EFFECT OF VEGETATION MAINTENANCE OF AN ELECTRIC TRANSMISSION RIGHT-OF-WAY ON REPTILE AND AMPHIBIAN POPULATIONS

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Abstract. A 2-year study of reptile and amphibian populations was conducted on a 230-kV transmission line right-of-way (ROW) of GPU Energy in the Allegheny Mountain Physiographic Province, Centre County, Pennsylvania, U.S., from June through October 1998 and March through October 1999. The objective was to compare the diversity and relative abundance of reptiles and amphibians between the ROW versus the adjacent forest, among five treatment units on the ROW, and between wire and borders zones on treatments on the ROW. Nine species were recorded during the study, with the three most common species being redback salamanders (Plethodon cinereus), northern redbelly snakes (Storeria occipitomaculata occipitomaculata), and northern ringneck snakes (Diadophis punctatus edwardsii). All nine species occurred on the ROW, but only redback salamanders and Jefferson salamanders (Ambystoma jeffersonianum) were found in the adjacent forest. The diversity and relative abundance ranged from six species in the stem-foliage unit to three species in the handcutting unit. Eight and six species, respectively, were noted in the wire and border zones of the ROW. However, 81% of the observations in wire zones were those of snakes, whereas 85% of the observations in border zones were salamanders. The ROW contained a much more diverse community of reptiles and amphibians than the adjacent forest. Forest-management practices can have negative impacts on populations of amphibians and reptiles. Thus, this study provides important information on forest-management practices required for the conservation of reptiles and amphibians.

Key Words. Amphibians; herbicides; reptiles; right-of-way; salamanders; snakes; tree control.

Forest-management practices can have negative impacts on populations of amphibians and reptiles (e.g., Ash 1997; deMaynadier and Hunter 1998; Rodewald and Yahner 1999). From an ecological perspective, woodland salamanders comprise a major portion of the total vertebrate biomass in an ecosystem (Burton and Likens 1975). Amphibians (e.g., woodland salamanders) feed on a variety of invertebrates, whereas reptiles (e.g., snakes) feed on both invertebrate and small mammals (Shaffer 1991). These vertebrates are important components of the food chain. There is increasing global concern for the decline of amphibian populations (Blaustein and Wake 1990; Fisher and Shaffer 1996).

Vegetation management along a 4.8-km (10-mi) portion of the right-of-way (ROW) in Centre County, Pennsylvania, U.S., has been studied since 1953 (Yahner et al. 1999a). The ROW is a 230-kV transmission line of GPU Energy in the Allegheny Mountain Physiographic Province. The project addresses two long-term objectives since its inception: 1) to compare the effectiveness of commonly used herbicide and mechanical maintenance treatments on control of target trees and development of tree-resistant plant cover types to handcutting without herbicides, and 2) to determine the effect of these maintenance treatments on selected wildlife species of high public interest.

The objective was to compare the diversity and relative abundance of reptiles and amphibians between the ROW versus the adjacent forest, among five treatment units on the ROW, and between wire and borders zones on treatments on the ROW. Because forest-management practices can have negative impacts on populations of amphibians and reptiles, the study is timely from an ecological and public-relations perspective.

METHODS

Five treatment units were selected for study: 1) handcutting, 2) high-volume basal spray, 3) mowing plus herbicide, 4) stem-foliage spray, and 5) foliage spray. Beginning in 1982, each unit was treated using the wire zone-border zone method (Figure 1). This method is designed to produce a tree-resistant low shrub-forb-grass cover type on the wire zone and a tall shrub-forb cover type on the border zone.

Each of the units was treated by herbicides and/or mechanical in 1987 and again in 1996. Details of these treatments can be obtained in Bramble et al. (1999) and Yahner et al. (1999a).

The handcutting unit had a tree-shrub cover type on both wire and border zones; oaks (bear oak [Quercus ilicifolia] and various oak species [Quercus spp.]) predominated in the wire zone, and oaks, blueberry (Vaccinium spp.), and blackberry (Rubus alleghenensis) were common in the border zone of this unit. The high-volume basal spray unit was characterized by a shrub-forb cover type on both wire and border zones, including mountain laurel (Kalmia latifolia), sweet fern (Myrica peregrina), blueberry, blackberry, witchhazel (Hamamelis virginiana), and goldenrod (Solidago spp.). The mowing plus herbicide consisted of a grass-forb cover type on the wire zone and a shrub-forb cover type on border zones. In the wire zone, grasses (e.g., fescue [Festuca elatior] and poverty grass [Danthonia spicata]) and hay-scented fern (Dennstaedtia punctilobula) were common. In the border zone, witchhazel, blueberry, sweet fern, hay-scented fern, and goldenrod were abundant. The stem-foliage spray had a forb-shrub cover type on the wire zone, consisting mainly of hay-scented fern and goldenrod, and a shrub-forb-grass cover on the border zone, comprised of witchhazel, sweet fern, blueberry, hay-scented fern, and poverty grass. The foliage spray was characterized by a shrub-forb-grass cover type on both zones, and principal species were blueberry, blackberry, sweet fern, hay-scented fern, and poverty grass.

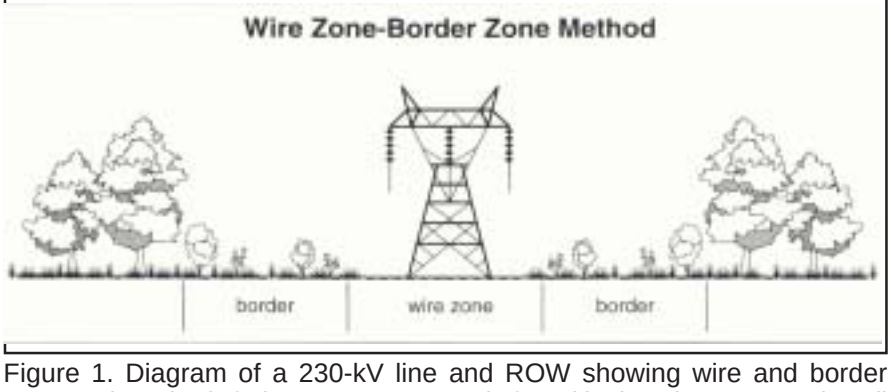

Figure 1. Diagram of a 230-kV line and ROW showing wire and border zones. A low shrub-forb-grass cover type is found in the wire zone, and a tall shrub-forb cover type is present in the border zone.

Figure 2. A large coverboard (background) and a small coverboard (foreground) are seen at a sampling point in the forest adjacent to the right-of-way (photo taken by RHY in July 1999).

Three sampling points were established in the wire zone, in the border zone, and 40 m (131 ft) into the adjacent forest in each treatment unit, giving nine sampling points per unit. A distance of 40 m from a forest edge was used for sampling points into the adjacent forest because woodland salamanders may be relatively scarce within 25 m (82 ft) of edges (deMaynadier and Hunter 1998). At each sampling point, one large coverboard (waferboard, approximately 30 ∞ 120 ∞ 1.5 cm [12 ∞ 48 ∞ 0.6 in.]) and three small coverboards (untreated pine, approximately 15 ∞ 90 ∞ 2 cm [6 ∞ 36 ∞ 0.8 in.]) were placed flush with the soil surface (DeGraaf and Yamasaki 1992; Rodewald and Yahner 1999; Yahner et al. 1999b) (Figure 2).

Coverboards were checked at each sampling point one to three times per season (spring, summer, and autumn) for the presence of reptiles and amphibians beneath them (Rodewald and Yahner

1999; Yahner et al. 1999b). These coverboards represented potential refugia and resting sites for reptiles and amphibians. During each sampling period, at least 1 hour was spent searching for reptiles and amphibians on the soil surface in wire zones, border zones, and adjacent forest. In 1998, rocks and logs were overturned to check for reptiles and amphibians for comparison to data collected beneath coverboards (Yahner et al. 1999b).

RESULTS AND DISCUSSION

Diversity and Relative Abundance on ROW Versus Adjacent Forest

Nine species of reptiles and amphibians were observed on the right-of-way and in the adjacent forest in 1998 and 1999 (Table 1). All nine species were found on the ROW, whereas only two species occurred in the adjacent forest. These included 137 observations of one toad species, three salamander species, and five snake species. Because animals observed were not permanently marked for individual recognition, the same individual may have been observed more than once during the study. However, sampling periods were spaced at least 2 to 3 weeks to minimize recounting the same individual more than once.

The three most common species in decreasing order of relative abundance were redback salamanders (n = 71 observations or 52% of total), northern redbelly snakes (n = 27, 20%), and northern ringneck snakes (n = 15, 11%) (Table 1). In several studies of terrestrial salamander populations in the northeastern United States, redback salamanders are the most abundant species of salamander (e.g., DeGraaf and Yamasaki 1992; Rodewald and Yahner 1999). Although timber rattlesnakes (Crotalus horridus**)** were once common on the ROW when it was first established in the 1950s (W. C. Bramble, personal observation), none was found in our study. Timber rattlesnakes, like many terrestrial salamanders, are species of special concern and are in need of protection (Yahner 2000).

Table 1. Diversity and relative abundance of reptiles and amphibians under coverboards, rocks, or logs or on the soil surface on the ROW and in adjacent forest in Centre County, Pennsylvania, 1998–1999.

	Coverboards		Miscellaneous		
Species	ROW	Forest	ROW	Forest	Total
Toad					
E. American toad (Bufo americanus americanus)	0	0	1	0	1
Salamanders					
Jefferson salamander (Ambystoma jeffersonianum)	3	4	0	1	8
Redback salamander (Plethodon cinereus)	31	35	0	5	71
Spotted salamander (Ambystoma maculatum)	1	0	0	0	1
Snakes					
E. garter snake (Thamnopnis sirtalis sirtalis)	7	0	1	0	8
E. smooth green snake (Opheodrys vernalis vernalis)	4	0	1	0	5
Mountain earth snake (Virginia valeriae pulchra)	1	0	0	0	1
N. redbelly snake (Storeria occipitomaculata occipitomaculata)	27	0	0	0	27
N. ringneck snake (Diadophis punctatus edwardsii)	11	0	4	0	15
Total observations	85	39	7	6	137

More observations of salamanders were in the forest (n = 45, 59%) than on the ROW (n = 35, 41%) (Table 1). Based on the number of coverboards in the forest versus the ROW, only two-thirds of the salamanders would be expected to occur in the forest. Thus, although salamanders occurred on the ROW, they showed a preference for habitat in the adjacent forest. Salamanders require the moister microclimatic conditions for foraging and breeding (Shaffer 1991), which were present in the adjacent forest compared to the dryer conditions on the ROW. In contrast, snakes were found exclusively on the ROW, which provided a combination of shrubby and grassy habitat for these species.

Diversity and Relative Abundance per Treatment Unit

Ninety-two reptiles and amphibians were recorded on the five treatment units in 1998 and 1999 combined (Table 2). The most common species was the redback salamander

(34% of total), followed by the northern redbelly snake (29%) (Figure 3) and the northern ringneck snake (16%).

The number of species per treatment unit varied from six species in stem-foliage spray to three in handcutting (Table 2). Twenty-four reptiles and amphibians were found in each of the high-volume basal spray, stem-foliage spray, and foliage spray units. The shrub-forb-grass cover types in these three units provided a diverse habitat for a variety of reptiles and amphibians. In contrast, only four reptiles and amphibians were noted in handcutting. The cover type in this unit was relatively homogeneous and was similar to young, even-aged forest stands, which are of little value to amphibian and reptiles as habitat (Rodewald and Yahner 1999).

Table 2. Diversity and relative abundance of reptiles and amphibians in five treatment units on the ROW in Centre County, Pennsylvania, 1998–1999.

Species	Hand-cutting	High-volume basal spray	Mowing plus herbicide	Stem-foliage spray	Foliage spray	Total
Toad						
American toad	0	0	0	1	0	1
Salamanders						
Jefferson salamander	1	2	0	0	0	3
Redback salamander	23	5	6	15	31	
Spotted salamander	1	0	0	0	0	1
Snakes						
E. garter snake	0	7	0	0	1	8
E. Smooth green snake	0	0	2	1	2	5
Mountain earth snake	0	0	0	1	0	1
N. redbelly snake	0	4	4	13	6	27
N. ringneck snake	0	8	5	2	0	15
Total species	3	5	4	6	4	9
Total observations	4	24	16	24	24	92

Figure 3. A northern redbelly snake under a coverboard in a stem-foliage spray treatment unit in May 1999. This species, which feeds on insects and other invertebrates, was the most common snake found on the ROW. Adult redbelly snakes are only about 20 to 25 cm (8 to 10 in.) in length. They are very secretive and are seldom found, even by those who spend a considerable time in the outdoors. Thus, the use of coverboards is an effective way to monitor this species on a ROW (photo taken by RHY).

Diversity and Relative Abundance in Wire Versus Border Zones

Eight and six species of reptiles and amphibians, respectively, were found in wire and border zones on the ROW in 1998 and 1999 (Table 3). In addition, 63% of the sightings occurred in wire zones compared to 34% border zones. Eighty-one percent of the sightings in wire zones, however, were those of snakes, whereas 85% in border zones were those of salamanders. A ROW using the wire zone–border zone method (Figure 1) creates suitable habitat for both terrestrial salamanders and snakes (Figure 3).

CONCLUSIONS

The ROW in this study contained a much more diverse community of reptiles and amphibians than the adjacent forest. With the exception of handcutting, all treatment units provided suitable habitat for these vertebrates. The border zones of the ROW ensured moist microenvironments for salamanders, and the wire zones provided suitable habitat for snakes. Utility companies are encouraged to adopt the wire zone-border zone method because it provides acceptable habitat for a variety of reptile and amphibian populations noted in this study.

Table 3. Diversity and relative abundance of reptiles and amphibians in wire versus border zones on ROW in Centre County, Pennsylvania, 1998–1999.

Species	Wire zone	Border zone	Total
Toad			
American toad	1	0	1
Salamanders			
Jefferson salamander	2	1	3
Redback salamander	9	22	31
Spotted salamander	1	0	1
Snakes			
E. garter snake	7	1	8
E. smooth green snake	5	0	5
Mountain earth snake	0	1	1
N. redbelly snake	20	7	27
N. ringneck snake	13	2	15
Total species	8	6	9
Total observations	58	34	92

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Résumé. Une étude de deux ans, de juin à octobre 1998 et de mars à octobre 1999, sur les populations de reptiles et d'amphibiens a été menée à l'intérieur de l'emprise d'une ligne électrique de 230 kV de la compagnie GPU Energy dans la province physiographique d'Allegheny Mountain (comté de Centre) en Pennsylvanie. L'objectif était de comparer la diversité et l'abondance relative en reptiles et en amphibiens entre l'emprise et la forêt environnante, parmi cinq unités traitées différemment et toutes situés dans l'emprise, ainsi qu'entre les zones traitées situées sous les fils et celles sur les bordures de l'emprise. Neuf espèces ont été suivies au cours de l'étude, les trois plus fréquentes étant la salamandre à dos rouge (Plethodon cinereus), le serpent septentrional à ventre rouge (Storeria occipitomaculata occipitomaculata) et le serpent à cou cerclé septentrional (Diadophis punctatus edwardsii). Toutes les neuf espèces étaient présentes dans l'emprise, mai seulement les salamandres à dos rouge et les salamandres de Jefferson (Ambystoma jerffersonianum) étaient aussi présentes dans la forêt adjacente. La diversité et l'abondance relative vari-aient de six espèces dans l'unité de feuillage-tiges à trois pour l'unité fauchée manuelle-ment. Huit et six espèces respectivement ont été observées dans les zones des fils et dans les bordures de l'emprise. Par contre, dans les zones des fils, les serpents comptaient pour 81% des cas, tandis que dans les zones de bordures, 85% des cas étaient des salamandres. L'emprise renfermait une diversité beaucoup plus importante de communautés de reptiles et d'am-phibiens que la forêt adjacente. Les pratiques de gestion forestière peuvent avoir des impacts négatifs sur les populations d'amphibiens et de reptiles. En conclusion, cette étude fournit des informations importantes sur les pratiques de gestion forestière requises pour la conservation des reptiles et des amphibiens.

Zusammenfassung. In den Allegheny-Bergen inmitten von Pennsylvania, USA wurde 1998 von Juni-Okt. und 1999 von März-Okt. entlang einer 230 kV Überlandstromleitung der GPU Energie 2 Jahresstudien an den Reptilien- und Amphibienpopulationen durchgeführt. Das Thema bestand darin, die Diversität und relative Anzahl der Reptilien und Amphibien zwischen 5 verschiedenen Behandlungstypen der Leitungskorridore und der Zwischenräume zw. Draht und Randzonen im Vergleich zu den benachbarten Feldern zu erfassen. Während der Studie wurden 9 Spezies aufgezeichnet, innerhalb. der 3 gewöhnlichsten Arten: Plethodon cinerus, Storeria occipitomaculata und Diadophis punctatus. Alle 9 Spezies tauchten in den Korridioren auf, aber nur die Plethodon-Salamander und der Jeff. Salamander kamen auch in den benachbarten Forsten vor. Die Diversität und die Anzahl rangierte von 6 Spezies in der Blatt/Stamm-Abschnitten bis zu 3 Spezies in der handgeschnittenen Abschnitten. 8 und 6 Spezies wurden in der Draht- und Randzone der Korridore registriert. Dennoch waren 81 % der beobachteten Spezies in der Drahtzone Schlangen und 85 % in der Randzone Salamander. Der Korridor enthält eine größere Vielzahl von Reptilien und Amphibien als der benachbarte Wald. Forstmanagementpraktiken können einen negativen Einfluß auf die Population von Amphibien und Reptilien haben. Daher liefert diese Studie wichtige Informationen für Praktiken im Forstmanagement, die für die Erhaltung von Reptilien und Amphibien erforderlich sind.

Resumen. Entre Junio-Octubre de 1998 y Marzo-Octubre de 1999, se condujo un estudio sobre las poblaciones de reptiles y anfibios en el derecho de vía (ROW) de las líneas de 230 kV de transmisión de energía GPU en la provincia fisiográfica montañosa de Allegheny, Condado Central, Pennsylvania. El objetivo fue comparar la diversidad y abundancia relativa de los reptiles y anfibios, entre el ROW y los bosques adyacentes, entre cinco unidades de tratamiento en el ROW y entre las zonas de frontera y de cerca de alambre contra los ROW. Se registraron nueve especies durante el estudio, siendo las tres más frecuentes las salamandras de lomo rojo (Plethodon cinereus), las víboras panza roja (Storeria occipitomaculata) y las víboras de collar (Diadophis punctatus edwardsii). Todas las nueve especies se encontraron en el ROW, pero solamente las salamandras de lomo rojo y las salamandras Jefferson (Ambystoma jeffersonianum) se encontraron en los bosques adyacentes. La diversidad y abundancia relativa varió de seis especies en el follaje a tres especies en las unidades cortadas manualmente. Se encontraron ocho y seis especies, respectivamente, en las zonas de cerca con alambre y de frontera del ROW. Sin embargo, el 81% de las observaciones en las zonas de cerca estuvieron con serpientes, mientras que el 85% de las observaciones en las zonas de frontera lo estuvieron con salamandras. Los ROW tuvieron mucha mayor diversidad en la comunidad de reptiles y anfibios que el bosque adyacente. Las prácticas de manejo del bosque pueden impactar negativamente sobre esas poblaciones. Por consiguiente, el estudio proporciona información importante de las prácticas de manejo requeridas para la conservación de los reptiles y anfibios.