

BREEDING-BIRD POPULATION CHANGES FOLLOWING RIGHT-OF-WAY MAINTENANCE TREATMENTS

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Abstract. The effects of herbicide and mechanical vegetation maintenance treatments on breeding-bird populations were compared on electric transmission rights-of-way (ROW) in the Allegheny Mountain and Piedmont Physiographic Provinces in Pennsylvania (hereafter termed the Allegheny ROW and the Piedmont ROW, respectively). Bird density decreased from pre-treatment (June) to post-treatment (August) in 1987 on handcut and mowed plus herbicide-treated ROW areas on both the Allegheny and Piedmont ROW; whereas, bird density increased on basal-, stem-foliage-, and foliage-sprayed ROW from pre- to post-treatment. A decrease occurred on the mowed ROW areas only on the Piedmont ROW. Retention of shrubby borders by selective treatment was a major factor in retaining the pre-treatment bird populations in the post-treatment period.

The objective of our study was to determine the effects of herbicidal and mechanical maintenance treatments on abundance and distribution of breeding-bird populations on two rights-of-way (ROW) in widely separated locations in Pennsylvania, the Allegheny Mountain and Piedmont Physiographic Provinces (Figure 1). Bird censuses were conducted before and after ROW maintenance treatments in June and August 1987, respectively, and in June and August 1988.

The vegetation of the two ROW was similar in structure with tree, shrub, and herb layers present on both ROW. Although plant species composition was somewhat different between ROW, some important species were common to both. The abundance of white ash (*Fraxinus americana*) on the Piedmont ROW and its absence on the Allegheny ROW were an important species difference. However, red maple (*Acer rubrum*) and sassafras (*Sassafras albidum*) were common trees on both ROW.

Two common shrubs of the Allegheny ROW, blackberry (*Rubus allegheniensis*) and dewberry (*Rubus* spp.), were also common on the Piedmont

ROW. However, blueberry (*Vaccinium* spp.), witchhazel (*Hamamelis virginiana*), and sweetfern (*Comptonia peregrina*) were characteristic shrubs on the Allegheny ROW in contrast to black haw (*Viburnum prunifolium*), raspberry (*Rubus strigosus*), and gray dogwood (*Cornus paniculata*) on the Piedmont ROW.

Goldenrod (*Solidago* spp.) was a common forb on both ROW. Bracken (*Pteridium aquilinum*), hayscented fern (*Dennstaedtia punctilobula*), and sheep sorrel (*Rumex acetosella*) were characteristic of the Allegheny ROW in contrast to wild strawberry (*Fragaria virginiana*), common cinquefoil (*Potentilla simplex*) and goosegrass (*Galium aparine*) on the Piedmont ROW.

Five grasses characteristic of the Allegheny ROW were tall meadow fescue (*Fescue elatior*), poverty grass (*Danthonia spicata*), panic grass (*Panicum* spp.), vernal sedge (*Carex pensylvanica*), and mountain rice (*Oryzopsis asperifolia*). On the Piedmont ROW, fall panic grass (*Panicum dichotomifolium*), deertongue

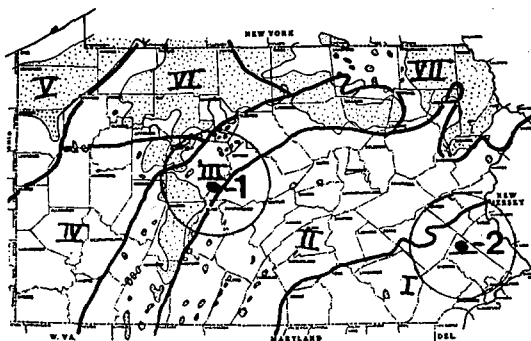


Figure 1. Locations of the Allegheny Mountain ROW (1) in the Allegheny Mountain Physiographic Province (III) and the Piedmont ROW (2) in the Piedmont Physiographic Province (I) in Pennsylvania.

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grass (*Panicum clandestinum*), foxtail grass (*Setaria glauca*), and broomsedge (*Andropogon virginicus*) were characteristic species.

Literature Review

A number of studies conducted on electric transmission ROW have indicated that a particular maintenance technique may have a definite effect on breeding-bird populations. For example, in Tennessee, mowing increased diversity and density of breeding birds on a ROW compared to those in an adjacent forest (5). In New York, basal herbicide applications and cut and stump spraying were more favorable to bird density and diversity than mowing or aerial spraying, owing primarily to increased shrub cover (8). In Maryland, selective herbicide applications created more habitat and bird diversity than annual mowing (6), and breeding bird density was highest on the shrubby portion of the mowed ROW (4). Also in Maryland, selective basal applications did not produce adverse changes in vegetation over a period of 4 years that were sufficient to alter the normal fluctuations in bird species density (7). In a report on ROW studies in 4 states, the number of bird species were found to be similar on both broadcast and selectively-sprayed ROW (3).

The effects of 5 different ROW maintenance techniques on a breeding-bird population were studied on an electric transmission line in central Pennsylvania in June 1982 and in June and July 1983 (1). The number of birds decreased on handcut and herbicide pellet-treated areas, and increased on ROW areas given stem-foliage, summer basal, and frill and squirt treatments.

Methods

ROW treatments. Each ROW research segment was divided into "treatment units" that were about 500 feet in length, which was sufficient to permit use of a commercial line clearance crew. Treatments were replicated 4 times on the Allegheny ROW and 3 times on the Piedmont ROW.

A method referred to as the "wire zone-border zone method" was used for all treatment units (Figure 2). 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 on the wire zone.

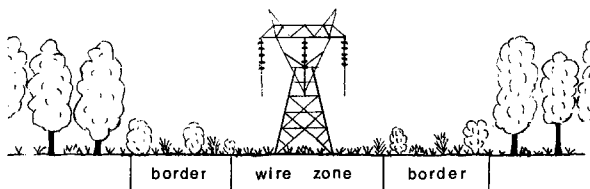


Figure 2. Diagram of a 230 kV line ROW to show (1) a wire zone that included the ROW lying under the wires plus about 10 feet on each side and (2) border zones that included the remainder of the ROW lying on each side of the wire zone. A low shrub-forb-grass cover type occupied the wire zone with a tall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

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 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 (90.5%) 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%). The border zones were treated as for "mowing" above.
6. High volume selective basal spray. Trees and tall shrubs on the wire zones 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.

Bird census method. Breeding-birds were censused during 4 time periods to determine the effects of mechanical and herbicidal maintenance treatments that were applied on both ROW in July 1987. A pre-treatment census was conducted in late May and June 1987. A post-treatment census followed in August 1987, 3 weeks after maintenance treatments. Two censuses were made late May-June and August 1988 to determine population changes 1 year subsequent to treatments.

During each of the four time periods, breeding birds were censused on 6 consecutive days along each ROW. Censuses were conducted from sunrise to about 0900 hours. All birds seen or heard were noted, and the location of each bird relative

to wire and border zones in each treatment unit was plotted on a map of the ROW. Treatment units averaged 3.5 acres on the Allegheny ROW and 1.7 acres on the Piedmont ROW.

Results

Control of ROW trees. Herbicide sprays that were applied by a commercial line clearance company proved to be highly effective in reducing trees to a low density of less than 500 per acre on both ROW. These thorough herbicide applications were an essential requirement for the bird impact study which was designed to compare herbicide with mechanical treatments.

In contrast to the above, tree density on handcut ROW treatment units in 1988 was 2900 trees per acre on the wire zone of the Allegheny ROW and 3900 on the Piedmont ROW wire zone. It is also important to note in connection with results of the bird census that both handcutting and mowing reduced trees and tall shrubs to a cut stubble

Table 1. Bird populations on the Allegheny and Piedmont ROW treatment units in June and August 1987 and 1988. All treatments were applied in July 1987.

Treatment	Zone	Allegheny ROW				Piedmont ROW			
		1987		1988		1987		1988	
		June	Aug.	June	Aug	June	Aug.	June	Aug
		No. birds per acre per day							
Handcutting	Wire	2.3	0.2	0.8	0.8	6.8	0.3	1.4	0.2
	Border	3.4	5.9	6.3	3.6	4.9	2.4	2.7	1.5
	Entire ROW	2.9	3.1	3.6	2.2	5.9	1.4	2.1	0.9
Mowing	Wire	2.3	4.3	1.3	6.7	10.2	0.2	1.4	0.9
	Border	4.9	14.1	9.2	17.6	4.9	5.7	6.2	7.4
	Entire ROW	3.6	9.2	5.3	12.2	7.6	3.0	3.8	4.0
Mowing plus herbicide	Wire	5.3	1.2	0.7	1.0	7.9	5.7	2.0	0.6
	Border	3.3	11.2	8.6	9.3	5.6	12.0	7.2	7.3
	Entire ROW	4.3	6.2	4.7	5.2	6.2	8.9	4.1	4.0
Selective basal spray	Wire	5.6	9.3	5.1	9.3	-	-	-	-
	Border	5.2	14.8	6.6	10.9	-	-	-	-
	Entire	5.4	12.1	5.9	10.1	-	-	-	-
Stem-foliage spray	Wire	3.9	12.7	1.1	5.5	5.7	7.3	7.4	6.8
	Border	2.8	9.1	4.2	9.7	3.7	7.3	5.5	6.1
	Entire ROW	3.4	10.9	2.7	7.6	4.7	7.3	6.5	6.5
Foliage spray	Wire	1.5	8.2	1.0	6.1	8.8	20.6	4.9	10.7
	Border	2.4	6.9	4.2	7.5	3.2	5.9	7.9	7.4
	Entire ROW	2.0	7.6	2.6	6.8	6.0	13.2	6.4	8.9

about 4 to 6 inches in height in August 1987.

Effect of ROW treatments on bird density.

Bird density, expressed as numbers of birds of all species combined counted per acre per day, decreased from June 1987 (pre-treatment) to August 1987 (post-treatment) on wire zones of the handcut and mowed plus herbicide units on both ROW (Table 1). In contrast, bird density on wire zones on the herbicide-sprayed treatment units on both ROW increased or remained constant from June to August 1987. The presence of dead trees with brown foliage provided perches and excellent cover for birds on these herbicide-treated units.

Changes in bird density that followed specific ROW treatments may be summarized as follows:

Handcutting (HC). Bird density decreased considerably from June 1987 (pre-treatment) to August 1987 (post-treatment) on the handcut wire zones of both ROW (Figures 3 and 4). A low tree sprout cover type was present on the wire zone (Figure 8). However, bird density on selectively cut border zones remained high enough during that period to permit the bird density to remain constant on the entire Allegheny ROW, and to maintain a low density on the Piedmont ROW.

Mowing (M). Bird density increased from June to August 1987 on the mowed wire zone of the Allegheny ROW on which shrub cover remained at 27%

after mowing (Figure 3). However, bird density decreased sharply from June to August 1987 on the mowed wire zone of the Piedmont ROW where trees and shrubs were reduced to a low cut stubble and a forb-grass cover type dominated the ROW (Figure 4).

Mowing plus herbicide (MH). Bird density decreased from June to August 1987 on the mowed wire zone on both ROW (Figures 3 and 4). Bird density increased on the selectively sprayed border zones.

Selective basal spray (SB). Bird density increased on the wire and border zones from June to August 1987 on the Allegheny ROW. Selective basal was not used on the wire zone of the Piedmont ROW owing to its high tree density.

Stem foliage spray (F). Bird density increased on the wire zones from June to August 1987 on both ROW.

Foliage spray (F). Bird density increased on the wire zones from June to August on both ROW.

To compare with the bird population changes after ROW treatments recorded in 1987, bird censuses were again carried out in June and August 1988 without intervening treatments. Just as in 1987, bird density increased, or remained stable, on the wire zones of the stem-foliage and foliage spray units on both ROW from June to August 1988

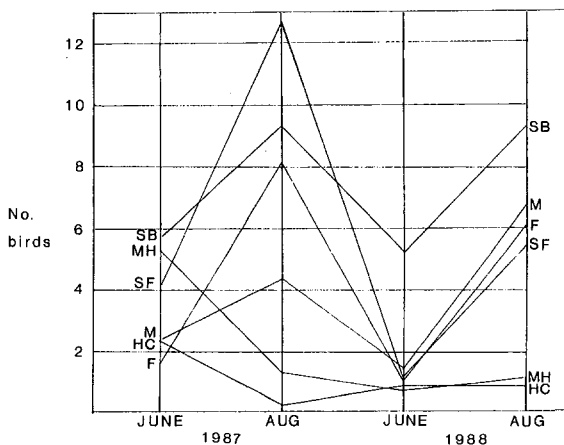


Figure 3. Changes in the number of birds counted per acre per day on the wire zone of treatment units on the Allegheny ROW from June 1987 (pretreatment) to August 1987 (post-treatment), and from June 1988 to August 1988. HC=handcutting, M=mowing, MH=mowing plus herbicide, SF=stem-foliage spray, F=foliage spray.

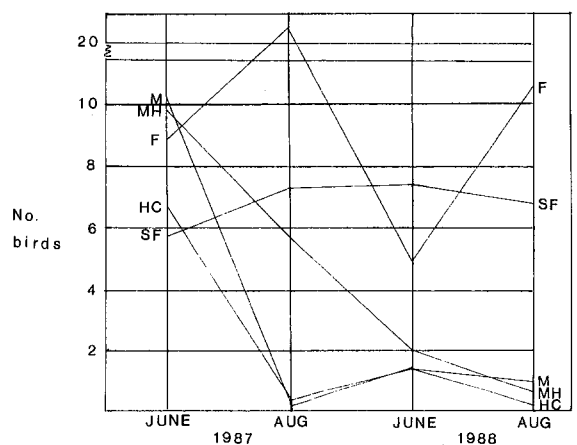


Figure 4. Changes in the number of birds counted per acre per day on the wire zone of treatment units on the Piedmont ROW from June 1987 (pretreatment) to August 1987 (post-treatment), and from June 1988 to August 1988. HC=handcutting, M=mowing, MH=mowing plus herbicide, SF=stem-foliage spray, F=foliage spray.

in the absence of intervening ROW treatments (Table 1). It appears, therefore, that an increase from June to August is a normal occurrence that was not interfered with by herbicide sprays. Such an increase is probably due to additions of young of the year and entry of birds from other areas. On the other hand, the adverse impacts of handcutting and mowing appeared to be carried over to 1988 on both ROW where decreases in bird density again occurred on the wire zones from June to August in the absence of treatments (Table 1).

The retention of shrubby border zones through use of selective basal sprays and selective cutting appeared to be a major factor in maintaining the pre-treatment bird population on the ROW. This was clearly shown by spot maps of birds counted over the 6 day census period (Figure 5). Only 2 birds were spotted in August 1987 on the clearcut wire zone on the Allegheny ROW as contrasted to 58 birds spotted on the selectively cut border zones. A similar condition existed on the Piedmont ROW where only 2 birds were spotted on the clearcut wire zone in contrast to 12 on the border zone.

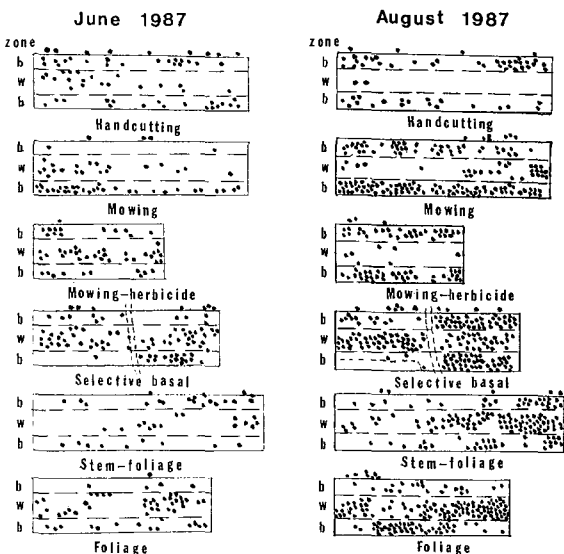


Figure 5. Spot maps of birds counted over a 6 day census period in June (pretreatment) and August (post-treatment) 1987 on treatment units on the Allegheny ROW. Each rectangle represents a treatment unit; each dot represents 1 bird counted on wire zones (w) and border zones (b).

Effects of ROW treatments on bird species.

The total number of bird species (species richness) remained stable or increased on the entire ROW area (wire plus border zones) in August 1987, 3 weeks after treatment, on the Allegheny ROW (Table 2). On the Piedmont ROW, however, the number of bird species in August 1987 increased only after herbicide treatments; while decreasing on handcutting and mowing units. Between June and August 1988, the number of bird species on herbicide-sprayed units increased, or remained stable, on both ROW. However, bird species decreased in 1988 on handcut units on both ROW and increased, or remained stable, on mowing and mowing plus herbicide units.

A compilation of breeding-bird species counted on the two ROW by the 4 censuses indicated that there were important similarities in the species composition of the ROW studied (Table 3). For example, there was a high similarity in species richness: 39 species on the Allegheny ROW and 42 on the Piedmont ROW. Also, of the 5 most common species on the Allegheny ROW, 4 were common on the Piedmont ROW. There were also some important species differences between the two ROW. Twelve species counted on the Allegh-

Table 2. Number of bird species (species richness) on the Allegheny and the Piedmont ROW in June 1987 and 1988 and August 1987 and 1988. Treatments were applied in July 1987.

Treatment	No. bird species (6 day census)			
	1987		1988	
	June	August	June	August
Allegheny ROW				
Handcutting	14	14	11	9
Mowing	12	26	14	26
Mowing plus herbicide	10	16	14	13
Selective basal spray	13	26	14	22
Stem foliage spray	10	17	12	19
Foliage spray	10	27	11	19
Average	11	21	13	18
Piedmont ROW				
Handcutting	10	8	13	5
Mowing	20	11	15	13
Mowing plus herbicide	19	23	17	17
Stem-foliage spray	13	20	17	20
Foliage spray	19	24	14	18
Average	18	17	15	15

Table 3. Bird populations in June 1987 (pretreatment) and August 1988 (post-treatment) on the Allegheny Mountain and Piedmont Province ROW (No. = total birds counted and % = proportion of population).

Species	Allegheny ROW				Piedmont ROW			
	June 1987		Aug 1988		June 1987		Aug 1988	
	No.	%	No.	%	No.	%	No.	%
Chestnut-sided warbler <i>Dendroica pensylvanica</i>	65	18	14	2	-	-	-	-
Field Sparrow <i>Spizella pusilla</i>	56	15	207	26	44	13	24	14
Gray catbird <i>Dumetella carolinensis</i>	41	11	50	6	18	5	17	7
Rufous-sided towhee <i>Pipilo erythrophthalmus</i>	38	10	101	13	31	9	17	7
Common yellowthroat <i>Geothlypis trichas</i>	36	10	67	9	30	9	19	8
American redstart <i>Setophaga ruticella</i>	25	7	17	2	-	-	1	0.4
Brown-headed cowbird <i>Molothrus ater</i>	25	7	1	0.1	12	3	-	-
Indigo bunting <i>Passerina cyanea</i>	20	6	27	2	19	5	7	3
Song sparrow <i>Melospiza melodia</i>	11	3	99	13	2	0.6	1	0.4
Chipping sparrow <i>Spizella passerina</i>	9	3	1	0.1	-	-	-	-
Rose-breasted grosbeak <i>Pheucticus ludovicianus</i>	8	2	9	1	-	-	-	-
American goldfinch <i>Carduelis tristis</i>	8	2	13	2	21	6	4	2
American robin <i>Turdus migratorius</i>	5	1	2	0.9	3	1	4	2
Red-eyed vireo <i>Vireo olivaceus</i>	5	1	22	3	-	-	-	-
Black-and-white warbler <i>Mniotilta varia</i>	4	1	9	1	1	0.3	-	-
Scarlet tanager <i>Piranga olivacea</i>	2	0.5	15	2	-	-	1	0.4
Golden-winged warbler <i>Vermivora chrysoptera</i>	2	0.5	2	0.3	-	-	18	7
Cedar waxwing <i>Bombycilla cedrorum</i>	2	0.5	3	0.4	11	3	-	-
Least flycatcher <i>Empidonax minimus</i>	1	0.3	13	2	-	-	1	0.4
Ruby-throated hummingbird <i>Archilochus colubris</i>	1	0.3	-	-	1	0.3	1	0.4
Great crested flycatcher <i>Myiarchus crinitus</i>	1	0.3	-	-	1	0.3	1	0.4
Black-capped chickadee <i>Parus atricapillus</i>	1	0.3	35	4	10	3	-	-
Eastern bluebird <i>Sialia sialis</i>	1	0.3	-	-	-	-	-	-
Eastern phoebe <i>Sayornis phoebe</i>	-	-	16	2	-	-	3	1
Downy woodpecker <i>Picoides pubescens</i>	-	-	12	2	-	-	2	0.8
Eastern wood-pewee <i>Contopus virens</i>	-	-	10	1	1	0.3	-	-
Tufted titmouse <i>Parus bicolor</i>	-	-	10	1	4	1	6	2
Ruffed grouse <i>Bonasa umbellus</i>	-	-	9	1	-	-	-	-
House wren <i>Troglodytes aedon</i>	-	-	5	0.7	8	2	34	14
Canada warbler <i>Wilsonia canadensis</i>	-	-	3	0.4	-	-	-	-
Dark-eyed junco <i>Junco hyemalis</i>	-	-	2	0.3	-	-	-	-
Ovenbird <i>Seiurus aurocapillus</i>	-	-	1	0.1	-	-	-	-
Hairy woodpecker <i>Picoides villosus</i>	-	-	1	0.1	1	0.3	2	0.8
Common flicker <i>Colaptes auratus</i>	-	-	1	0.1	5	2	1	0.4
Yellow-billed cuckoo <i>Coccyzus americanus</i>	-	-	1	0.1	-	-	1	0.4
White-breasted nuthatch <i>Sitta carolinensis</i>	-	-	1	0.1	-	-	-	-
Blackburnian warbler <i>Dendroica fusca</i>	-	-	1	0.1	-	-	-	-
American kestrel <i>Falco sparverius</i>	-	-	1	0.1	-	-	-	-
Blue-winged warbler <i>Vermivora pinus</i>	-	-	-	-	38	11	8	3
Cardinal <i>Cardinalis cardinalis</i>	-	-	-	-	17	5	30	12
Prairie warbler <i>Dendroica discolor</i>	-	-	-	-	16	5	2	0.8
Eastern kingbird <i>Tyrannus tyrannus</i>	-	-	-	-	13	4	9	3
Blue jay <i>Cyanocitta cristata</i>	-	-	-	-	8	2	14	5
Yellow-breasted chat <i>Icteria virens</i>	-	-	-	-	6	2	1	0.4
Blue-gray gnatcatcher <i>Poliophtila caerulea</i>	-	-	-	-	5	2	-	-
Wood thrush <i>Hylocichla mustelina</i>	-	-	-	-	4	1	-	-
Common grackle <i>Quiscalus quiscula</i>	-	-	-	-	4	1	-	-
Mourning dove <i>Zenaida macroura</i>	-	-	-	-	2	0.6	4	2
Northern oriole <i>Icterus galbula</i>	-	-	-	-	2	0.6	5	2
White-eyed vireo <i>Vireo griseus</i>	-	-	-	-	1	0.3	-	-
Black-eyed cuckoo <i>Coccyzus erythrophthalmus</i>	-	-	-	-	1	0.3	-	-
Blackpoll warbler <i>Dendroica striata</i>	-	-	-	-	1	0.3	-	-
Mockingbird <i>Mimus polyglottos</i>	-	-	-	-	1	0.3	-	-
Total		367		782		343		248

eny ROW were absent on the Piedmont ROW; conversely 16 species counted on the Piedmont ROW were not found on the Allegheny ROW. The most notable differences were the presence of the chestnut-sided warbler, rose-breasted grosbeak, red-eyed vireo, and chipping sparrow only on the Allegheny ROW, versus the presence of blue-winged warbler, northern cardinal, prairie warbler, eastern kingbird, blue jay, and yellow-breasted chat only on the Piedmont ROW.

To further characterize the bird population of the ROW, the Simpson diversity index was calculated to indicate the degree of evenness in the distribution of individuals among the common species in August 1988. The diversity indices were relatively high on both ROW and ranged from 0.95 to 0.97 on the Piedmont ROW and from 0.86 to 0.91 on the Allegheny ROW. This indicates that the number of birds was evenly distributed among species.

Composition of the ROW plant cover types that developed after specific ROW treatments appeared to have a definite relationship with the size of the bird populations (Table 4). For example, the shrub-forb-grass cover type that followed selective basal spraying (Figure 6) with a 116% shrub

cover had the highest bird population among the wire zone cover types. Conversely, the grass-forb wire zone cover type that followed mowing plus herbicide (Figure 7) and stem-foliage spray treatments with a 75% and 50% grass cover, respectively, and a sparse shrub cover had the lowest wire zone bird populations.

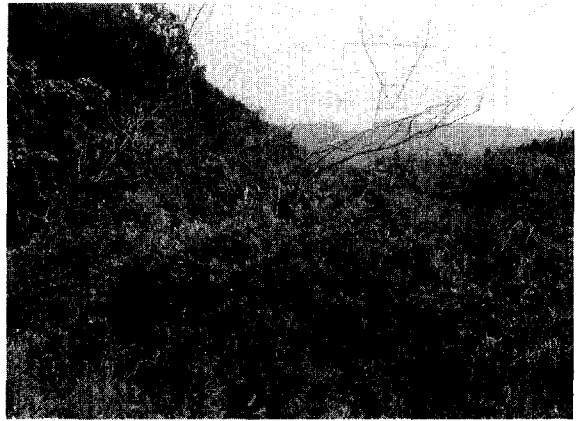


Figure 6. Shrub (blueberry)-forb (goldenrod)-grass (fescue) cover type on the wire zone and a shrub (witchhazel) cover type on the border zone developed after a selective basal spray. The ROW bird count was 9.3 per acre per day on the wire zone and 14.8 on the border zones in August 1987.

Table 4. The relationship between ROW treatment, plant cover type, and bird population on the Allegheny ROW in August 1988. The percent cover value of each life form is shown in brackets.

ROW wire zone		ROW border zone		No. birds counted per acre per day August 1988		
Treatment	Cover type	Treatment	Cover	Wire Zone	Border Zone	Entire ROW
Handcutting	Tree sprout (28%)	SC*	Shrub (53%)	0.8	3.6	2.2
Mowing	Grass-forb-shrub (6%-41%-27%)	SBS	Shrub (66%)	6.7	17.6	12.2
Mowing plus herbicide	Grass-forb (75%-<1%)	SBS	Shrub (94%)	1.0	9.3	5.2
Selective basal spray	Shrub-forb-grass (116%-21%-5%)	SBS	Shrub (82%)	9.3	10.9	10.1
Stem-foliage spray	Grass-forb (58%-29%)	SBS	Shrub (76%)	5.5	9.7	7.6
Foliage spray	Forb-grass (14%-24%)	SBS	Shrub (67%)	6.1	7.5	6.8

* = selective cutting, SBS = selective basal spray

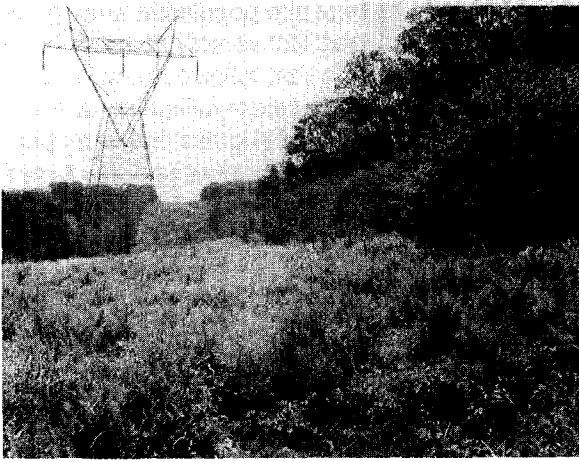


Figure 7. Grass (poverty grass)-forb (goldenrod) cover type on the wire zone and a shrub (witchhazel) cover type on the border zone that developed after a mowing plus herbicide treatment on the wire zone and a selective basal spray on the border zone. The bird count in August 1987 was 1.2 per acre per day on the wire zone and 11.2 on the border zone.

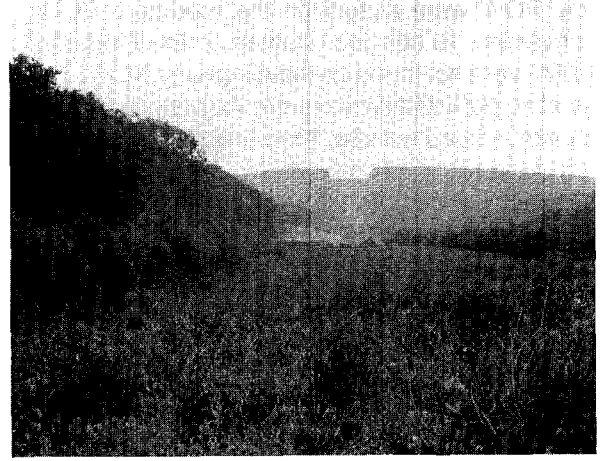


Figure 8. A low tree sprout (from cut stubs of oaks and red maple) cover type on a handcut wire zone June 1987. A tall shrub cover type (witchhazel and bear oak) that developed on the border zone after selective cutting is on the left. The bird count was 0.2 per acre per day on the wire zone and 5.9 on the border zone in August 1987.

Of special interest, was the relatively high bird populations of the shrub cover type that followed selective basal spraying of border zones on all treatment units (Table 4). These shrubby border zones supplemented the grass-forb wire zone cover types to provide shrub cover and thus maintain a reasonably high bird population on the entire ROW units. Thus, the low bird population of 1.0 birds counted per acre per day on the grass-forb wire zone of the mowing plus herbicide unit was supplemented by 9.3 birds per acre per day on the selectively sprayed border zones to produce a population of 5.2 birds per acre per day counted on the entire treatment unit.

The apparent relationship of the size of the bird population with presence of shrub cover (Figure 8) was not entirely unexpected as the common bird species found on the ROW are typical of abandoned shrubby fields, moist thickets, and brushy slopes (2).

The bird population engaged in normal activities, including nesting (Figure 9) on both ROW and on both mechanically- and herbicide-treated units. For example, on the first census day in August 1987, 3 weeks after treatment, birds were observed singing and calling on all ROW treatment units (Table 5). On handcut and mowed units of the

ROW, however, these activities and foraging were observed only on border zones, while birds were foraging on both wire and border zones on herbicide-treated units. Trees and tall shrubs on border zones were being used as perches (Figure 10). In addition, the dead standing trees on the wire zone of stem-foliage and foliage-sprayed units also were used for perching.

Comparison of the bird population on the Allegheny ROW with the adjoining oak forest population indicated that the number of birds was significantly less ($P=0.05$) in the forest where that were only 1.3 birds counted per acre per day in June 1987 and 2.1 in August 1987 as compared with 3.6 in June 1987 and 8.1 in August 1987 on the ROW. The number of bird species present was also fewer in the forest, with 9 in June and 13 in August 1987, than on the ROW with 11 and 21 on the same dates.

Common birds observed in the forest such as ovenbird, wood thrush, white-breasted nuthatch, veery, and hairy woodpecker, were found only occasionally on the ROW. However, certain other forest bird species were common on the ROW. These included American redstart, American robin, red-eyed vireo, least flycatcher, chipping sparrow, rose-breasted grosbeak, scarlet tanager, and black-and-white-warbler.

Table 5. Typical activity of birds on the Allegheny and Piedmont ROW in August 1987, 3 weeks after treatment.

Treatment	Singing		Bird activity Calling		Perching		Foraging	
	Wire zone	Border zone	Wire zone	Border zone	Wire zone	Border zone	Wire zone	Border zone
No. birds, Allegheny ROW August 1, 1987								
Handcutting		2		2		1		1
Mowing		4		5		4	2	16
Mowing plus herbicide		4		5		2	1	2
Selective basal	3	6	5	4	1		4	2
Stem-foliage	1	1	4	3	5		4	2
Foliage	1	4		2	10	1	6	6
Total	5	21	9	21	16	8	17	29
% of Total	4	17	7	17	13	6	13	23
No of birds, Piedmont ROW August 8, 1987								
Handcutting		2						
Mowing	1		4					
Mowing plus herbicide		2	1	3		1	2	6
Stem-foliage	1	1	6			4	14	
Foliage	1	1	1	2			7	
Total	2	7	8	9	0	5	23	6
% of Total	3	12	13	15	0	8	38	10

**Figure 9. A towhee nest with 3 eggs in blackberry on the wire zone of a selective basal spray unit in July.**

In addition, several forest species of special interest were observed on the ROW which appeared to function as a large forest opening. Ruffed grouse used the Allegheny ROW and several large flocks of wild turkeys were observed feeding on this ROW in 1988 and 1989. Individual wild turkey were seen on the Piedmont ROW and a turkey nest with eggs was found on the border zone.

Discussion

An unexpected result of this study, which was important to ROW management, was the retention of a large and diverse bird population on herbicide-treated ROW units after treatments were applied, in two very different physiographic provinces, the Allegheny Mountain and Piedmont. This appeared to be due in large part to creation



Figure 10. Rufous-sided towhee perched on a dead tree branch on the border zone of a selective basal spray unit

of a favorable ROW habitat through use of the wire zone-border zone method that retained shrubs as a dominant component of vegetation on border zones.

This meant that a combination such as a low grass-herb wire zone resulting from a stem-foliage spray, with a shrub cover type on border zones, resulting from a selective basal spray, retained a large ROW bird population with high species diversity.

In contrast, handcutting of wire zones on both ROW resulted in a decreased bird presence on the ROW, even though birds were fairly abundant on the selectively-treated border zones. Complete removal of trees and tall shrubs on the wire zone by mechanical cutting left cut stubble and slash which produced an adverse impact on birds that was carried over into the year after treatment.

It is also important to note that although the common bird species on the ROW were those typical of shrubby habitats which represent early stages of plant succession, certain forest-inhabiting species also were observed using the ROW. Evidently, the ROW served as an attractive forest opening.

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Résumé. Les effets de traitement à l'herbicide et mécanique pour le contrôle de la végétation sur la reproduction des populations d'oiseaux étaient comparés pour les corridors de lignes de transmission électrique (ROW) des provinces physiographiques d'Allegheny Mountain et du Piedmont en Pennsylvanie. La densité d'oiseaux décroissait d'avant (juin) à après (août) le traitement en 1989 pour les secteurs de corridors des deux provinces (Allegheny et Piedmont) traités par coupe manuelle et par fauchage avec herbicide; tandis que la densité d'oiseaux s'accroissait d'avant à après le traitement pour les corridors traités par arrosage par la base, par arrosage foliaire et par arrosage sur les tiges et les feuilles. Une décroissance se produisait pour les corridors fauchés du Piedmont seulement. Le maintien de bordures arbustives au moyen d'un traitement sélectif était un facteur majeur de conservation des populations d'oiseaux entre les périodes précédant et suivant le traitement en question.