FINAL REPORT
to

West Virginia Division of Forestry
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VIGOROUS ESTABLISHMENT OF NATIVE VEGETATION ON LANDINGS AND SKID ROADS IN THE UPPER ELK RIVER WATERSHED

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Introduction and Background

The West Virginia forestry community has long known that controlling non-point source pollution from forest management activities is important. The West Virginia Division of Forestry published a set of Forest Practice Standards in 1972, which were the first of their kind in the eastern United States. After the Federal Water Pollution Control Act Amendments of 1972 (PL92-500), specifically section 208 of this law, the West Virginia forestry community was mandated to develop a Silvicultural Water Management Plan for West Virginia. An advisory committee, made up of individuals from the public and private sector, developed a Best Management Practice (BMP) manual in the late 1970's that was intended to reduce soil erosion due to forestry (Sherman 1985). 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 of logging operations, and required that logging sites be reclaimed within seven days of the completion of operations.

Thus regulations, both mandatory and voluntary, have been enacted in West Virginia. Have they, however, reduced non-point source pollution due to forest management practices in West Virginia? Evaluations of BMP use in West Virginia were conducted in 1981, 1986, and 1990 when a more voluntary approach was used to address this issue. Although compliance with BMPs increased annually (from 59% to 75%), each evaluation found some weaknesses in loggers harvesting and reclamation procedures. These weaknesses were used to rewrite the BMP manuals so that the deficiencies could be addressed and to further direct education efforts in subsequent harvesting operations (Whipkey 1991). In 1995-1996 Egan and Rowe (1997) evaluated BMP use after the LSCA and found slight increases in compliance levels since Whipkey's study in 1991. Among the deficiencies reported by Egan and Rowe (1997) was the need for improvements in haul and skid road drainage practices (Egan and Rowe 1997). In 2004 Wang and Goff (2004) found similar BMP compliance in West Virginia.

Forest roads, skid trails, and landings are the primary source of non-point source pollution, or sedimentation, after logging operations in West Virginia (Egan et al. 1996, Kochenderfer et al. 1997). These sediments make their way to streams and can have a negative effect on vertebrate and non-vertebrate wildlife populations. Natural characteristics, such as depth, temperature and stream width, can also be affected by sedimentation. Because landings and forest roads 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.

Erosion from skid trails and landings is often intensified by the compacted nature of the soils following timber harvest (Figure 1). Compacted soils in areas frequented by logging equipment results in a poor seedbed for the establishment of vegetation following harvest; Severe compaction may even persist for decades (Corns 1988). Usually, these areas are reclaimed by sowing seed in the divots created by dozer tracks. Although this process may lead to seedling establishment, germination is often delayed, and vegetation may develop in a "spotty" fashion (Figure 1). Further, seed mixtures used for reclamation are composed of non-native seeds dominated mainly by fescues. The establishment of native vegetation on skid roads and landings not only controls sedimentation, but it also provides nesting, feeding, and escape habitat for wildlife and promotes healthy, native plant diversity in watershed forests.

Figure 1. Soil compaction and spotty germination in dozer tracks.

Our research was conducted in the Upper Elk Watershed of the Elk River Watershed in West Virginia (Figure 2). The watershed is a high-quality coldwater system with 16 streams (23 kilometers) listed under the draft 303(d) list. The entire Elk watershed extends half the length of the state, originating in the Allegheny Mountains to the east and flowing west to meet the Kanawha River at Charleston, West Virginia. Private individuals own most of the land in the watershed; however, 26% is public land in the Monongahela National Forest. The Upper Elk watershed is 95% forested and supports some of the highest quality hardwoods in the United States.

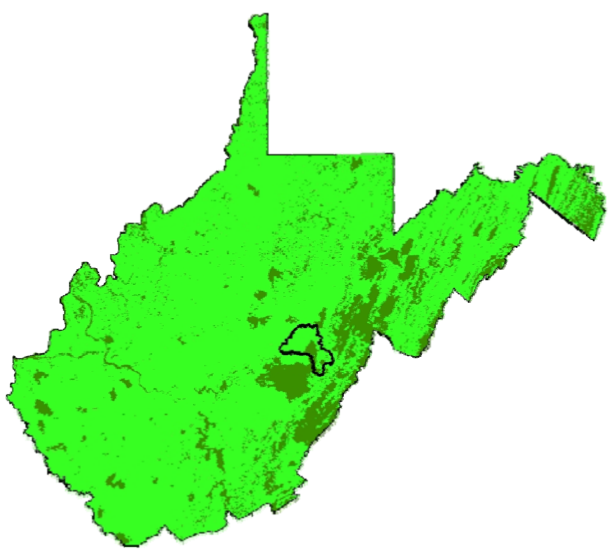

Figure 2. Location of the Upper Elk Watershed in West Virginia.

Methods

Program Development and Wood Product Industry Involvement

We developed a program to recruit landowners in the Upper Elk Watershed for participation in this research project. Brochures were developed to describe the project and its objectives, and mailed out to landowners in the Upper Elk Watershed (Appendix A). Additionally, representatives from the Appalachian Hardwood Center visited several timber companies in the watershed to discuss the project and recruit them for participation. These were the first steps to identifying possible study areas within the watershed and to educate landowners on the project.

Development of Seed Mixtures

Our objective was to develop seed mixtures that in addition to meeting BMP requirements for sediment control, were also native and offered wildlife and aesthetic benefits. We developed 3 native seed mixtures for this project based on 3 specific enhancement criteria, and compared them to a fourth non-native mixture used currently by timber companies for reclamation (Table 1). First, we developed a stabilization mixture for use by timber companies. Its main purpose was to prevent erosion on landings, embankments, and skid trails. The second seed mixture was developed as a forage source for wildlife. Several private landowners have expressed an interest in converting landings and roads into forest openings that benefit wildlife on their property. The third mixture focused on wildflowers, and was developed for private landowners or for industry that may have a landing where they are looking for a nice esthetic. Both the wildlife and wildflower mixtures also contained the stabilization mix because the main purpose of this project was to prevent erosion from reclaimed areas. A fourth, non-native mix was also tested. This mix is the traditional mix used currently by timber companies in the watershed for reclamation.

Table 1 . Seed mixture composition and seeding rates. Mixtures were spread at a rate of 5.1 kg/hectare (25 lb/acre).

Mix	Common Name	Scientific Name	Rate (kg/hectare)	Percent
Stabilization	Annual Winter Wheat	*Triticum aestivum L.*	2.0	40
	Deer Tongue Grass	*Panicum clandestinum, Tioga*	0.3	6
	Silky Wild Rye	*Elymus villosus*	1.2	24
	Creeping Red Fescue	*Festuca rubra*	1.5	30
Wildlife	Annual Winter Wheat	*Triticum aestivum L.*	0.5	10
	Deer Tongue Grass	*Panicum clandestinum, Tioga*	0.1	2
	Creeping Red Fescue	*Festuca rubra*	0.7	14
	Partridge Pea	*Chamaecrista fasciculata*	1.3	25
	White Clover	*Trifolium repens, Ladino*	2.5	49
	Rubus	*Rubus allegheniensis*	0.02	1
Wildflower	Annual Winter Wheat	*Triticum aestivum L.*	1.0	20
	Deer Tongue Grass	*Panicum clandestinum, Tioga*	0.2	3
	Silky Wild Rye	*Elymus villosus*	0.6	12
	Creeping Red Fescue	*Festuca rubra*	0.8	15
	Ox Eye Sunflower	*Heliopsis helianthoides*	0.3	5
	Wild Blue Lupine	*Lupinus perennis*	0.5	10
	Black-eyed Susan	*Rudbeckia hirta*	1.1	21
	New England Aster	*Aster novae-angliae*	0.2	4
	Showy Tick Trefoil	*Desmodium canadense*	0.5	10
Traditional	Orchard Grass	*Dactylis glomerata L.*	*	*
	Rye Grain	*Secale cereale*		
	Birdsfoot Trefoil	*Lotus corniculatus L.*		
	Timothy Grass	*Phleum pratense*		
	Red Clover	*Trifolium pratense*		
	Perennial Ryegrass	*Lolium perenne L.*		
	Unknown Seed			

*****Seeding rates and percentages are unknown for the traditional mixture.

Study Site Identification

Satellite imagery of the Upper Elk Watershed taken in 2003 was used to identify candidate landings and skid trails for this project (Figure 3). Foresters from the West Virginia Division of Forestry and local timber companies also provided assistance in locating possible sites and in making contacts with landowners. Extensive site visits were required to select study sites in both 2005 and 2006.

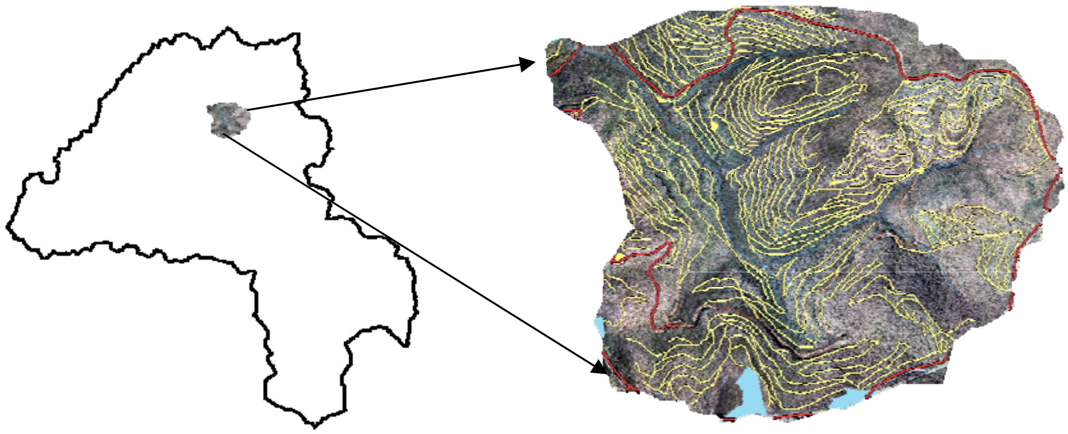

Figure 3. Digital imagery of the Upper Elk Watershed with skid trails and landings.

Landing Reclamation

Twelve landings were reclaimed during the spring of 2005 and twelve landings during the spring of 2006 for this project (Figure 4); two of the landings reclaimed in 2006 were sites that were unsuccessfully planted in 2005. Soil samples were taken from landings in 2005 and sent in for analysis to determine lime and fertilizer requirements for the watershed. Landing preparations included soil scarification using a modified ripper-tooth dozer-blade assembly (Figure 5) and plantings of native seed mixtures. The modified ripper-tooth dozer-blade assembly (Figure 5) was developed to turn up the soil on landings and create better seed to soil contact than is created by traditional dozer blade dragging of landings before planting. The assembly can be hydraulically fitted onto any dozer and requires no extra modifications to the dozer blade for use. Two ripper-assemblies are available for companies and landowners in the watershed. Landings were seeded and mulched by hand in 2005 using no additional fertilizer or lime. The scarified soil on landings was dragged using a harrow drag and ATV, and then rolled flat after planting using a lawn roller and ATV, for optimum seed to soil contact. All areas were reclaimed using a 4.5 kg/ha (25lb/acre) seeding rate and were mulched with straw to prevent non-native seed contamination. Silt fence was installed around landings to decrease potential erosion during scarification and reclamation (Appendix B).

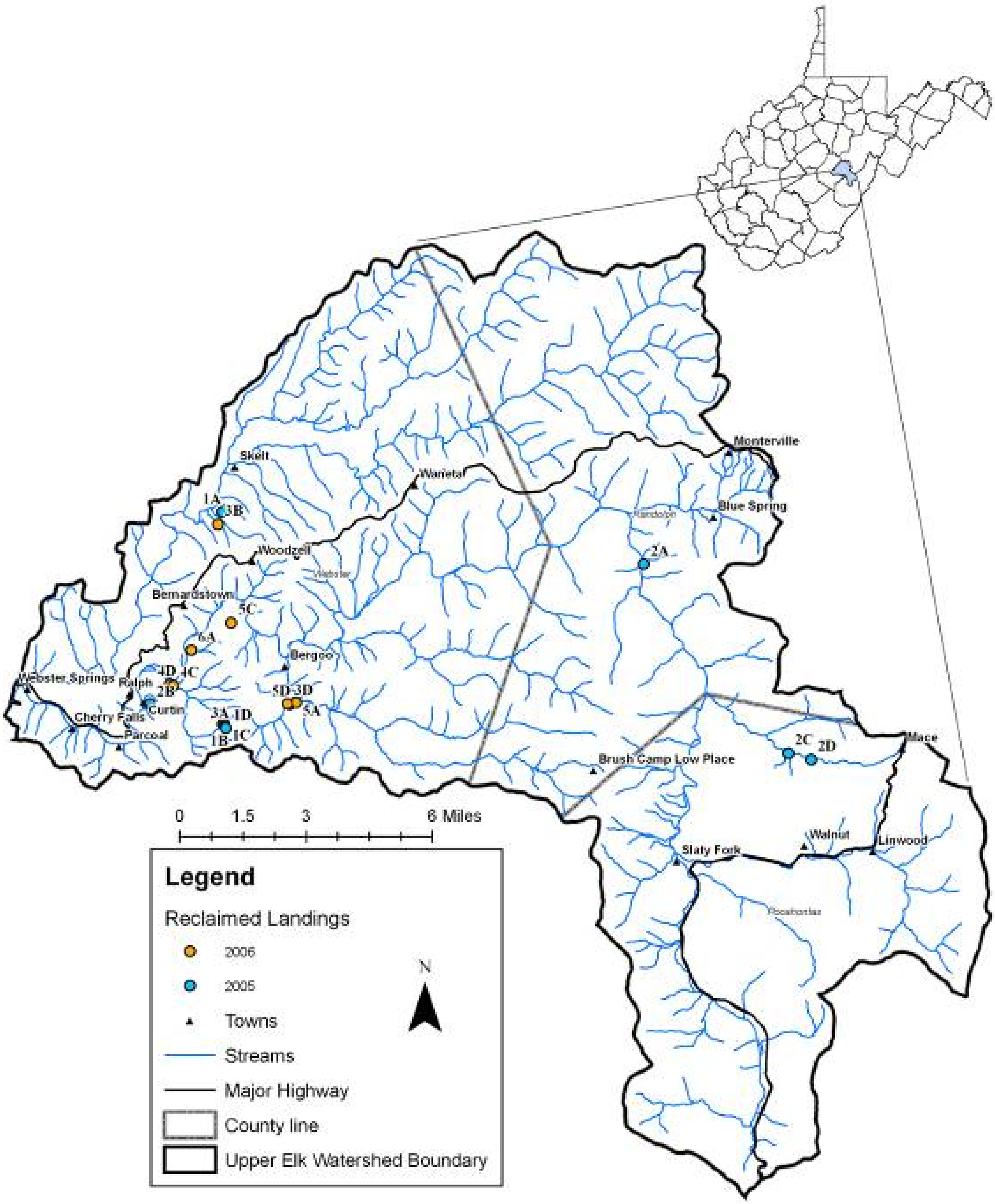

Figure 4. Reclaimed landings in 2005 and 2006 in the Upper Elk Watershed.

Figure 5. Modified ripper-tooth dozer-blaze assembly

In 2006, a hydroseeder was used to plant landings. Both fertilizer and lime were added to the seeding mixture to maximize planting success. Hydroseeding became the main method of planting in 2006 and resulted in the development of an affordable, easy to use 500-gallon hydroseeder (Figure 6) made possible through supplemental grant money provided by the Upper Elk Soil Conservation District. The hydroseeder was mounted onto a trailer that can be pulled behind a vehicle.

Figure 6. 500-gallon log landing hydroseeder mounted on a trailer to be pulled behind a truck.

To measure sediment eroding from log landings, a modified silt-fence method of collection was used (Robichaud and Brown 2002). This technique is simple, efficient once fences are installed, and inexpensive relative to other sediment collection techniques (Robichaud and Brown 2002). Sediment "wells" were constructed of silt fencing (Amoco geo-textile #2016, Austell, Georgia) on the greatest slope of each log landing. Fencing was installed in a 3.2M x 3.2M square to prevent outside sediment from running into the calculated area of the well (Appendix B). Once secured with wooden stakes, excess fencing at the bottom of the slope was folded towards the upslope (Appendix B). The edge of the fencing was secured using turf staples placed every 6 cm. This upturned area created a collection well from which to collect sediment. The collection well material area could be precisely calculated and represented a definitive boundary between the soil and collected sediment.

Soil movement was assessed by collecting sediment samples from landings during the summer of 2005 and 2006 on a bimonthly (every two weeks) basis using shovels, brooms, and hand brushes. Sediments were placed into an already weighed, plastic bucket and weighed on site. A small sub-sample was obtained from the homogenized sample and brought back to the laboratory for drying. Sub-samples were dried at 105 °C to a constant temperature (Robichaud and Brown 2002). Dry weight of the sediment was calculated for each sub-sample, which was then used to calculate the dry weight of each sample.

Seed Mixture Success

Vegetation was clipped in July and September 2005 and 2006 from 3, 1/3-m^2 plots on each landing. Samples were brought back to the lab and dried in a forced-air oven to a constant mass to test for biomass. During clipping, percent cover and height were measured in each 1/3-m^2 plot and an average was calculated for each landing.

Skid Trail Reclamation

All skid trails chosen for reclamation work were monitored during the summers of 2005 and 2006. Twelve, untreated skid trail sections (~ 10 meters in length) of equal grade were randomly selected and paired with a skid trail section of equal length and grade that received a fiber mat and native grass seed. Sediment traps were constructed with silt fence at the downslope ends of each skid trail section (Appendix C). Sediments were collected from silt traps three times during summer 2005 and bimonthly during summer 2006 following the same methods used to collect sediment on landings.

Hydroseeding skid trails was a logistic problem because commercially available hydroseeders were too large to use on most skid trails. As a result, a smaller 200-gallon hydroseeder (Figure 7) mounted on an ATV trailer was developed to be pulled behind a dozer using the supplemental funds provide by the Upper Elk Soil Conservation District. The skid trail and landing hydroseeders are now available to companies and landowners for use in the watershed.

Figure 7. Skid trail hydroseeder mounted on an ATV trailer to be pulled behind a dozer.

Road Embankment Reclamation

A combination of the stabilization mixture and wildlife mixture was given to a local logging operator to use in hydroseeding haul road embankments in 2006. Haul road embankments were monitored bimonthly (every two weeks) during the summer of 2006 for vegetation establishment and sediment movement. Ten sections of the same log road were monitored using the same methods as skid trail sediment collection (Figure 8). Four silt traps were randomly placed below embankments seeded with our wildlife mixture, 4 silt traps were randomly placed on embankments seeded with the traditional mixture, and 2 silt traps were randomly placed on embankments that were not seeded. All slopes on the log road were similar at well locations.

Figure 8. Silt fence trap on log road embankment planted with native seed mixture.

Wildlife Surveys and Forage Quality

Landings were monitored for small mammal use in June, August, and October 2005 and 2006 to determine how well seed mixtures created habitat for wildlife. Small animal use is a good indicator of overall habitat and forage quality of each mixture. Fourteen trapping stations were set on each landing with 1 ventilated Sherman live trap (Trap-LFAHD-P, H. B. Sherman Traps, Tallahassee, Florida) and 1 medium-sized Tomahawk live trap (#202, Tomahawk, Tomahawk Live Trap Company, Wisconsin). Traps were monitored for 4 nights on each landing during each month.

Samples from vegetation clippings were sent to the West Virginia University rumen analysis lab for forage quality testing. The samples were tested for % NDF, % ADF, and % Crude Protein. %NDF and %ADF are measures of indigestible a forage is to wildlife. Therefore, lower %ADF and %NDF values suggest higher quality forage for wildlife. Additionally, biomass measurements indicate the amount of forage being provided by each mixture.

Results

Seed Mixture Success

Biomass is an important measure of sediment stabilization and habitat structure. Biomass was highest (36.43 g/m^2) on landings planted with the traditional mixture, followed by closely by the wildlife mixture (20.86 g/m^2), wildflower mixture (9.50 g/m^2), and stabilization mixture (8.00 g/m^2) (Table 2). Percent cover is a measure of unexposed soil on the landings. Average percent cover was highest on landings planted with the traditional mixture (87.85 %), followed by the wildlife mixture (69.60 %), wildflower mixture (41.00 %), and stabilization mixture (33.57 %) (Table 2). Vegetation height is a measure of structure and growth. Average height was highest on the landings planted with the wildlife mixture (25.4 cm), followed by the traditional mixture (21.1 cm), stabilization mixture (18.1 cm), and wildflower mixture (11.5 cm) (Table 2).

Each mixture reduced different amounts of sediments. Soil was collected from 2 non-vegetated landings in 2005. Non-vegetated landings yielded 488.9 kg/ha of sediment. Sediment reductions were 85.74 % for the traditional mixture, 75.73 % for the wildlife mixture, 43.71 % for the stabilization mixture, and 27.59 % for the wildflower mixture (Table 2).

Table 2. Average biomass, % cover, height, and sediment collected for each mixture over the course of the study.

Mixture	Average Biomass(g/m^2)	Average % Cover	Average Height (cm)	Average Sediment Dry Weight (kg/m^2)	Average Total Sediment Dry Weight (kg/ha)	% Sediment Reduction
Non-vegetated	-	-	-	1.98	488.99	-
Traditional	36.4	87.9	21.1	0.28	28.23	85.74
Stabilization	8.0	33.6	18.1	0.87	86.53	43.71
Wildlife	20.9	69.6	25.4	0.48	48.05	75.73
Wildflower	9.5	41.0	11.5	1.43	143.35	27.59

Landing Sediments

Due to the destruction of sediment monitoring stations by vandals during the summer of 2006, only sediment data from landings collected during 2005 was used for sediment expansion calculations. An average of 197.97 kg/ha of sediments were collected from landings without vegetative growth (Table 3). On average, 62.4 kg/ha were collected from landings with vegetation (Table 4). These data suggest that a 68 % reduction in the amount of sediments moving on landings that were vegetated versus those without vegetation establishment.

Table 3. Sediments collected on landings without vegetation growth during summer 2005 in the Upper Elk River Watershed.

Site	Sediment Dry Weight (Grams/10 m^2)	Total Sediment (kg/ha)
1A	30.2	324.9
2D	6.6	71.0
Mean	***18.4***	***197.9***
StDev	***16.7***	***237.2***

Table 4. Sediments collected on landings with native vegetation establishment during the summer of 2005 in the Upper Elk River Watershed.

Site	Sediment Dry Weight (Grams/10 m^2)	Total Sediment (kg/ha)
1B	0	0
1C	0	0
2A	15.6	167.8
2C	6.4	67.8
3C	7.1	76.4
Mean	***5.8***	***62.4***
StDev	***6.4***	***69.2***

Skid Trail Sediments

Road sections with no fiber mulch or seeding averaged 1722.7 kg/ha in 2005 and 6557.2 kg/ha in 2006 compound to those with fiber mulch and seeding averaged 344.0 kg/ha in 2005 and 603.5 kg/ha in 2006. Vegetation averaged 17.5 cm in height in 2005 and 24.25 cm in 2006 on fiber mulch treated road sections; no vegetation was observed on sections without fiber mulch during the study period (Table 5). The planting of native vegetation and use of fiber mats accounted for an 80% reduction in the amount of sediments moving from skid trails in 2005 and 92% in 2006 in the Upper Elk River watershed.

Table 5. Sediments collected on skid trails planted with native vegetation and covered with fiber mats and skid trails without reclamation during the summer of 2005 in the Upper Elk River Watershed.

Skid Trail Section	Treatment	Area (m^2)	Area (acres)	Sediment Collected (Grams/ m^2)	Sediment Collected (kg/ha)
2005					
1	Ref	23.6	.015	2633	1103.8
3	Ref	25.7	.015	140	53.8
5	Ref	19.5	.012	2338	1186.4
7	Ref	9.9	.005	2590	2591.5
9	Ref	26.1	.017	6155	2332.6
11	Ref	52.7	.032	16356	3068.3
	Average	**26.2**		**5035.3**	**1722.7**
	StDev	**14.3**		**5872**	**1130.8**
2	Planted	50.1	.032	696	137.2
4	Planted	29.8	.017	148	49.1
6	Planted	18.5	.012	531	283.6
8	Planted	15.4	.009	961	615.0
10	Planted	35.2	.022	1135	318.8
12	Planted	24.1	.015	1614	660.3
	Average	**28.9**		**847.5**	**344.0**
	StDev	**12.7**		**509**	**248.0**
2006					
1	Ref			1017.00	418.7
3	Ref			0.00	0
5	Ref			3284.00	1622.3
7	Ref			13761.00	16994.8
9	Ref			20661.00	7290.4
11	Ref			68511.00	13017.1
	Average			**17872.33**	**65572.1**
	StDev			**26097.11**	**715.9**
2	Planted			250.00	47.5
4	Planted			25.00	8.8
6	Planted			244.00	120.5
8	Planted			1945.00	1201.0
10	Planted			3381.00	927.9
12	Planted			3196.00	1315.7
	Average			**1506.83**	**603.6**
	StDev			**1544.54**	**610.9**

Road Embankment Sediments

Embankments with no vegetation averaged 4687.8 kg/ha, those with traditional vegetation averaged 1914.4 kg/ha, and those with native vegetation averaged 1976.9 kg/ha (Table 6). Vegetation averaged 24.75 cm in height on embankment sections seeded with the traditional mixture and 17.5 cm in height on embankment sections seeded with the native mixture. The use of the traditional mixture accounted for a 59% reduction in sediments and the native mixture accounted for 58% reduction in sediments moving from log road embankments in the Upper Elk Watershed.

Table 6. Sediments collected on log road embankments planted with a native seed mixture, planted with the traditional mixture, and left with no vegetation during the summer of 2006 in the Upper Elk River Watershed.

Embankment Section	Treatment	Area (m^2)	Area (acres)	Sediment Collected (kg/m^2)	Sediment Collected (kg/ha)
1N	None	8.65	.025	2.79	3455.5
2N	None	17.42	.012	11.99	5924.0
	Average	**13.03**		**7.39**	**4689.8**
	StDev	**6.20**		**6.50**	**1745.5**
1B	Traditional	13.45	.007	0.17	143.3
2B	Traditional	12.37	.007	0.23	195.9
3B	Traditional	10.09	.005	2.89	3580.3
4B	Traditional	11.29	.007	4.54	3737.9
	Average	**11.80**		**1.96**	**1914.4**
	StDev	**1.44**		**2.13**	**2015.8**
1C	Native	14.41	.009	1.76	1091.7
2C	Native	8.17	.005	4.39	5425.4
3C	Native	12.13	.007	0.48	397.7
4C	Native	10.69	.005	0.80	992.9
	Average	**11.35**		**1.86**	**1976.9**
	StDev	**2.62**		**1.77**	**2319.3**

Watershed Level Sediment Reductions

To estimate the effect of seeding all landings and skid trails in the study area using the described methods, the approximate areas of recent skid trails and landings in the Upper Elk River watershed were calculated. Methods described in Petty et al. (2005) were used to approximate these areas (Table 7). Harvested acreage in the watershed has increased since the watershed harvest area was approximated, most likely making our sedimentation calculations lower than what is most current.

Table 7. Forestry related land-use statistics estimated from digitizing all visible timber harvests using the WV Statewide Addressing and Mapping Board imagery set. The imagery was captured during "leaf-off" at a negative scale of 1 inch = 240 feet' in the spring of 2003, which produced natural color digital orthophotos at a 2 foot pixel resolution. The ortho-rectification process has achieved < 9.8 feet. horizontal error at a 95% confidence level. The TIFF files used are 10,000 feet X 10,000 feet uncompressed 24-bit natural color at a pixel resolution of 2.0 feet.

Total Hectares	Harvested Hectares	Landing Hectares	Skid Trail Hectares
380773.5	157310.0	482.6	13190.3

If all recent landings (<5 years of age) were vegetated using native seed mixtures, an estimated 11.8 ton reduction in sediments from landings during the growing season could be expected (0.1 tons/day reduction) (Table 8).

Table 8. Sediment reductions from landings estimated for the Upper Elk River watershed.

	Tons	Tons/Day
Total Sediments	17.26	0.14
Reduction	11.82	0.10
Remaining	5.44	0.04

If all recent skid trails (<5 years of age) were vegetated using native seed mixtures and fiber mats, a total of 3285.8 tons of sediments, based on 2005 data (Table 9), would not move from skid trails during the growing season (26.7 tons/day reduction), and 14188.9 tons (107.5 tons/day reduction) of sediments based on 2006 data (Table 10). This is assuming that all skid trails averaged at least 15% grade – thus these estimates are likely inflated.

Table 9. Sediment reductions from skid trails estimated for the Upper Elk River watershed in 2005.

2005	Tons	Tons/Day
Total Sediments	4105.65	33.38
Reduction	3285.75	26.71
Remaining	819.90	6.67

Table 10. Sediment reductions from skid trails estimate for the Upper Elk River watershed in 2006.

2006	Tons	Tons/Day
Total Sediments	15627.32	118.39
Reduction	14188.86	107.49
Remaining	1438.47	10.90

Wildlife Surveys and Forage Quality

Species caught most often in traps included the white-footed deermouse (*Peromyscus leucopus)*, North American deermouse (*Peromyscus maniculatus*), Eastern chipmunk (*Tamias striatus*), Virginia opossum (*Didelphis virginia*), Allegheny woodrat (*Neotoma magister*), Southern red-backed vole (*Clethrionomys gapperi*), woodland vole (*Microtus pinetorum*), and Northern short-tailed shrew (*Blarina brevicauda*). Animal abundances were highest on landings planted with the stabilization mixture and wildlife mixture, and lowest on landings planted with the wildflower and traditional mixture. Animal diversity was highest on landings planted with the wildlife mixture, followed by the stabilization mixture, traditional mixture, and then the wildlife mixture (Table 11). These numbers relate closely to the amount of biomass grown by each seed mixture (Table 12). In general, mixtures that grew higher amounts of biomass had relatively higher animal abundances and diversity.

Table 11. Small mammal relative abundance and diversity (richness) found on landings with each of the mixtures.

	Small Animal Relative Abundance	Small Animal Species Diversity
Stabilization	6.0	3.5
Wildlife	4.5	4.0
Traditional	3.0	3.0
Wildflower	3.0	2.0

% NDF and % ADF should be low, whereas % Crude Protein and Biomass should be high. Crude protein was highest for the traditional mixture (13.50 %), and lowest in the stabilization mixture (7.22 %). % NDF was lowest in the wildlife mixture (41.78 %), and highest in the stabilization mixture (53.71 %). % ADF was lowest in the wildlife mixture (29.23 %), and highest in the wildflower mixture (37.27 %) (Table 12). Looking at the combined data for trapping and forage quality, the wildlife mixture is the best mixture for wildlife habitat and forage.

Table 12. Forage quality of mixtures.

	% NDF	% ADF	% Crude Protein	Biomass (g/m^2)
Stabilization	53.71	35.99	7.22	36.43
Traditional	46.57	32.53	13.50	8.00
Wildlife	41.78	29.23	11.02	20.86
Wildflower	47.95	37.27	9.22	9.50

Management Implications

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. Creating a proper seedbed for quick vegetation establishment is important, and current methods can be revised to work more efficiently. The establishment of vegetation on skid roads appears to be the most critical when it comes to sediment movements. After harvesting in West Virginia, skid roads and trails represent approximately 10 percent of the total harvest area. Therefore, vigorous establishment of vegetation on skid roads should be of top priority when timber harvesting sites are reclaimed.

Using native seed mixtures for reclamation is an important consideration for the future. Forest openings created by timber harvesting can be transformed into a valuable resource for native wildlife. Thus, minimizing sediments by using planted native mixtures can provide broad benefits to overall forest ecosystem. Sediment control using native vegetation is equal, and sometimes less than, that of traditional seeding mixtures. However, native vegetation provides better quality forage and habitat to wildlife while also maintaining native, forest biodiversity. Further experimentation with native seed mixtures may yield an option that provides equal, if not better, sediment control than the traditional mixture, while also improving for forest wildlife and biodiversity.

Most research has shown that sediment levels return to pre-harvest levels within three years of harvest. Reductions of the magnitude found indicate that the use of fiber mats and proper re-vegetation of skid roads after harvest has good potential for limiting sediment movement after timber harvest. It has been found that forest litter and vegetation strips reduce the amount of sediments that actually make it into a stream system. Therefore, one cannot assume that the reductions documented 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.

Outreach

A major objective of this project was to educate landowners in the watershed on the project, as well as provide them with resources and tools to perform many of the same practices that were researched. This was done in several ways. First, seed mixes were distributed to local landowners. Approximately 20 hectares (48 acres) worth of seed was distributed to be used in log landing, skid trail, and road embankment reclamation. A ripper-tooth assembly for plowing landings was developed, as was a log landing and skid trail hydroseeder. All of these tools are now available to landowners for use in the watershed.

To educate and demonstrate the use of the tools and inform stakeholders of their availability, a workshop was hosted on September 26, 2006. Forty-eight people (Figure 9) participated in the workshop including WVU researchers, Forest Industry representatives, WV Division of Forestry personnel, consulting foresters, and landowners. Tours were given of several landings and a demonstration of our log-landing vegetation method which included ripping the landing with the ripper-tooth assembly, smoothing the ripped area with the dozer blade, and hydroseeding the newly exposed soil was given.

Figure 9. Photos from the landing and skid trail reclamation demonstration held on September 26, 2006 near Webster Springs, WV.

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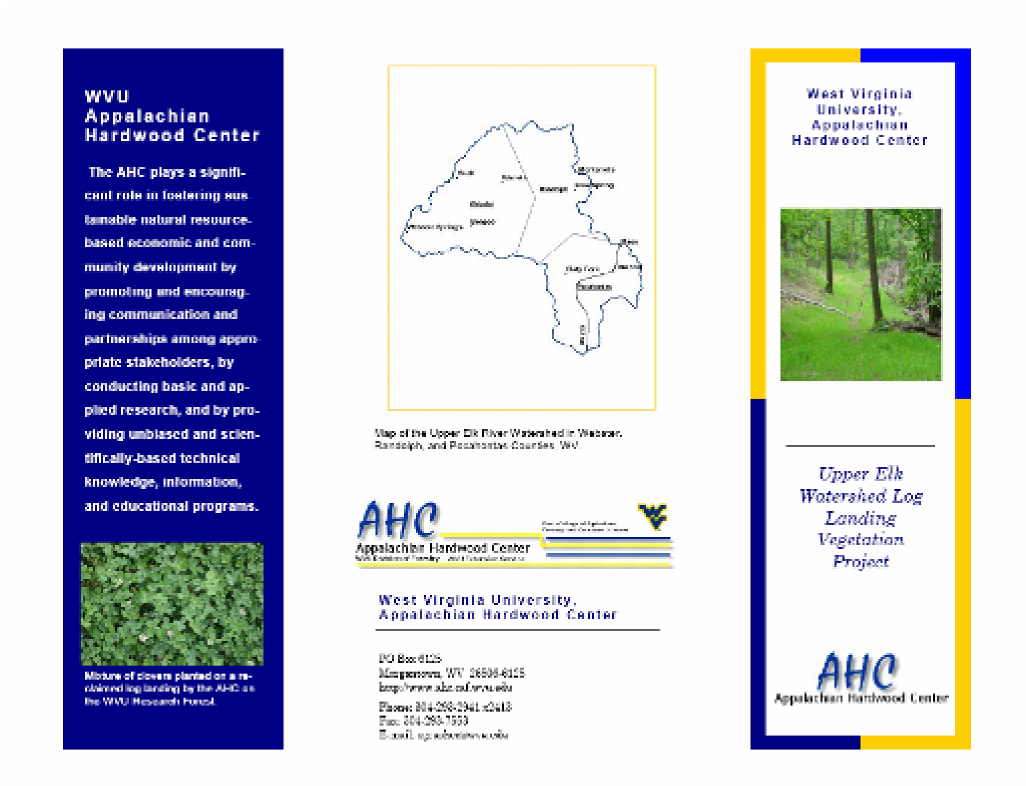
Appendix A: Brochure developed by the Appalachian Hardwood Center to recruit landowners for the project.



WVU Appalachian Hardwood Center

The AHC plays a significant role in fostering sustainable natural resource-based economic and community development by promoting and encouraging communication and partnerships among appropriate stakeholders, by conducting basic and applied research, and by providing unbiased and scientifically-based technical knowledge, information, and educational programs.

Mixture of clovers planted on a reclaimed log landing by the AHC on the WVU Research Forest.

Map of the Upper Elk River Watershed in Webster, Randolph, and Pocahontas Counties, WV.

AHC Appalachian Hardwood Center

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West Virginia University, Appalachian Hardwood Center

Upper Elk Watershed Log Landing Vegetation Project

AHC Appalachian Hardwood Center

Wanted: log landings and skid trails with little vegetation!

The Appalachian Hardwood Center at West Virginia University has initiated a cooperative project with the West Virginia State Division of Forestry and the West Virginia Department of Environmental Protection using Clean Water Act 319 Funds. The objective of this project is to develop new landing and skid road reclamation techniques in the Upper Elk River watershed. We plan to create optimum seedbeds on landings and skid trails in the Upper Elk River area. These areas will then be seeded with various native and naturalized seed and tree mixtures that provide soil stabilization as well as benefits to aesthetics, water quality, and wildlife.

Log landing with little vegetation establishment in the Upper Elk River watershed.

The main goal of this project is to reduce sedimentation into the Elk river through vegetation establishment.

How do I become Involved?

If you are a landowner in the Upper Elk River watershed (east of Webster Springs to 219, see map) and have landings and/or skid roads with inadequate vegetation growth, we are looking for you!

What are the requirements?

If you agree to participate, the Appalachian Hardwood Center will reclaim log landings and skid roads on your property. Sites will be reclaimed using a soil preparation attachment mounted to a bulldozer. Areas will then be seeded with native mixtures herbs, grasses, and tree species. All services will be provide free of charge as long as you allow our staff to monitor vegetation growth, water inputs and outputs, and wildlife use. The majority of the reclamations will occur during the early spring through early summer of 2005. Monitoring will last through the summer of 2006.

Example of soil scarification attachment that will be used to prepare seedbeds on log landings and skid trails.

Who do I contact?

If you would like to become involved in this effort, please contact Shawn Grushecky or Dave McGill with the Appalachian Hardwood Center. More information can also be obtained from the local WV Division of Forestry Offices in Webster Springs.

Shawn Grushecky

(304)- 293-2941 x2418

Dave McGill

(304) 293-2941 x2474

Mayford Luke, WVDOF Webster Springs

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AHC Appalachian Hardwood Center

West Virginia University, Appalachian Hardwood Center

Appendix B: Log landing reclamation methods: (a) harrow drag, (b) lawn roller, (c) silt fence installation, (d) finished landing, (e) silt fence collection well setup.

(a) 

(b) 

(c) 

(d) 

(e) 

Appendix C: Skid trail reclamation and sediment collection: (a) silt fence well on skid trail and (b) silt fence well set-up. Drawing includes catchment area (A), water bar (B), silt fence stake (C), and silt fence (D) with silt trap at base.

(a)

(b)