recognized and respected (Thom 1997). Ecoforestry attempts to maintain these complex interactions while harvesting forest goods to meet the requirements of humans over the long-term, in other

words, sustainable (Thom 1997). It places priority firstly on maintaining the ecological integrity of forests, so that they can provide the economic needs of humans and the forestry industry. To this end, if future research suggests the 30-50 m buffer with selective harvesting to be superior to the current method of riparian protection, maybe a buffer such as the varying 30-50 m buffer with selective harvesting should be implemented as the required protection along waterbodies to maintain ecosystems. To maintain sustainable forests maybe we should be attempting to leave as much value as we can in a forest, instead of taking as much value as we can out of a forest; a new concept that is long overdue within a century old industry in Newfoundland.

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