

RESISTANCE OF PLANT COVER TYPES TO TREE SEEDLING INVASION ON AN ELECTRIC TRANSMISSION RIGHT-OF-WAY

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Abstract. A study of resistance of common plant covers to tree invasion was made on an electric transmission right-of-way (ROW) in an oak-hickory forest in central Pennsylvania. Tree seedling counts were made on belt transects in 1984, 1985, and 1986 after ROW maintenance was applied in 1982. Cover types dominated by dense patches of grasses and herbs were highly resistant to tree invasion. Also resistant were shrub covers dominated by blueberry (*Vaccinium angustifolium* and *V. vacillans*) and bear oak (*Quercus ilicifolia*). Shrub covers dominated by blackberry (*Rubus allegheniensis*) and witchhazel (*Hamamelis virginiana*) were of low resistance to tree invasion. A tree sprout-shrub cover that developed after handcutting contained numerous tree seedlings.

Key words. Right-of-way; cover type; tree invasion.

Résumé. Une étude sur la résistance d'un couvert de plantes des prés à l'invasion des arbres a été faite dans une servitude de transmission électrique (ROW) dans une forêt de chêne-noyer de la Pennsylvanie. Les dénombrements de semis ont été faits en bandes transversales en 1984, 1985 et 1986, après que l'entretien de la servitude ait été instaurée en 1982. Les types de couverts dominés par des taches denses de gazon et d'herbes étaient hautement résistants à l'invasion des arbres des couverts d'arbustes dominés par le bleuët (*Vaccinium angustifolium* et *V. vacillans*) et le chêne à feuilles de houx (*Quercus ilicifolia*) étaient aussi résistants. Les couverts arbustifs dominés par les mûres (*Rubus allegheniensis*) et l'hamamélis (*Hamamelis virginiana*) offraient une faible résistance à l'invasion des arbres. Un couvert d'arbres et de rejets d'arbustes qui s'est développé après une coupe manuelle contenait de nombreux semis d'arbres.

Development of a low plant cover resistant to tree invasion is an important objective of right-of-way management. Such resistant cover, by reducing tree density (number trees per acre), will lower the cost and increase the effectiveness of ROW maintenance.

The objective of this study was to measure the effectiveness of several natural ROW plant covers in limiting tree seedling density. Development of these cover types in relation to the kind of maintenance technique used was also in-

vestigated as part of a broader study.

The kind of plant cover that should be developed on ROW has been a matter of controversy for over 35 years. An early opinion on the desirability of plant cover types on ROW favored "shrublands", derived from broadcast spraying. However, hayscented fern (*Dennstaedtia punctilobula*) and bracken (*Pteridium aquilinum*) were described as resistant species to tree invasion and panic grass (*Panicum* spp.) as possibly resistant. Goldenrods (*Solidago* spp.) were also given high value as deterrents to tree seedling invasion (4).

A study of a ROW on post-agricultural land in Connecticut indicated that dense shrub clonal patches were highly resistant to tree invasion (7). Although open grass forb cover contained the most tree reproduction, little bluestem grass (*Andropogon scoparius*) in dense stands exhibited remarkable stability.

A study of tree seedlings present in patches of common ROW species in Pennsylvania indicated that meadow fescue (*Festuca elatior*), rough goldenrod (*Solidago rugosa*), bear oak (*Quercus ilicifolia*) and blueberry (*Vaccinium* spp.) were most resistant to tree invasion (1). Also in Pennsylvania, a dense cover of bracken, poverty grass (*Danthonia spicata*), rough goldenrod, and flattop aster (*Aster umbellatus*) in forest openings prevented establishment of hardwood seedlings during more than 50 years (5).

A report prepared for the Canadian Electrical Association examined the importance of creating a stable low-growing vegetation cover which impedes invasion and growth of tall-growing plants (8). Competition and allelopathy were discussed in relation to their stabilizing effects on plant associations.

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Methods

Tree seedling counts were made on belt transects in late summer of 1984, 1985, and 1986 on ROW areas that had received maintenance treatment in 1982. Cover values of plant species present on treatment areas were estimated in six broad classes following a method developed for ROW use (2). One belt transect (6.6 x 165 feet) was located on the ROW area under the wires in the dominant cover type of each 2.5-acre ROW treatment area. Two tree height classes, less than 1 foot and 1 to 3 feet, were recognized to distinguish recently established tree seedlings from those that were well established. Tree seedlings present were red maple (*Acer rubrum*), black cherry (*Prunus serotina*), red oak (*Quercus rubra*), white oak (*Quercus alba*), black oak (*Quercus velutina*), chestnut oak (*Quercus prinus*), and sassafras (*Sassafras albidum*). The ROW treatments applied in four replications in 1982 were:

1. *Handcutting* in which all trees and tall shrubs were cut.
2. *Selective summer basal spray* consisting of a mixture of Garlon 4 (2 gal.), Cidekick (0.5 gal.) and fuel oil (25 gal.) in 72.5 gal. of water applied to trees and tall shrubs.
3. *Selective stem-foliage spray* consisting of a mixture of Weedone 2, 4-DP (0.5 gal.), Amdon 101 (0.5 gal.) and Surfel (0.25 gal.) in 98.75 gal. of water applied to trees and tall shrubs.
4. *Broadcast pellet application* of Tordon 10K applied over the entire ROW wire zone area to remove trees, tall shrubs, and blackberry.
5. *Selective frill and squirt application* of Tordon RTU applied to trees only over the entire ROW.

Results

A high degree of resistance to tree invasion was shown by six plant cover types (Table 1). These cover types were dominated by dense patches of resistant species of either grasses and herbs (meadow fescue, poverty grass, panic grass, hayscented fern) or shrubs (blueberry and bear oak) (Figures 1-4). Although tree seedlings were not found in any of these types in 1986, a few were present in three types in 1984 and 1985.

Such changes from year to year may be expected due to elimination of seedlings by adverse weather conditions, plant competition, allelopathy, and destruction by wildlife (deer, small mammals, etc.)

A low degree of resistance to tree invasion was shown by six cover types in which numerous seedlings were found in 1985 and 1986 (Table 1). These shrub-herb and shrub-grass covers were dominated by shrubs of low or variable resistance to tree invasion, primarily blackberry, dewberry and witchhazel, (Figure 5). A tree sprout-shrub cover found on handcut ROW areas (Figure 6) was of very low resistance to tree invasion (Table 1). This type was dominated by clumps of tree sprouts below which shrubs and herbs grew sparsely in broken patches that were open to tree invasion.

Although designation of cover types by their life forms has been used for initial recognition in the field, identification as a grass-herb cover or shrub-herb cover, etc., must be accompanied by their dominant species composition which actually determines resistance to tree invasion (Table 1). For example, a shrub-grass cover dominated by blueberry and fescue grass was found to be highly resistant to tree invasion, while a shrub-grass cover dominated by blackberry and poverty grass was not resistant. In general, cover types dominated by blackberry were not resistant to tree invasion.

Resistance of individual plant species to tree invasion has been grouped for convenient reference into three classes: 1) species that were highly resistant, 2) species that were usually resistant but under certain conditions were of less resistance, and 3) species of low resistance (Table 2). Variable resistance was typified by poverty grass which was highly resistant under favorable growth conditions, but it often grew in tufts or clumps on poor sites where it was of low resistance to tree invasion. Hayscented fern was a special case as it usually was of high resistance and formed large patches; however, it was occasionally killed by late frosts which opened the patches to invasion over large ROW areas. Dewberry and sheep sorrel were resistant when in dense patches, but often grew in broken patches intermingled with species of lesser resistance which

Table 1. Tree seedlings counted in common ROW plant cover types in 1984, 1985 and 1986

Cover type	Dominant species 1986	Cover value %	Year	Number tree seedlings per acre Height class		
				1 ft.	1-3 ft.	Total
Resistant to tree invasion						
1. Grass-shrub (Fescue-dewberry)	Fescue grass	88	1984	0	0	0
	Poverty grass	15	1985	0	0	0
	Bear Oak	38	1986	0	0	0
	Dewberry	38				
	Blackberry	15				
2. Herb-grass (Hayscented fern- poverty grass)	Hayscented fern	38	1984	0	0	0
	Sheep sorrel	38	1985	0	0	0
	Poverty grass	15	1986	0	0	0
3. Shrub-grass (Blueberry-fescue)	Blueberry	63	1984	0	0	0
	Bear oak	15	1985	0	0	0
	Fescue grass	38	1986	0	0	0
	Dewberry	38				
	Witchhazel	38				
4. Grass-herb (Poverty grass- loosestrife)	Poverty grass	63	1984	0	0	0
	Panic grass	15	1985	40	0	40
	Loosestrife	15	1986	0	0	0
5. Grass-shrub (Fescue-witchhazel)	Fescue grass	87	1984	0	40	40
	Panic grass	15	1985	40	40	80
	Witchhazel	38	1986	0	0	0
6. Herb-grass (Goldenrod-fescue)	Goldenrod	58	1984	0	0	0
	Fescue	15	1985	40	0	40
			1986	0	0	0
Not resistant to tree invasion						
1. Shrub-herb (Witchhazel- blackberry)	Witchhazel	68	1984	0	400	400
	Blackberry	38	1985	200	200	400
	Sheep sorrel	38	1986	200	500	700
	Hayscented fern	38				
2. Shrub-herb (Blackberry-bracken)	Blackberry	63	1984	0	0	0
	Blueberry	38	1985	160	40	200
	Dewberry	38	1986	80	40	120
	Sweetfern	15				
	Bracken	15				
	Goldenrod	15				
	Vernal sedge	15				
3. Shrub-grass (Blackberry-poverty grass)	Blackberry	63	1984	0	0	0
	Poverty grass	63	1985	80	80	160
	Goldenrod	15	1986	80	120	200
4. Shrub-herb (Dewberry-hayscented fern)	Dewberry	63	1984	0	0	0
	Blackberry	15	1985	280	120	400
	Blueberry	15	1986	280	40	320
	Hayscented fern	38				
5. Tree-shrub (Tree sprouts- blueberry)	Tree sprouts	80	1984	1240	0	1240
	Blueberry	53	1985	3520	1960	5480
	Dewberry	15	1986	1120	2040	3160
	Bracken	38				
	Vernal sedge	15				
	Loosestrife	3				
6. Tree-shrub (Tree sprouts- dewberry)	Tree sprouts	105	1984	80	320	400
	Dewberry	88	1985	200	240	440
	Blueberry	38	1986	120	200	320

resulted in moderate resistance.

The typical cover type that may be expected from applications of common maintenance techniques can usually be predicted with a high degree of certainty (Figure 7). However, the presence of certain cover types were often determined by their presence on the ROW before treatments were applied. This often resulted in a cover not typical of the treatment prescribed. For example, where large patches of meadow fescue were dominant on a ROW area, a selective basal maintenance spray retained these fescue patches, and the result was a selective basal-sprayed ROW area dominated by grass rather than the shrub-herb-grass type normally expected.

Another important feature of ROW which affects the kind of cover type that will be produced by a ROW maintenance treatment is the presence of

viable seeds in the upper layers of soil. Hutnik et al (6) found that most of the viable dormant seed in the ROW seedbank were grasses, whereas seed of shrub and tree species were rare, even in the forest adjoining the ROW. As a result, any treatment which kills large patches of vegetation favors the establishment of grasses rather than shrubs and trees in spite of the nature of the cover type before treatment. This helps explain why applications of foliage spray, stem-foliage spray, mowing, and mowing with herbicide spray all result in a herb-grass cover in the years immediately after treatment (Figure 7).

Discussion and Summary

The degree of resistance of various types of plant cover to tree invasion is an important factor in planning long-term maintenance of a transmission line. Each year a supply of tree seeds enters



Figure 1. Grass cover type (tall meadow fescue) highly resistant to tree invasion.



Figure 2. Shrub-grass cover type (blueberry-fescue) highly resistant to tree invasion.



Figure 3. Herb-grass cover type (goldenrod-fescue) highly resistant to tree invasion.



Figure 4. Herb-grass cover type (hayscented fern-blueberry) resistant to tree invasion.

a ROW as a result of wind, water, gravity, and animal transportation. After a ROW maintenance treatment, conditions are often especially favorable for germination of these seeds. However, large numbers of grass and herbaceous seed may also germinate, and soon competition becomes the dominant factor in determining the number and vigor of tree seedlings in the post-treatment vegetative cover.

A resistant grass-herb cover dominated by fescue grass, poverty grass, panic grass, hayscented fern and resistant shrubs may be en-

couraged by planned use of herbicide treatment techniques. This requires knowledge of the plant species present at the time of application and an understanding of their development by vegetative spread and their reproduction potential by seed both from plants currently present and in the soil seedbank.

With the knowledge that has been accumulated on the effects of various common ROW maintenance techniques on plant cover, it is now possible to predict the type of ROW cover that will develop following application of those techniques



Figure 5. Shrub-herb cover type (blackberry-goldenrod) of low resistance to tree invasion.

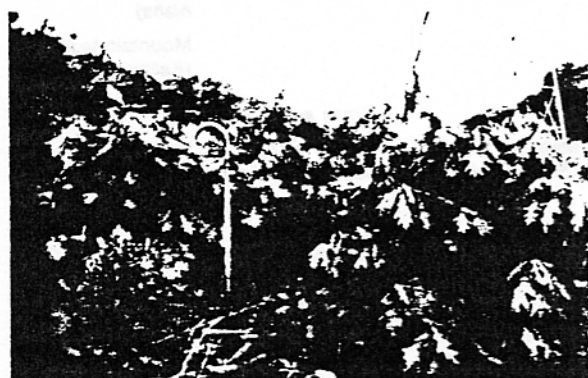


Figure 6. Tree-shrub-herb cover type (oak sprouts-blueberry-goldenrod) of low resistance to tree invasion.

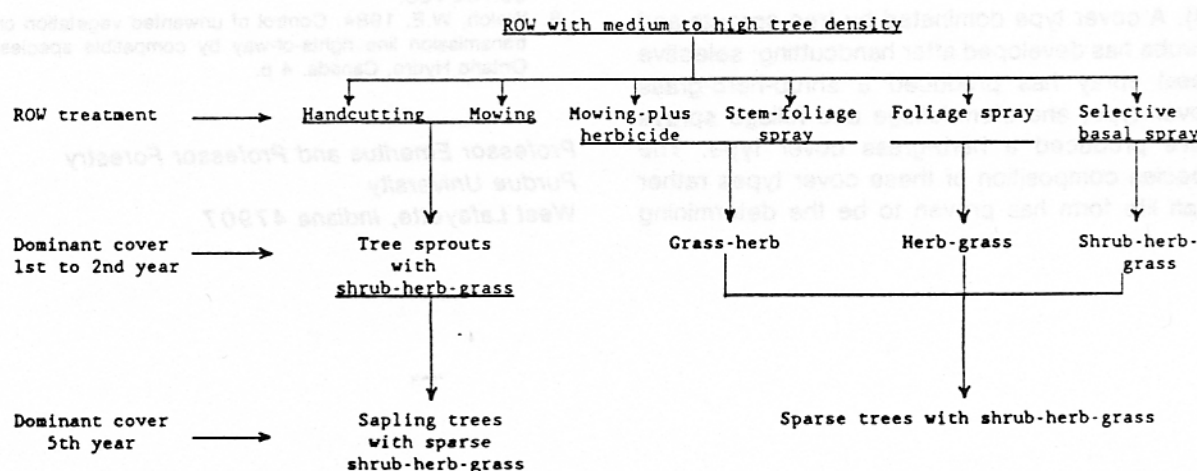


Figure 7. Model for prediction of plant cover types that will develop after specific ROW maintenance treatments on mesophytic upland sites.

Table 2. Resistance to tree invasion of plant species commonly found on the ROW

Highly resistant species	Moderately resistant (variable) species	Low resistance species
Shrub		
Blueberry (<i>Vaccinium vacillans</i> and <i>V. angustifolium</i>)	Dewberry (<i>Rubus hispidus</i>)	Blackberry (<i>Rubus alleghensis</i>)
Bear oak (<i>Quercus ilicifolia</i>)		Sweetfern (<i>Comptonia peregrina</i>)
		Witchhazel (<i>Hammamelis virginiana</i>)
		Mountain laurel (<i>Kalmia latifolia</i>)
Grass and Sedges		
Meadow fescue (<i>Festuca elatior</i>)	Poverty grass (<i>Danthonia spicata</i>)	Vernal sedge (<i>Carex pensylvanica</i>)
	Panic grass (<i>Panicum latifolium</i>)	
Herbaceous		
Goldenrod (<i>Solidago rugosa</i> and <i>S. graminifolia</i>)	Hayscented fern (<i>Dennstaedtia punctilobula</i>)	Loosestrife (<i>Lysimachia quadrifolia</i>)
Bracken (<i>Pteridium aquilinum</i>)	Sheep sorrel (<i>Rumex acetosella</i>)	

(3). A cover type dominated by tree sprouts and shrubs has developed after handcutting; selective basal spray has produced a shrub-herb-grass cover type; and stem-foliage and foliage sprays have produced a herb-grass cover type. The species composition of these cover types rather than life form has proven to be the determining

factor in their resistance to tree invasion.

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