BEST MANAGEMENT PRACTICES FOR EROSION CONTROL FROM BLADED SKID TRAILS

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ABSTRACT

Sediment from forest operations is primarily associated with roads and skid trails. We evaluated five skid trail closure treatments applied to bladed skid trails in the Virginia Piedmont. Closure treatments were Waterbars, Seed, Mulch, Pine slash, and Hardwood slash. Sediment traps were used to collect monthly sediment samples for one year. The Mulch, Pine slash, and Hardwood slash treatments produced erosion of less than 4 tons/acre/year while the Waterbar only treatment produced over 60 tons/acre/year. Seed was better than Waterbar only, but was not as effective as the other treatments. Other factors that contributed to sediment production included time since installation, frost heaving, and precipitation quantity and intensity. These data indicate that best management practices which favor ground cover by slash, vegetation, or similar treatments should provide adequate erosion control.

INTRODUCTION

Numerous research projects have concluded that forest roads and skid trails produce a disproportionate quantity of sediment as compared to other forest operations (e.g. Reid and Dunne 1984, Swift 1985, Megahan and others 2001, Litschert and MacDonald 2009). Bladed skid trails are commonly used on steep terrain in order to facilitate ground based skidding (Garland 1997). Kochenderfer (1977) found that bladed skid trails can comprise 2-10% of the harvest area, but Jackson and others (2002) found that even greater areas are found in harvests with poor preharvest planning. Due to difficult terrain and the typically minimal standards used to construct such trails, erosion is often a concern (Croke and others 1999, Ziegler and others 2007). Garland (1997) outlined the environmental and economic advantages of preharvest planning of skid trails. Worrell and others (2011) found that bladed skid trails in the Allegheny Plateau region of Virginia produced erosion rates greater than 25 tons/acre/year. These erosion rates are of concern to landowners due to potential losses in productivity and to society because of potential stream sedimentation problems (Aust and Blinn 2004, Anderson and Lockaby 2011). Forestry Best Management Practices (BMPs) used to stabilize bladed skid trails include water control structures, revegetation, and addition of soil cover (Grace and others 1998, Grace 2002, Shepard 2006). The objective of this project was to evaluate the erosion control efficacy of five different bladed skid trail closure BMPs.

METHODS

STUDY SITE AND TREATMENTS

The study was conducted at the Virginia Tech Reynolds Homestead Forestry Research Center near Critz, VA. The site is located in the upper Piedmont Physiographic Province (Fenneman 1938). A 25 acre site was selected and had been clearcut harvested, prescribed burned, and was scheduled for replanting. Soils were Fairview sandy clay loams and sideslopes ranged from 20-30%. We located the centerline for six bladed skid trails of approximately 250 feet in length on 10-15% grades. Each skid trail was constructed with a John Deere 450 bulldozer and waterbars were installed approximately every 50 feet. The water bars provided separation between each 50 foot segment, which provided the experimental unit area. PVC gutters were installed at the base of each skid trail segment and were attached to geotextile sediment traps.

The six trails each had five skid trail closure treatments randomly assigned to the trail, creating 30 experimental units. Treatments were 1) Waterbar with bare soil (Waterbar), 2) Waterbar with fertilizer, lime, and grass seed (Seed), 3) Waterbar with seed and mulch (Mulch), 4) Waterbar and hardwood slash (Hardwood), and 5) Waterbar and pine slash (Pine). For the Seed and Mulch treatments we applied lime (one ton/acre), 10-10-10 fertilizer (200 lbs/acre), and a blend of winter rye, timothy, orchard grass, perennial rye, medium red clover, and annual rye at 50 lbs/acre. Reseeding was conducted until all Seed plots had at least 40% cover.

FIELD METHODS

Geotextile sediment traps (Robichaud and Brown 2002) were weighed monthly with a crane scale mounted on a bulldozer blade. Soil moisture was obtained for each sediment trap so that weights could be corrected for soil moisture. Soil weights were also corrected for bag weights. A subproject evaluated the sediment trapping efficiency of the sediment traps and found that the traps collected 70% of the sediment so final weights were adjusted to reflect total sediment.

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STATISTICAL ANALYSIS

Data were analyzed as a Randomized Complete Block Design with repeated measures (Schabenberger and Pierce 2002). The six skid trails provided the blocks, the trail closure BMPs provided five treatments, and the monthly erosion measurements during a 13 month period served as the repeated measures. Data were analyzed with SAS version 9.2 statistical software (SAS Institute 2008). Treatments were judged to be statistically different at an alpha level of 0.05 and Tukey mean separation tests were used to separate treatment effects.

RESULTS AND DISCUSSION

The five skid trail closure treatments had significantly different rates of erosion (p=0.02) (Table 1). Overall, the Waterbar treatment was the least effective for controlling erosion (61.3 tons/acre/year) and produced erosion rates similar to active construction (Yoho 1980). The Seed treatment, even with relatively low establishment (40-60% cover) reduced erosion by 77.1% as compared to the Waterbar treatment. The two slash treatments (Hardwood and Pine) and the Mulch treatment all had erosion rates that would be considered sustainable for agricultural operations and that reduced erosion by over 93% as compared to the Waterbar treatment. Our results are typically supported by literature from a variety of areas and situations. McGreer (1981) evaluated slash as an erosion control treatment on skid trails in Idaho and had similar results. Grusheky and others (2009) evaluated the use of fiber mats for erosion control in West Virginia and concluded that they provided more immediate and effective erosion control than seed only.

Examination of the treatment effects during each monthly measurement period revealed that the significantly different erosion rates were typically associated with one of three situations (Table 2). Periods having precipitation greater than 2.2 inches resulted in higher erosion rates, particularly during intense precipitation events. For example, May, June, October, and January had precipitation greater than five inches/month and only October did not have significantly greater erosion for at least one of the treatments. October had several events of low intensity, thus it did not have significantly different erosion rates for any treatment. Treatments that did not provide cover immediately after application (both Waterbar and Seed) had higher erosion rates (Table 2). For example, the Waterbar and Seed treatments had the highest rates of erosion during the first two months following treatment because they did not immediately provide cover. Periods of frost heaving during January and February were also associated with higher erosion on the bare soil of the Waterbar treatments. The data indicate that the Waterbar treatment was still eroding significantly faster than the other treatments even at the end of the collection period.

CONCLUSIONS

These data indicate the importance of cover for minimizing erosion from bladed skid trails. Additional considerations are logistics, costs, and additional benefits of the treatments. The Mulch, Pine, and Hardwood treatments all provide effective and immediate erosion control. Both slash treatments potentially have the added benefits of reducing off road vehicle traffic and providing erosion control for several years after application. The Mulch treatment requires less equipment for application, but requires purchase of straw bales. The Mulch treatment could also potentially become less effective if unfavorable condition such as drought killed seeded vegetation after mulch decomposition. The Hardwood and Pine slash treatments could be conducted as part of the harvesting operation with minimal costs. However, the slash would not be available for chipping if this were a whole tree harvest operation. A typical harvest operation of 50 acres could have five acres of bladed skid trails (10% of area). If we assume that we would track slash onto the skid trails to a depth of at least one foot, this would require over 4,000 tons of wood. This slash would have environmental benefits, but the costs of leaving this much slash may become of more concern if additional biomass markets emerge.

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Table 1—Average soil erosion rate (tons/acre/year) for the five skid trail closure methods. Treatments with different letters are statistically different (alpha = 0.05). Each average is based on 78 measurements (6 blocks x 13 months)

Erosion Control Treatment	n	Erosion	Standard Deviation	Erosion Reduction Relative to Waterbar
		(tons/acre/year)		(%)
Waterbar	78	61.3 a	8.1	na
Seed	78	14.0 b	4.1	77.1
Hardwood	78	4.0 bc	0.7	93.5
Pine	78	2.6 cd	0.5	95.8
Mulch	78	1.3 d	0.2	97.9

Table 2—P-values, erosion, and precipitation by closure treatment and collection period. Within a month, treatments with different letters are statistically different (alpha = 0.05). Each treatment x period combination represents the average of six bladed skid trails (blocks)

	----------Month----------												
Treatment	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
P-value 0.001	0.001	ns	ns	0.03	ns	ns	ns	0.001	0.001	ns	0.001	0.001	
	----------(Erosion (tons/acre))----------												
Waterbar	11.6 a	11.0 a	1.2 a	0.3 a	2.5 a	1.8 a	0.7 a	1.7 a	6.9 a	8.5 a	1.8 a	9.0 a	9.6 a
Seed	4.3 b	4.9 b	0.1 a	0.0 a	0.6 a	1.8 a	0.1 a	0.2 a	1.2 b	0.7 b	0.9 a	1.0 b	1.0 b
Hardwood	1.1 c	0.8 c	0.1 a	0.0 a	0.1 b	0.1 a	0.1 a	0.1 a	1.0 b	1.3 b	0.2 a	0.4 b	0.2 b
Pine	0.7 c	0.4 c	0.0 a	0.0 a	0.1 b	0.1 a	0.1 a	0.1 a	0.5 b	0.5 b	0.1 a	0.2 b	0.1 b
Mulch	0.4 c	0.2 c	0.0 a	0.0 a	0.1 b	0.1 a	0.1 a	0.0 a	0.4 b	0.2 b	0.1 a	0.1 b	0.1 b
	----------(inches/month)----------												
Precipitation	6.9	5.3	1.5	1.0	3.4	8.3	4.9	1.9	8.9	3.9	2.2	4.4	3.7