Rhizomes for Vegetating and Stabilizing Steep Forest Road Banks[1]

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On a woods road cut bank no natural vegetation had become established during the first growing season wherever the slope exceeded 100 percent. Horizontally planted, 12-inch segments of hay-scented fern rhizomes appear promising for stabilizing soils on steep slopes.

In mountainous terrain, logging roads and road banks are often the primary source of stream siltation (5,6). The principle objectives of revegetating logging roads and banks are protecting stream quality by controlling erosion and siltation, and keeping drainage ditches from filling in. In addition, stabilizing inactive logging roads and banks ensures that they will be of future service with minimum upkeep or grading.

The slope angle of the road bank on the uphill side of a logging road largely determines soil stability, because both natural and artificially seeded vegetation rarely become permanently established on steep slopes, those with 100 percent slope or greater (4). Although seeds will often germinate on steep slopes, seedlings wash out when surface runoff and raindrops detach surface soil particles. Some natural revegetation on such banks occurs when mats of litter containing roots of woody and herbaceous plants break away from the top of the bank, lodge and take root on the slope below. Only after many years, however, when erosion at the top of the bank has reduced the percent slope, does natural vegetation from seed become permanently established.

Because of the threat of erosion and the resulting stream sedimentation, roads and banks should be revegetated quickly (4,5). In some instances soil disturbed by logging road construction and use must be stabilized by seeding grasses and legumes, but most level areas and gentle slopes quickly seed-in with natural vegetation. Identifying those areas that need special treatment and those that will seed-in naturally gives a more effective and, in the long run, a much less expensive soil stabilization program for roads and road banks.

Different plants vary in their ability to control erosion (3). Grasses and other plants with a dense, fibrous, lateral root system are much more effective at preventing soil detachment than are species with tap roots (1). With most shrubs, a companion species of some fast-growing plant is often needed to stabilize the soil until these woody plants are well established and completely occupy the site (3).

Perennial rhizomes of certain native forbs form a dense network of roots just beneath the soil. We decided to test certain native species, noted for their ability to rapidly colonize and form quick cover. These species were tested for their ability to stabilize soils on selected portions of road banks (exceeding 100 percent slope) along a newly constructed woods road at the West Virginia University Forest in northern West Virginia. We selected hay-scented fern, *Dennstaedtia punctilobula* (Michx.) Moore; New York fern, *Thelypteris noveboracensis* (L.) Nieuwl.; and whorled loosestrife, (*Lysimachia quadrifolia* (L.) for this study. These aggressive native species colonize road banks with moderate slopes and thrive under a variety of conditions of light and moisture.

The purpose of this study was to determine the best method of establishing these plants, their survival, and rate of spread on steep road banks where natural regeneration is sparse and temporary.

Plot Establishment

In June 1981, test plantings were established on a road bank at the West Virginia University Forest. This woods road had been constructed in November 1979, but the steeper parts of the road bank had not seeded-in with natural vegetation.

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Colonies of the test species were located, and these plants were dug by hand to secure large lengths of rhizomes. These were stored in moist sphagnum moss until planting.

The 12 planting treatments varied by species. Similar treatments were used for hay-scented fern and whorled loosestrife: 6-inch rhizome segments planted vertically and horizontally, and 12-inch rhizome segments planted vertically and horizontally. New York fern, because of its delicate rhizomes, had slightly different treatments. In addition to the hand 12-inch rhizomes planted horizontally, small bundles (hanks) of rhizomes were planted horizontally, and golf-ball-sized rolls of rhizomes were also used.

Four planting sites-areas that had failed to seed-in with natural vegetation due to the steep slope-were randomly selected on steep road banks with exposed soil. On each site, randomly spaced plots were located for the 12 treatments. Each plot contained a checkerboard planting of 36 rhizomes. These were firmly planted in the clay loam soil at a 1-inch depth, except for the vertical plantings where the top of the rhizome was $^1/_2$ inch from the soil surface. Plots extended from the top to the toe of the road bank, a distance of 6 to 8 feet.

Analysis and Results

In July, August, and September 1981 and June 1982 each planting was counted. The August inventory yielded the highest sprouting percentages for most of the treatments (table 1). September counts were lower because some ferns had begun to yellow and die down in late summer, and some withered fronds had disappeared, making the August figures the most reliable of the first-year counts. June 1982 evaluations only gave an indication of survival and vigor because some fronds, particularly those of hay-scented fern (fig. 1), come up slowly in late spring.

The August 1981 measurements were compared using preplanned orthogonal contrasts. These tests (table 2) show where significant differences between species and planting methods exist. The average number of fronds per planted rhizome for the four planting blocks by months, species, and treatments are given in table 3.

Discussion

Rhizome carbohydrate levels are known to show seasonal fluctuations (2). In our study, the rhizomes were planted in June, soon after fronds had developed, so that carbohydrate levels were at their annual low after frond emergence. This may have decreased the vigor and number of sprouts.

Soil nutrient levels were not examined, but they may have been an important factor affect-

Table 1—*Percentage of planted rhizomes with one or more plants averaged by species and treatment*

	1981			1982
	July	August	Sept.	June
Hay-scented fern				
6-in Vertical	12.5	14.6	14.6	8.4
12-in Vertical	14.6	20.1	19.4	7.0
6-in Horizontal	22.2	34.0	32.6	13.2
12-in Horizontal	37.5	50.7	48.6	20.8
New York fern				
Hank	26.4	33.4	33.3	29.2
Ball	18.1	29.2	30.6	20.2
6-in Horizontal	20.2	25.7	25.0	11.1
12-in Horizontal	31.2	39.6	35.4	29.2
Whorled loosestrife				
6-in Vertical	2.1	7.0	9.0	9.0
12-in Vertical	4.9	11.8	10.4	10.4
6-in Horizontal	12.5	24.3	27.1	16.7
12-in Horizontal	9.0	29.2	29.8	21.5

Figure 1—*Hay-scented fern, 12-inch horizontal planting, exhibiting good sprouting and vigor.*

ing survival. Road bank cuts consist of exposed subsoil, which is often lower in essential nutrients than surface soil. Thus fertilizer application might have substantially improved the vigor and growth of planted rhizomes.

Moisture is another important factor. Because all blocks had essentially the same aspect, northwest to northeast, slope was the only variable we examined influencing soil moisture. Horizontal plantings had the advantage of greater surface moisture. In horizontal planting it was also easier to firm the soil tightly around the rhizome, a difficult problem with vertical planting.

In 1982 it was noted that pieces of root mat (that is, soil interlaced with fern rhizomes) had frequently become detached from the top margin of the slope and moved down the bank surface. Where the slope was gentle, these had lodged and rooted. On the steeper banks these often accumulated at the bottom of the slope. Once they had rooted, these acted as centers of spread for ferns and constituted an important type of natural establishment of vegetation on cut banks. Those sprouting rhizomes present the second year appeared to be the same rhizomes that had sprouted in 1981. Few if any of the inactive 1981 rhizomes sprouted in 1982. Horizontally planted rhizomes appeared to sprout only from their tips in 1981, but in 1982 they also sprouted from other points.

Signs of bank stabilization were evident within the blocks of fern plantings. In many cases, areas with planted fern rhizomes appeared as islands of raised soil, for nearly 2-inches of soil had eroded from the surrounding unstabilized areas.

Summary

On the cut bank of a woods road, established in 1979, no natural vegetation had become established during the first growing season wherever the slope exceeded 100 percent. Horizontally planted, 12-inch segments of hay-scented and New York fern rhizomes appear promising for stabilizing soils on steep slopes where natural vegetation has not seeded-in.

Hay-scented fern, because of its more robust rhizomes, showed the highest survival and greatest propensity to colonize these areas of disturbed soil. New York fern appeared less aggressive but was more effective than whorled loosestrife in both rate of survival and vigor.

Table 2—*Orthogonal contrasts and F values for sprouting and vigor means.*

Orthogonal contrasts	Calculated F value	
	Sprouting	Vigor
1. New York fern vs. hay-scented fern and whorled loosestrife	3.16	7.88**
2. Hay-scented fern vs. whorled loosestrife	4.42*	30.96***
3. New York fern hank & ball vs. New York fern, 6- & 12-inch horizontal	.07	.12
4. New York fern hank vs. New York fern ball	.09	3.74
5. 6-inch Treatments vs. 12-inch treatments	2.93	7.87**
6. Vertical treatments vs. horizontal treatments	20.97***	24.61***
7. Contrast No. 6 x contrast No. 5	.46	2.24
8. Contrast No. 1 x contrast No. 5	.16	.20
9. Contrast No. 2 x contrast No. 5	.81	2.20
10. Contrast No. 2 x contrast No. 6	.28	5.34*
11. Contrast No. 2 x contrast No. 6 x contrast No. 5	.28	.80

* Calculated F greater than critical F 0.05 (4.14).
** Calculated F greater than critical F 0.01 (7.47).
*** Calculated F greater than critical F 0.001 (13.09).

Table 3—*Average number of fronds per planted rhizome for the four rhizome planting blocks by month, species, and treatment*

	1981			1982
	July	August	Sept.	June
Hay-scented fern				
6-in Vertical	0.15	0.32	0.37	0.18
12-in Vertical	.24	.50	.51	.11
6-in Horizontal	.34	.72	.86	.31
12-in Horizontal	.50	1.40	1.49	.58
New York fern				
Hank	.35	.93	.99	.87
Ball	.20	.59	6.60	.42
6-in Horizontal	.25	.56	.58	.81
12-in Horizontal	.51	1.08	.92	.65
Whorled loosestrife				
6-in Vertical	.03	.09	.10	.11
12-in Vertical	.06	.14	.12	.12
6-in Horizontal	.14	.28	.30	.24
12-in Horizontal	.09	.42	.45	.26

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