

RECLAMATION OF SKID ROADS WITH FIBER MATS AND NATIVE VEGETATION: EFFECTS ON EROSION

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Abstract—A research study was established to test the effectiveness of fiber mats and native seed mixtures in reducing soil erosion from newly-constructed skid roads in the Elk River Watershed in central West Virginia. Twelve road sections of equal grade were paired with a randomly-selected section receiving a fiber mat and native grass seed while the other road section was not treated. Silt fences with sediment traps were constructed at the downslope ends of each road section. Sediments were collected from silt traps three times during the summer of 2005. Road sections with no fiber mulch or seeding averaged 174.1 g/m² and those with fiber mulch and seeding average 34.9 g/m². Vegetation averaged 17.5 cm in height on fiber mulch treated road sections; no vegetation was observed sections without fiber mulch during the study period. Further research is needed to develop a cost/benefit analysis of employing the road reclamation approach used in this pilot project.

INTRODUCTION

The forestry community has long known that controlling non-point source pollution from silvicultural activities is important. Most states now have forest practice standards or best management practices that require the control of sediments from exposed areas. West Virginia published a set of Forest Practice Standards in 1972, which were the first of their kind in the eastern United States. In 1992, the West Virginia Legislature passed the Logging Sediment Control Act (LSCA). The LSCA mandated that loggers become licensed and certified, notify the West Virginia Division of Forestry about logging operations, and mandated that logging sites be reclaimed within seven days of the completion of operations.

Forest roads, trails, and landings are the primary sources of non-point source pollution, primarily in the form of eroded soil sediments (Egan and others 1996, Kochenderfer and others 1997). Sediments that make their way to a stream channel can be deposited in deeper pools and, once introduced into a stream, can have deleterious affects on both vertebrate and non-vertebrate aquatic wildlife populations. Sedimentation can also affect the natural characteristics (i.e., depth, temperature, width) of the stream itself.

Since landings, forest roads, and skid trails are the largest potential source for sedimentation, it is natural for the forestry community to concentrate their research, education and outreach efforts in this area. This focus is especially justified since Egan and Rowe's 1997 study found that improvements could be made in skid road drainage and that in 2000, LSCA oriented logging inspections found that 11 percent of compliance problems were due to skid/haul road problems (Milauskas 2001). Likewise, a 2001 LSCA evaluation found that 13 percent of compliance problems were due to skid and/or haul roads (Milauskas 2002).

Exposed soils following harvesting operations represent the main potential for erosion. If vegetation is not established quickly, erosion of these exposed surfaces is likely until natural herbaceous and woody vegetation becomes established. The establishment of vegetation on skid roads not only lessens erosion, but it also provides nesting, feeding, and escape habitat for wildlife. After harvesting in West Virginia, skid roads and trails represent approximately 10 percent of the total harvest area (Provencher 2004). Thus,

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vigorous establishment of vegetation on skid roads should be of top priority when timber harvesting sites are reclaimed. Currently in West Virginia, only those skid roads that exceed 15 percent slope, or are within 100 feet of a landing or water crossing must be seeded.

The objective of this pilot project was to document the effectiveness of fiber mats and native vegetation for reducing sediments from skid roads in a high quality watershed in West Virginia. Results from this research project will help refine reclamation techniques so that the impact of sedimentation can be reduced after timber harvesting in West Virginia.

METHODS

This pilot project was initiated in the Upper Elk River Watershed near Webster Springs, West Virginia (fig. 1). The Upper Elk Watershed is a high-quality coldwater system with 16 streams (37 miles) identified under Section 303(d) of the Federal Clean Water Act.

The Elk watershed extends the length of half the state, beginning in the Allegheny Mountains in the east and flowing west to meet the Kanawha River at Charleston, WV, the urbanized and political center of West Virginia. Most of the watershed is under private ownership, divided mainly among three large forest products companies. However, 26 percent of the watershed is publicly owned as part of the Monongahela National Forest. The upper Elk watershed is 95 percent forested and supports some of the highest quality hardwoods in the United States. The quality and quantity of timber in the area leads to a substantial amount of cutting activity in this watershed.

During the spring of 2005, a private timber operator agreed to allow our team to establish this research project within a newly completed harvest unit. Twelve short sections of skid road were identified along two major skid roads from the main landing area. Skid road sections were paired, thus we identified six areas for treatment and six reference road sections within the harvest unit.

Road sections were delineated based on known water-breaks. For example, the start of each section contained pre-established water bars. Sediment catchments were then constructed below the water bar. Sediment catchments consisted of high-quality silt fence staked perpendicular to the road from cut bank to the end of opposite cut bank or fill slope. A 12-inch lip was turf-stapled to the road and served as the sediment trapping area. The total area of the section was calculated based on disturbed skid road section that fell between the sediment trap and the water bar (fig. 2). All skid road sections were chosen so that sediments would flow naturally towards the sediment traps. Slopes ranged from 4 to 36 percent (average = 18 percent) on the selected road sections and were paired based on proximity and slope. Treated areas averaged 16 percent slope, while reference sections had an average slope of 19 percent. Slopes found on both treated and reference sections are above the minimum 15 percent where vegetation establishment is mandated by the WV LSCA.

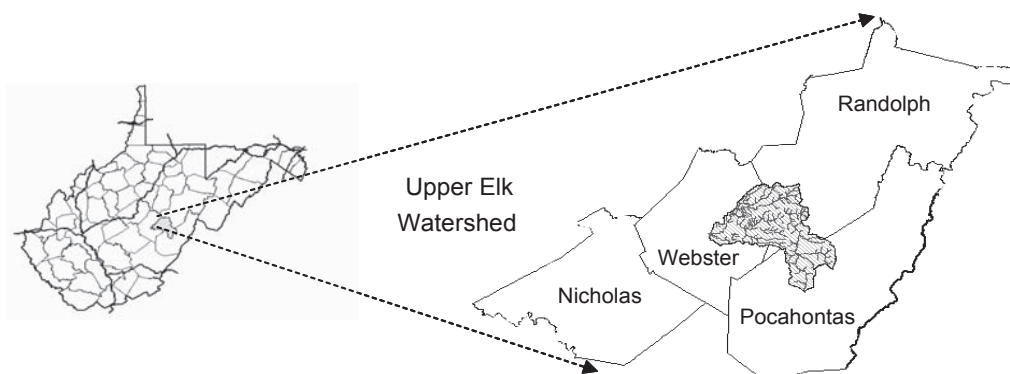


Figure 1—Location of the Upper Elk River Watershed in West Virginia

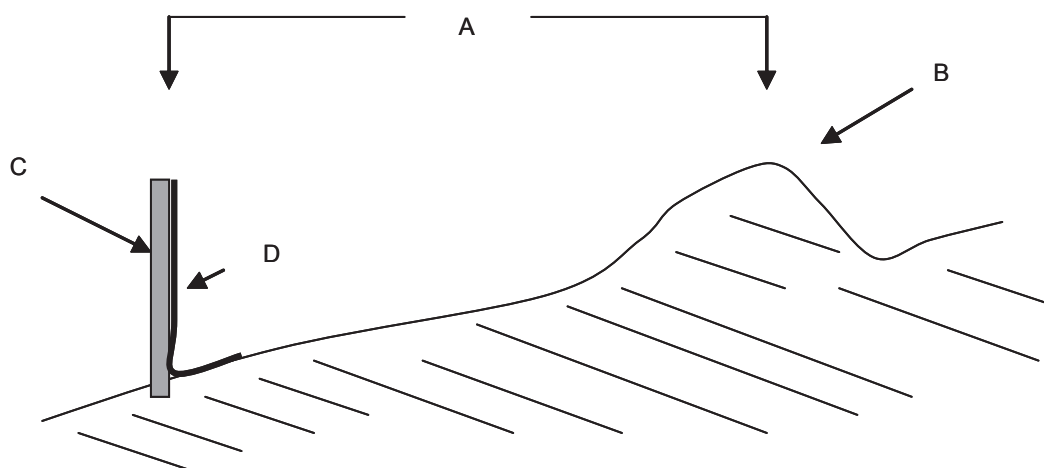


Figure 2—Schematic drawing detailing sediment collection area used on skid roads in the Upper Elk River Watershed in West Virginia. Drawing includes (A) catchment area, (B) water bar, (C) silt fence stake, and (D) silt fence with silt trap at base.

After sediment traps were created, six sections of the paired areas were selected randomly for vegetation treatment. A mixture of native vegetation was chosen for treatments (table 1). Seed was spread manually on the six sections. A high-velocity natural fiber mat purchased from Ernst Conservation Seeds was then unrolled on the section and staked into place. Sediment traps were emptied three times from the period of late June to August, 2005. All collected sediment was placed in labeled bags and returned to a laboratory. Sediments were then oven dried until their mass did not change. Weights were then recorded for use in subsequent analyses. Average vegetation height was also recorded during each sediment collection period.

An analysis of covariance (ANCOVA) was used to test for differences in sediments eroded from skid road sections while adjusting for slope and length. The following model was used (all tests of significance were conducted at an $\alpha = 0.05$ level):

$$Y_{ij} = \mu + \alpha_i + \beta_1 \chi_i + \varepsilon_{ij}$$

where

Y_{ij} = sediments collected per unit area

μ = the overall mean of sediments collected per unit area

α_i = effect of the i th treatment group

$\beta_1 \chi_i$ = covariates (slope and section length)

ε_{ij} = random effect that represents all uncontrolled variability

RESULTS

Total sediments displaced within each road section were standardized to g/m^2 by dividing the sum of sediments collected during the three time periods by the associated catchment area. Catchment areas averaged 26.2 m^2 on reference sites and 28.9 m^2 on treated skid road sections. Mean length of catchment area was 7.5 m and 7.9 m on reference and treated areas, respectively. Collected sediments ranged from 5.0 g/m^2 on a treated skid road section to 310.6 g/m^2 on a reference section (table 2). Average sediment per area was 174.1 g/m^2 on reference sites and 34.9 g/m^2 on treated sites. Vegetation averaged 17.5 cm on treated sites, no vegetation was observed during the sampling period on reference skid road sections.

Table 1—Seed mixture used to reclaim skid trail sections in the Upper Elk River watershed near Webster Springs, WV

Common name	Scientific name	Rate kg/ha
Annual winter wheat	<i>Triticum aestivum</i> L.	8.9
Little bluestem	<i>Schizachyrium scoparium</i>	2.7
Big bluestem	<i>Andropogon gerardii</i>	4.5
Side oats gramma	<i>Bouteloua curtipendula</i>	2.7
Silky wild rye	<i>Elymus villosus</i>	5.8
Creeping red fescue	<i>Festuca rubra</i>	6.7

Table 2—Characteristics of skid trails treated in the Upper Elk River watershed near Webster Springs, WV which includes slope, area, total sediments collected, total sediments collected in relation to area, and average vegetation height

Skid trail section	Treatment	Slope percent	Area m ²	Length m	Sediment collected gm	Sediment/ area gm/m ²	Vegetation height cm
1	Reference	8	23.6	7.4	2 633	111.7	—
2	Treated	11	50.1	10.9	696	13.9	16.5
3	Reference	4	25.7	7.6	140	5.4	—
4	Treated	14	29.8	9.5	148	5.0	26.2
5	Reference	11	19.5	6.0	2 338	120.1	—
6	Treated	18	18.5	6.7	531	28.7	20.3
7	Reference	26	9.9	4.3	2 590	262.3	—
8	Treated	26	15.4	5.2	961	62.3	17.8
9	Reference	13	26.1	6.6	6 155	236.1	—
10	Treated	11	35.2	8.3	1 135	32.3	13.5
11	Reference	34	52.7	13.3	16 356	310.6	—
12	Treated	36	24.1	6.7	1 614	66.8	10.9

^a Treated skid trail sections were covered with fiber mulch mats and seeded; reference skid trail sections were not treated.

— = the reference skid trails sections were not treated, thus vegetation height for the reference treatments was not available.

We found a significant difference in sediments collected from treated skid road sections ($p=0.0215$). Sediments collected on treated skid roads were significantly lower than those collected on reference sections.

DISCUSSION

Forest roads and skid trails are the first access system used in the Appalachian Region to move wood products to market. Soil exposed during harvesting activities, specifically road construction, is known to be the greatest contributor to stream sedimentation (Kochenderfer 1970, Kochenderfer and Aubertin 1975, Patric 1976). Subsequently, practices have been developed that focus on reducing erosion from forest roads, including leaving log slash barriers, seeding fill areas, creating broad-based drainage dips, and daylighting (Kochenderfer 1970), all of which are recommended practices under the WV LSCA.

Most research has shown that sediment levels return to pre-harvest levels within three years of harvest (Hornbeck and Reinhart 1964, Patric 1980, Kochenderfer and others 1997). Since soil exposed during the construction of road systems appears to be the “weak link” when it comes to sediment movement following harvesting, we focused our efforts on reducing its severity. Reductions of the magnitude found in this pilot project indicate that the use of fiber mats and proper re-vegetation of skid roads after harvest has good potential for limiting in-stream sedimentation. It has been found that forest litter and vegetation strips reduce the amount of sediments that actually make it into a stream system (Swift 1986). Therefore, we cannot assume that the reductions we found would mirror those found at streamside. However, keeping sediment from moving from the road systems limits the amount buffered by litter and vegetation surrounding the stream corridor, thus adding to their protective qualities.

Kochenderfer and others (1997) found that the sediment increases following harvest represent a small percentage of the total sediment delivered from a watershed during a 100 year rotation. Therefore, our reductions alone may not significantly reduce stream sedimentation over a typical rotation. However, since most of our study site was in an industrial timber production area, multiple timber harvests will occur in the watershed over the next rotation, all with the potential to increase sediment delivery out of the system. Therefore, sediment reductions of the magnitude found have the potential to significantly reduce sedimentation over a long rotation.

We acknowledge that the effect of the fiber mats used cannot be separated from the impact of the vegetation establishment. However, vegetative growth was quite vigorous on treated skid roads, and the root structure associated with it likely contributed to the reduction in sediments found and will provide extended life to the protected soil as the fiber mats decompose. However, most of the initial reduction in sediments found during this research can likely be attributed to the effects of the fiber matting used. More research is underway in this watershed to determine if seeding alone has a similar impact on sediment reduction.

Likewise, the extra costs associated with the reclamation work done in this pilot project have not been compared to traditional techniques. Expenses associated with BMP establishment can be substantial (Egan 1999), therefore, the cost/benefit relationship of these techniques should be further investigated.

A novel aspect of this pilot project was the use of native vegetation in seeding mixtures. The establishment of native vegetation on skid roads and landings not only controls sedimentation, but it also provides natural habitat for wildlife, while limiting the spread of non-native invasive plants. Current BMP regulations under the WV LSCA do not require the use of native plant species, however, the impacts of choosing natives over exotics and naturalized species should be further investigated.

Regulations, both mandatory and voluntary, have been enacted in West Virginia to control sedimentation. Egan and Rowe (1997) evaluated BMP use after the WV LSCA and found significant increases in compliance levels. However, improvements in haul and skid road drainage practices needed to be improved (Egan and Rowe 1997). Further research is needed to refine techniques and develop a cost/benefit analysis on the feasibility of employing the reclamation approach used in this pilot project.

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