SMALL MAMMALS IN PLANT COVER TYPES ON AN ELECTRIC TRANSMISSION RIGHT-OF-WAY

by W.C. Bramble, R.H. Yahner, W.R. Byrnes, and S.A. Liscinsky

Abstract. A study of the abundance and diversity of small mammals in common plant cover types was made on an electric transmission right-of-way (ROW) in central Pennsylvania in 1989 and 1990. Two mechanical and five herbicide treatments had been applied in 1987 on four replicated ROW areas. A diverse and abundant population was found on the ROW, which included eight mammalian species with an average total density of 71.0 individuals per acre. Population density of all species combined in the six common ROW cover types ranged from 32.7 in the fescue grass type to 100.4 in the witchhazel type. Density of small mammals in the adjoining forest averaged 101.6 per acre, with only two species present.

Small mammals are important components of the ecosystem commonly present on an electric transmission right-of-way (ROW). As small mammals consume tree seeds, they play an important role in reducing tree invasion. They are themselves consumed by various predators, such as hawks, owls, and foxes, and, therefore, are important links in the wildlife food chain.

The objective of our study was to determine the relative abundance and species richness of small mammals in six common cover types that developed on a transmission line ROW following mechanical and herbicide treatments. A comparison was also made of ROW populations with that of the surrounding forest to determine the effect of the ROW on the small mammal population of the general area .

Literature Review

Very little information is available in the published literature on small mammal populations on electric transmission ROW on which herbicides were used. However, an excellent report on small mammal populations on a utility ROW was carried out in oak-hickory and pine forests in Tennessee on a ROW managed by brush hogging on a 3-year basis (3). A reasonable degree of specificity for forest edge and ROW habitats occurred among small mammal communities. The grass-forb (non-grass herbaceous species) cover typical of the mowed ROW also permitted establishment of small mammal populations different from those of the surrounding forest. The highest small mammal populations were found in the forest-ROW edges.

Two studies on small mammal populations in forests of central Pennsylvania are useful for comparison with abundance and species richness of ROW populations found in our study. In one, the number of small mammals captured in an aspen-mixed oak community ranged from five to six species captured in three consecutive years which is similar to the seven species captured in our study (4). In a second study, the number of small mammals captured per 100 trap nights averaged 14.8 in the Moshannon State Forest and 10.9 in the Rothrock State Forest which are similar to the average of 13.5 captured per 100 trap nights in our ROW study (5). A total of eight small mammal species was captured in the two forests.

Methods

ROW treatments. Each ROW research segment was divided into "treatment units" that were about 500 feet in length and sufficient to permit use of a commercial line clearance crew. Treatments were replicated four times.

A method referred to as the "wire zone-border zone method" was used for all treatment units (Figure 1). The wire zone included the ROW area lying under the transmission wires plus 10 feet on both sides. The border zones were the remainder of the ROW on both sides of the wire zone.

ROW maintenance treatments were applied in July 1987 as follows:

1. Handcutting - All trees and tall shrubs were cut to a stump height of about 4 inches on the wire

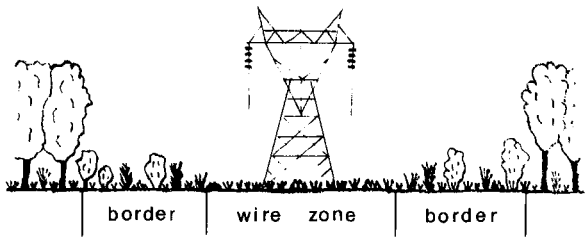

Figure 1. Diagram of a 230 kV line to show (1) a wire zone that included the ROW lying under the wires plus about 10 feet on each side, and (2) border zones that included the remainder of the ROW lying on each side of the wire zone. A low shrub-forb-grass cover type occupied the wire zone with a tall shrub-forb-grass cover type on border zones.

zone. Tall-growing tree species only were cut on border zones.

2. Mowing - The entire ROW wire zone was mowed to a height of about 6 inches. Trees only were selectively treated on the border zones with a low volume basal spray of Access (12.5%) plus Garlon 4 (12.5%) in oil (75%).

3. Mowing plus herbicide - The entire wire zone was mowed to a height of about 6 inches, and the cut stubble of woody plants was sprayed immediately with a mixture of Tordon K (0.75%) plus Garlon 3A (0.75%) in water (98.5%). The border zones were treated as for "mowing" above.

4. Stem-foliage spray - All trees and tall shrubs on the wire zone were sprayed to cover stems and foliage with a mixture of Tordon K (0.5%) and Garlon 3A (0.5%) in water (99%). The border zones were treated as for "mowing" above.

5. Foliage spray - All trees and tall shrubs on the wire zone were sprayed to wet their foliage with Accord (1%) in water (99%) . Border zones were treated as under "mowing" above.

6. High volume selective basal spray - Trees and tall shrubs on the wire zone were sprayed to cover the lower 18 inches of stems to a point of runoff to the root collar with Access (1.5%) in fuel oil (98.5%). Trees only were selectively sprayed on border zones.

7. Low volume basal spray - All trees and tall shrubs were sprayed to wet the lower 18 inches of stem and root collar with Access (12.5%) plus Garlon 4 (12.5%) in Arborchem basal oil (75%). Trees only were similarly treated on the border zones.

Cover types. The common cover types produced by the various treatments were first identified by their dominant life forms (tree, shrub, forb, grass), and secondly by their characteristic and dominant species (1).

1. Forest cover type (chestnut oak-red oak). The adjoining forest was classified as the chestnut oak-red oak forest type that is common on the ridge tops of the Appalachians (2).

2. Tree sprout cover type (oak, maple, and cherry stump sprouts). The characteristic and dominant species were chestnut oak (*Quercus prinus*), red oak (*Quercus rubra*), white oak (*Quercus alba*), black oak (*Quercus velutina*), black cherry (*Prunus serotina*), and sassafras (*Sassafras albidum*). Low shrubs, forbs, and grasses occupied small openings. This cover type developed on the ROW after handcutting of trees in 1987.

3. Grass-forb cover type (poverty grass-goldenrod). The characteristic and dominant species were poverty grass (*Danthonia spicata*) and goldenrod (*Solidago rugosa* and *S. gramini folia*). This type typically developed after either a foliage spray (Accord, 1% in 99% water), or after a stem-foliage spray (Tordon K, (0.5%) plus Garlon 3A, (0.5%) in water (99%)) that was applied on wire zones in 1987.

4. Low shrub cover type (blueberry-sweetfern). The dominant species were blueberry (*Vaccinium vacillans* and *V. angustifolium*) and huckleberry (*Gaylussacia baccata*) with scattered sweetfern (*Comptonia peregrina*). Bracken (*Pteridium aquilinum*) and grasses were present in openings. This type was produced by a selective basal spray (Access, 1.5% fuel oil, 98.5%), on both wire and border zones.

5. Grass cover type (tall meadow fescue) Tall meadow fescue (*Festuca elatior*) was the dominant species growing in dense stands. This cover type developed after treatment of the wire zone where fescue was already present in large patches.

6. Cane thicket cover type (blackberry) This type consisted of blackberry (*Rubus allegheniensis*) in

pure stands with a sparse ground cover of grasses and forbs. The cover type was produced by a selective basal spray (Weedone CB, 87.5% plus Garlon 4, 12.5% undiluted) on the border zones. 7. Tall shrub cover type (witchhazel) The dominant species was witchhazel (*Hamamelis virginiana*), which occurred in pure stands on selectively sprayed border zones (Weedone CB, 87.5% plus Garlon 4, 12.5%, undiluted).

Small mammal census method. Two small mammal censuses were taken both on the ROW and in the adjoining forest. The first census was taken in August 1989 on two replicates of each of the seven plant cover types. A second census was taken in August 1990 on three replicates of each cover type. Seven metal live traps were equally spaced in a 3x3x3 grid on a 50 x 60 foot area within each replication.

Traps were examined in the morning of five consecutive days. Species and number of individuals trapped were recorded as well as sex, age, and reproductive condition of each animal. Each individual was ear-tagged to identify recaptures. Trap nights per cover type totaled 70 in 1989 and 105 in 1990.

Results

Effect on small mammals. A diverse small mammal population composed of seven species in 1989 and eight species in 1990 was captured on the ROW (Table 1). The additional species in 1990 was an ermine (*Mustela ermina*) that was hunting on the ROW. This diversity was in sharp contrast to the total of two species captured in the

Table 1. Small mammal species and numbers of individuals captured in 6 ROW plant cover types and the adjoining forest in August 1989 and 1990.

	ROW cover types														Adjoining forest	
	Witchhazel		Blackberry		Blueberry-sweetfern		Poverty grass-goldenrod		Fescue		Tree sprout		ROW average			
Species	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
	No. individuals/acre															
White-footed mouse (Peromyscus leucopus)	72.6	58.1	65.3	72.6	43.5	53.2	29.0	72.6	0.0	0.0	7.3	48.4	36.3	50.8	79.8	116.1
Meadow vole (Microtus pennsylvanicus)	0.0	0.0	0.0	0.0	14.5	9.7	21.8	24.2	21.8	29.0	0.0	0.0	9.7	10.5	0.0	0.0
S. red-backed vole (Clethrionomys gapperi)	29.0	14.5	0.0	9.7	7.3	0.0	0.0	0.0	0.0	0.0	14.5	33.9	8.5	9.7	0.0	0.0
Masked shrew (Sorex cinerus)	14.5	0.0	0.0	0.0	0.0	4.8	7.3	4.8	7.3	0.0	7.3	0.0	6.0	1.6	7.3	0.0
N. short-tailed shrew (Blarina brevicauda)	0.0	4.8	7.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	2.4	0.8	0.0	0.0
Woodland jumping mouse (Napaeozapus insignis)	7.3	0.0	0.0	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.8	0.0	0.0
Meadow jumping mouse (Zapus hudsonius)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.7	7.3	0.0	0.0	4.8	1.2	2.4	0.0	0.0
Total all species	123.4	77.4	72.6	87.1	65.3	67.7	58.1	111.3	36.4	29.0	36.4	87.1	65.3	76.6	87.1	116.1
Average population	100.4		79.9		66.5		84.7		32.7		61.8		71.0		101.6	

adjoining undisturbed forest. Evidently, the ROW acted as a large forest opening which not only provided habitat conditions suitable for the forest species but also for numerous other nonforest species. Distinct differences in distribution of small mammal species among the cover types on the ROW were observed in both 1989 and 1990 (Table 1). It is of interest to note, however, that the occurrence of species in the ROW cover types closely followed that expected from descriptions in the literature (Table 2). This was exemplified by the three most common species on the ROW. The white-footed mouse was found in all cover types, except the fescue grass type. The meadow vole was found primarily in the fescue and poverty grass-goldenrod types. And the southern red-backed vole was found in shrub and tree sprout types, but not in the two grass cover types.

An obvious unevenness was observed in the distribution of numbers of individuals among species (Table 1). This was due to the relatively high abundance of the white-footed mouse in all cover types, except fescue grass where meadow vole was the predominant species. This unevenness was confirmed by a low Simpson index (a measure of the proportions of individuals in the various species) of 0.516 that was obtained for all cover types combined; with a maximum index possible of 0.882.

Relationship of small mammal populations with cover types. Although all ROW cover types and the adjacent forest type contained small mammals in appreciable numbers in both 1989 and 1990 (Figure 2), there were distinct differences between cover types. For example, the witchhazel cover type population was significantly larger (ANOVA - Duncan-Bonner test $p=0.05$) than any of the other five types. Also, populations in the blackberry, blueberry-sweetfern, and poverty grass-goldenrod cover types were significantly larger than in the tree sprout and fescue types.

The characteristic populations of cover types may be summarized as follows:

Forest cover type. The chestnut oak-red oak forest type, which was cleared to produce the ROW, was used as a baseline for comparison of the ROW population with the uncut forest.The outstanding features of the forest small mammal population was its relatively high population density, which averaged 101.6 individuals per acre (20.0/100 trap nights) for the two census years (Table 1); and its lack of species diversity. Only two species were captured in the forest in 1989 (white-footed mouse and masked shrew) and one species in 1990 (white-footed mouse).

ROW cover types. The six cover types that were commonly present on the ROW each contained at least three small mammal species, and as many as four to five (Table 1). A total of seven species was found on the ROW, and the individuals in the types ranged from 32.7 to 100.4 per acre (6.4 to 19.8/100 trap nights) (Figure 2).

Witchhazel cover type. Five small mammal species were found in this type; the most abun-

Table 2. Distribution of small mammals captured in forest and ROW cover types in relation to habitats reported to be typical of the species (6).

Small mammal species	Cover type	Habitat type typical of the species
White-footed mouse	Forest * Shrub * Tree sprout Grass-forb	Almost every habitat in their area
S. red-backed vole	Shrub * Tree sprout	Rocky forest and woodlands
Masked shrew	Shrub * Forest Tree sprout Grass Grass-forb	Forest and shrub-grown tracts
N. short-tailed shrew	Shrub * Tree sprout	Nearly all land habitats
Meadow vole	Grass-forb * Grass * Shrub	Meadowlands and woodland clearings
Woodland jumping mouse	Shrub*	Edge of a glade with open space for jumps
Meadow jumping mouse	Grass-forb * Grass * Tree sprout	Grassy areas

* = most heavily used.

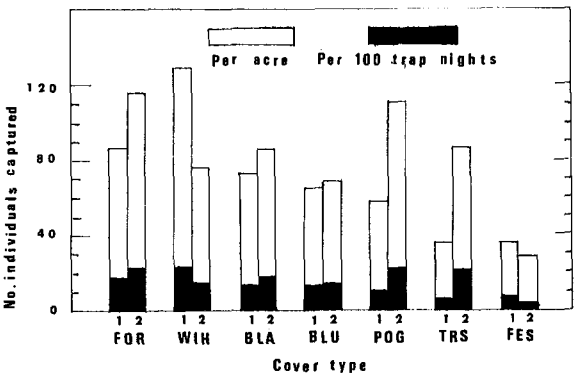

Figure 2. Number of individual small mammals captured per acre and per 100 trap nights in six ROW cover types and the adjoining forest in August 1989 (bar 1) and 1990 (bar 2). Plant cover type symbols are: FOR = forest, WIH = witchhazel, BLA = blackberry, BLU = blueberry-sweetfern, POG = poverty grass-goldenrod, TRS = tree sprout, FES = fescue.

dant of which were the white-footed mouse and the southern red-backed vole. The population average for the two census years was 100.4 per acre (19.8/100 trap nights), the highest of the ROW types and about the same as the forest.

Poverty grass-goldenrod cover type. This was one of the more productive types on the ROW. Four species were captured, with white-footed mouse and the meadow vole being the most common. The population averaged 84.7 individuals per acre (16.7/100 trap nights).

Blackberry cover type. Four species were also found in this type of which the most common were white-footed mouse and southern red-backed vole. The population averaged 79.9 individuals per acre (12.9/100 trap nights).

Blueberry-sweetfern cover type. Four species were captured in this type of which the white-footed mouse and meadow vole were the most common. The population averaged 66.5 per acre (13.1/100 trap nights).

Tree sprout cover type. Five species were captured in this type of which white-footed mouse and southern red-backed vole were most common. The population averaged 61.8 individuals per acre (12.1/100 trap nights).

Fescue cover type. Of the three small mammal species captured in this type, meadow vole was by far the most common, and this was the only type in which white-footed mouse was absent. The population averaged 32.7 individuals per acre (6.4/100 trap nights), which was the lowest of all cover types.

Reproductive condition. In 1990, 31 small mammals were necropsied in the laboratory. Of these, four individuals contained embryos. A meadow mouse, captured in poverty grass-goldenrod, had four well-developed embryos; a red-backed vole, captured in the tree sprout type, had four small embryos; a white -footed mouse, captured in poverty grass-goldenrod, had four small embryos; and a masked shrew, captured in blueberry-sweetfern, had five embryos. Therefore, it was evident that small mammals were reproducing on the ROW. They also were raising young as evidenced by the one percent of the total captured on the ROW that were young of the year.

Several other characteristics of the small mammal population were also of interest in this connection. For example, 74.1 percent of the population of white-footed mice were breeding adults. Also, the sex ratio for white-footed mouse was 1 male:0.6 females, and for all species it was 1 male:0.8 females, which is similar to the sex ratios of 1:0.9 in the Moshannon State Forest and 1:0.5 in the Rothrock State Forest both located in central Pennsylvania (4).

Discussion

The finding that an abundant and diverse small mammal population existed in the six common cover types on the ROW is particularly important in relation to cover type resistance to tree invasion. This is because small mammals consume seeds and seedlings, and where species that are primarily herbivores are abundant, they undoubtedly do much to prevent trees from becoming established. For example, creation of a poverty grass-goldenrod cover type on the ROW wire zone in which meadow vole was abundant could be an important objective of ROW management. This cover type has been produced on our ROW through application of several techniques including mowing plus herbicide (cut stubble) and stem-foliage spray, and is resistant to tree invasion.

Another important finding was that a combination of cover types on the ROW contained a more diverse and abundant small mammal population than would be found in any one of the types. Treatment Unit MH-1 is an example of this, where a fescue cover type was produced on the wire zone by a mowing plus herbicide treatment, and a blackberry cover type on the border zone by use of a selective basal spray. The small mammal population of the fescue cover type contained meadow vole, woodland jumping mouse, and meadow jumping mouse in 1989, with a total population of 58.8 individuals per acre. The blackberry cover type population consisted of 102.9 individuals per acre composed of white-footed mouse and northern short-tailed shrew. Thus, the production of two distinct cover types on the ROW produced a more diverse and abundant small mammal population than either one of the cover types alone.

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Résumé. *Une étude de l'abondance et de la diversité en* petits mammifères sur des types communs de couverts de plantes était réalisée sur un corridor de lignes électriques de transport du centre de la Pennsylvanie en 1989 et 1990. Deux traitements mécaniques et cinq à l'herbicide avaient été appliqués en 1987 sur quarte corridors régénérés qui incluaient huit espèces de mammifères avec une densité moyenne totale de 71.0 individus à l'acre. La densité en population de toutes les espèces combinées pour les six types communs de couverts végétals des corridors s'étalait de 32.7 dans le type herbacé à fétuques (*Festuca* spp.) à 100.4 dans le type à hamamélis. La densité en petits mammifères était de 101.6 à l'acre, avec seulement deux espèces présentes, pour la forêt avoisinante.

Zusammenfassung. Eine studie über den Reichtum und die Vielfalt von Kleinsäugern in einheimischen Pflanzengesellschaftstypen wurde 1989 und 1990 über eine elektronische Übertragungsleitung (ROW) im Zentrum Pennsylvaniens durchgeführt. Zwei mechanische und fünf Herbizid-Behandlungen wurden 1987 auf vier künstlich angelegten Leitungsstrecken angewandt, welche acht Säugetierarten mit einer durchschnittlichen Gesamtdichte von 71 Individuen pro acre (= 0,405 ha) beinhalteten. Die Populationsdichte aller Arten in den sechs einheimischen Pflanzengesellschaftstypen reicht von 32,7 Individuen pro Acre beim Schwingelgrastyp bis zu 100,4 Individuen pro Acre beim Viginischen Zauberstrauchtyp. Die Dichte von Kleinsäugern in dem angrenzenden Wald betrug durchschnittlich 101,6 Individuen pro Acre, wobei diese auf nur zwei Arten entfallen.