

Wildlife Inventory and Management
of
Railroad and Transmission Line
Rights-Of-Way
on the
New River Gorge National River

WILDLIFE INVENTORY
and
MANAGEMENT
OF RAILROAD AND TRANSMISSION LINE RIGHTS-OF-WAY
ON THE NEW RIVER GORGE NATIONAL RIVER

Edwin D. Michael
and Richard A. Voytko
Division of Forestry
West Virginia University
Box 6125 Morgantown, WV 26506

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Abstract

Railroad and transmission line rights-of-way (ROW) were studied in the New River Gorge National River (NRG NR) with the goal to create a wildlife management plan. Objectives included: (1) conducting a thorough review of the literature pertaining to wildlife on ROW, (2) collecting baseline data on wildlife using these areas (emphasis on breeding birds), (3) recommending future research needed, and (4) recommending management options.

A total of 58 bird species were observed on railroad and transmission line ROW during breeding bird surveys conducted in 1988-89. Railroad species richness was 46, transmission line, 35. Diversity indices indicated that the river forest was the most diverse habitat along railroads and the forest habitat was the most diverse along transmission lines. Density indices indicated that the indigo bunting (Passerina cyanea) and red-eyed vireo (Vireo olivaceus) were the most common species observed. Density estimates for the indigo bunting were 1.70 and 1.69 birds per ha on the railroad and transmission line, respectively. Density estimates for the red-eyed vireo were 1.60 and 1.70 birds per ha on the railroad and transmission line, respectively. The river forest edge habitat had the highest bird density on the railroad with 52.49 birds per ha. On transmission lines the edge habitat had the highest bird density at 27.76 birds per ha. Habitat associations were determined through Bonferroni's Z confidence intervals. The river side of the

railroad ROW was preferred by 9 species while 1 species preferred the hill side. The river forest was preferred by 3 species, river forest edge by 7 species, river near ROW by 2 species, and middle ROW and hill forest edge by 1 species each. On transmission lines 2 species preferred the ROW habitat, 1 species preferred the edge habitat, and 3 species preferred the forest.

Mammal species richness was 13, with 11 species occurring on railroads and 8 on transmission lines. White footed mice (Peromyscus leucopus), eastern woodrats (Neotoma floridana), and eastern chipmunks (Tamias striatus) were captured during small mammal trapping. With 450 trapnights on each ROW type, 69 white-footed mice were captured on railroads and 12 on transmission lines. One eastern woodrat was captured on transmission lines and 2 on railroads, while 3 eastern chipmunks were captured on railroads. Fecal counts indicated very little use of ROW by white-tailed deer (Odocoileus virginianus) during the winter (0 piles railroad and 13 piles transmission line, on >7 km of transects per ROW type).

A total of 15 reptile and amphibian species were observed on ROW, with 13 on railroads and 7 on transmission lines. Amphibian breeding ponds were observed on both types of ROW.

Management of ROW consists of 3 levels of increasing magnitude to increase wildlife species diversity, reduce herbicide use and improve park visitor perception of ROW.

INTRODUCTION

The value of rights-of-way (ROW) as wildlife habitat has received increased attention in recent years. Many studies have been conducted to assess the value of ROW as wildlife habitat and determine which species use these man-created habitats. Emphasis is now being focused on how ROW management can be modified to improve the wildlife value of ROW. Wise management of ROW can improve their value to wildlife and thus benefit people through increased wildlife recreation opportunities and through the value of a more wisely-managed ecosystem.

In the New River Gorge National River (NRG NR) there are 207 miles of ROW (Michael and Smith 1987). These ROW significantly affect the wildlife on the NRG NR by creating early successional stage habitats, fragmenting forest blocks, and creating edge habitats. The National Park Service was given the responsibility to manage the NRG NR through Public Law 95-625. This law states that the National Park Service has management responsibility for the purpose of conserving and interpreting outstanding natural, scenic, and historic values and objects in and around the New River Gorge. How can the National Park Service better manage those lands in the NRG NR which are used as either railroad, transmission line, telephone, or road ROW to promote these objectives?

Goal: Create a wildlife management plan for railroad and transmission line rights-of-way on the New River Gorge National River.

Objective 1. Conduct a thorough review of the literature pertaining to management of wildlife resources on rights-of-way.

Objective 2. Collect baseline data on wildlife using railroad and transmission line rights-of-way. Emphasis will be placed on breeding birds.

Objective 3. Recommend future research needed to properly manage the wildlife resources on rights-of-way.

Objective 4. Recommend management options to be included in a final management plan for rights-of-way.

LITERATURE REVIEW

Extensive research has been conducted on the environmental effects of transmission line ROW maintenance. Many of these studies were conducted in the eastern United States. Most studies of wildlife have dealt with birds on, and adjacent to, transmission line ROW. Mammals occurring on these ROW have also been studied in some detail. Little research has been conducted on reptiles and amphibians and most of the published information is anecdotal in nature. Railroad ROW have received little attention. Few wildlife studies have been conducted on railroads. Most of the available railroad literature deals with birds.

Birds

The structure of the vegetation in an area is the key to understanding the bird life occupying the area. MacArthur and MacArthur (1961) observed that bird species diversity could be predicted by the height profile of foliage density. This theory was further supported by future works (MacArthur et al. 1962, MacArthur 1964, Balda 1975). Therefore, the number of layers of vegetation, or the vertical structural diversity, is sufficient to account for the diversity of breeding bird species (MacArthur 1964). Later successional stages support greater species diversity than earlier stages due to the increased vegetational complexity (Balda 1975). When an area contains major differences such as between a

deciduous and coniferous forest, or horizontal structural diversity, the vertical diversity is no longer sufficient to account for species diversity (MacArthur 1964). Therefore, both the vertical and horizontal structural diversity are important in promoting bird species diversity. Plant species diversity, except by influencing this profile, has nothing to do with bird species diversity (MacArthur and MacArthur 1961).

Birds have been extensively studied on ROW. ROW can provide food and cover for both game and nongame birds (Bramble and Byrnes 1974). Railroad ROW provide habitat for many bird species in Iowa (Braband and Klaas 1981, Braband 1986). Stapleton and Kiviat (1979) observed breeding birds on railroad causeways along the Hudson River and noted behavioral changes when vegetation on one side of the causeway was cut. Singing birds of most species preferred the uncut side of the railroad over the cut side. Chasko and Gates (1982) studied avian habitat suitability on transmission line ROW in western Maryland and observed that vegetation patchiness improved nesting success. The edge of the ROW corridor has both positive and negative impacts on wildlife. Certain bird species have higher densities on these areas, but other species have lower densities (Kroodsma 1984). A sharply defined edge can act as a barrier rather than a transition zone between habitats (Chasko and Gates 1982). Nest predation has been observed to be higher on edges than in habitat interiors (Chasko and Gates 1982).

Increasing distance from a field-forest edge has been correlated with increased overall nest success and lower losses due to predation and cowbird parasitism (Gates and Gysel 1978). Wilcove (1985) and Yahner and Scott (1988) noted higher numbers of avian nest predators in edge habitats.

Anderson et al (1977) compared bird species diversity on 4 transmission lines with widths of 12 m, 30.5 m, 60 m, and 90 m and observed the highest species diversity and density on a ROW 30.5 m wide. Anderson et al (1977) also noted that specific management practices to favor specific bird species could alter the results of the study. A ROW management scheme, which significantly improves ROW for birds, includes selective vegetation maintenance (Ferguson 1976, Lawson and Gates 1981, Chasko and Gates 1982, Meyer and Provost 1981, Hanson 1988).

Mammals

Mammals have also been studied on ROW. Much emphasis has been placed on white-tailed deer (scientific names are presented in the tables). ROW can provide suitable habitat and are regularly used by deer (Bramble and Byrnes 1974, Mayer 1976, Bramble et al 1985). Ladino and Gates (1981) observed 12 species of mammals on or adjacent to transmission line ROW in western Maryland. Braband and Klaas (1981) observed 23 species of mammals on railroad ROW in Iowa. The corridor habitat consistently had the least overall mammal

activity (Ladino and Gates 1981). Schreiber et al (1976) observed the greatest number of species in edge habitats. Johnson et al (1979) noted that the edge and ROW had higher mammal species richness and diversity than adjacent forest areas. Common species observed by Ladino and Gates (1981) included the white-footed mouse, eastern chipmunk, and woodchuck. Maintenance techniques which are of special benefit to mammals include selective vegetation management for the benefit of small mammals (Ladino and Gates 1981), and the selective maintenance of the border zone while clearing the wire zone for the benefit of white-tailed deer (Bramble et al 1985). Bramble and Byrnes (1979) evaluated transmission line ROW for wildlife habitat values of white-tailed deer in central Pennsylvania. They rated a selectively sprayed ROW, an oak hickory forest, a wildlife food plot, and a wildlife forest opening. The ROW rated higher than all other areas.

Reptiles and Amphibians

Reptiles and amphibians have not been intensively studied on ROW. Ladino and Gates (1981) noted snakes, turtles, salamanders, and toads on their study area in western Maryland. Williams and Parker (1987) noted that box turtles used power lines and steep-sided gorges significantly less than maple forests on their Indiana study site.

ROW Vegetation

The type of vegetation which occurs on a ROW is determined by many factors. Johnston and Bramble (1981) noted a close relationship between adjoining forest type and the ROW community for transmission lines throughout New York State. Areas which were broadcast sprayed had more herbaceous cover than selectively sprayed areas, while selectively sprayed areas had a higher (though not significant) number of plants capable of interfering with transmission lines (Johnston and Bramble 1981). Bramble and Byrnes (1983) observed transmission line ROW in central Pennsylvania, which were handcut for a 30-year period, dominated by tree sprouts and seedlings with few shrubs and herbaceous plants, while an adjacent area which was selectively maintained with herbicides was dominated by shrub and herbaceous plants with numerous seedling and sapling trees. After 6 years, an area hand cut was dominated by tree sprouts, forest shrubs, and herbaceous plants while an adjacent broadcast spray area was dominated by herbaceous plants and grass. A selective basal spray area was dominated by forest shrubs and herbaceous plants with few tree sprouts (Bramble and Byrnes 1983).

Plant species which are resistant to herbicides can outcompete other species and create a "herbicide climax" community on blanket sprayed lines (Johnston 1973). The climax community which will develop on selectively sprayed areas will be dominated by shrubs (Johnston 1973). Niering

and Goodwin (1974) observed that selective herbicide management on a transmission line ROW in the Connecticut Arboretum resulted in a relatively stable shrub community and a less stable herb community. Areas of continuous dense shrub cover on their arboretum study area have resisted tree invasion for at least 15 years.

The toxicity to wildlife of herbicides used to maintain ROW vegetation has not been intensively studied in actual field situations. Michael and Smith (1987) provided a detailed examination of the toxicology of herbicides used in the NRGNR to wildlife. Other aspects of herbicide use, such as the carriers used with the actual herbicide chemical, have been only lightly studied. Fuel oil is sometimes used as a carrier and has been observed to seriously affect hatching success of birds (Kopisckie 1972).

STUDY AREA

The NRGNR is a 25,100-ha unit of the National Park Service located in southern West Virginia. The study area encompasses a 84-km section of the New River and adjacent gorge from Hinton to Fayetteville (Fig. 1). The NRGNR contains 333 km of ROW composed of 129 km of transmission lines, 124 km of railroad, 45 km of telephone, and 35 km of road ROW (Michael and Smith 1987).

Climate

The NRGNR has a seasonal continental, climate (National Park Service 1982). Precipitation averages about 40 inches in a year. Most precipitation occurs during winter storms and summer thundershowers. Summer highs are near 30 c and winter cold spells rarely send temperatures below -18 c.

Geology and Hydrology

Geology of the NRGNR is characterized by steep gorge walls and the swift flowing New River. Elevation ranges from 253 m to 1,000 m. Slopes are often >30% and gorge walls average 300 m in height. Massive sandstone cliffs occur on the upper walls along the northern part of the NRGNR and many cliffs were created by man along the railroad ROW. Soils in the NRGNR are generally silty or sandy loams which are very stony (National Park Service 1982). Steep slopes limit agricultural fields to a few flat areas in the southern

end of the national river.

The main hydrologic feature of the NRGNR is the New River. In addition to the river there are a number of smaller creeks which flow down the gorge wall. Water quality is generally good on the New River, but some tributaries are adversely affected by sewage discharges and acid mine drainage (National Park Service 1982).

Flora

The NRGNR is an area of mixed mesophytic forests. A narrow riparian forest occurs along the river and is dominated by sycamore and river birch. Riparian forests vary in width from a single line of trees to >50 m. Upland forests are comprised of mixed oak and maple with a wide variety of other species such as tulip poplar and black cherry. Rocky outcrops provide habitat for Virginia pine, white pine, and chestnut oak.

Land Use

A variety of land uses occur within the boundaries of the NRGNR. Much of the area remains in second growth forest. In the southern part of the NRGNR, where there is suitable land, some agricultural fields occur. Figure 1 shows the location of towns within the NRGNR

Recreation is the main use of the New River. Rafting occurs in the northern end of the national river from Thurmond to Ames. Fishing is common where there is access

to the river. Historical sites occur throughout the gorge and a trail system for the park is in the planning stage. Major concentrations of recreationalists occur at Fayette Station, Thurmond, and Sandstone Falls. A visitor center and observation platforms are located at Canyon Rim. Other visitor facilities are planned.

Railroad ROW

Most railroad ROW are located at the bottom of the gorge near the river. Branch lines go up out of the gorge through several creek valleys. Railroad ROW are maintained through the use of herbicides sprayed from a rail car or from trucks. Various mixture of Roundup, 2 4-D, Oust, and Arsenal are sprayed on the ROW at least once a year. This vegetation maintenance program creates a unique man-made habitat dominated by herbaceous vegetation. Common herbaceous species include grasses, goldenrod, and mullein. Some woody plants occur on these areas, but are never allowed to grow to any significant height. Ash, locust, red maple, slippery elm and especially box elder are native species which commonly attempt to colonize these areas. A wide variety of other native species also occasionally attempt to invade these areas. Two exotic species of woody plants often grow on railroad ROW. Paulonia is the most common exotic plant. It grows very well in the harsh conditions on the ROW. Japanese honeysuckle also often grows on these ROW.

Railroad ROW vegetation is limited to the sides of the ROW. The middle ROW is maintained to completely eliminate all vegetation. Adjacent to the railroad ROW, 2 forest types occur, an upland forest, and between the ROW and the river, a riparian forest.

Within the NRGNR 4 1-km sections of railroad ROW were selected for intensive study (Fig. 1). One study area (ROW 1) was located south of the Fayette Station bridge on river left. The ROW had a width of about 30 m and the river forest had a variable width from 20 m to about 40 m. A second study area (ROW 2) was located north of the New River Gorge Bridge on river right. This ROW was about 24 m wide. The river forest was usually >30 m wide. A third study area (ROW 3) was located on river right just north of Thurmond. This ROW was about 30 m wide and the adjacent river forest varied from 5 m to >50 m wide. The fourth study area (ROW 4) was located on river right north of Meadow Creek. This ROW was about 25 m wide and the adjacent river forest varied from 5 m to 20 m.

Transmission Line

Most transmission lines are located on the mountains above the New River. These ROW are covered with a wide variety of vegetation. Some areas are dominated by grasses and other herbaceous vegetation such as goldenrod. Blackberry and greenbriar dominate in some areas, while ericaceous shrubs dominate still other places. Many areas are

dominated by hardwood regeneration of a wide variety of species; often oaks, maples, and tulip poplar. Slope, aspect, maintenance history, and adjacent forest type are among the many factors which affect the type of vegetation present.

Indepth surveys were conducted on 3 1-km sections of transmission lines. One study area (ROW 9) was located on a ROW about 22 m wide on the mountain rising above the town of Thurmond. This 12 kv line had been aerially sprayed in 1986 with a mixture of Tordon 101, Garlon 3A, and Cidekick. ROW 9 was dominated by herbaceous vegetation and dead stems in most areas. A second study area (ROW 8) was located on the mountain top south of Edmond. This ROW was about 30 m wide and dominated in most areas by blackberry, hardwood regeneration, and ericaceous shrubs. This 69 kv line was aerially treated in 1984 with Tordon 101 and Cidekick and received a manual reclear with Weedone CB and Garlon 4 in 1986. A third study area (ROW 7) was located near Ames Heights. This area was dominated by herbaceous vegetation, blackberry, and oak regeneration, along with some Virginia pine. The ROW on this 69 kv line was about 20 m wide and was last maintained with a manual reclear in 1983 using Weedone and Garlon 4.

METHODS

Plot Design

On *each* 1-km section of ROW, 10 permanent plots were established 100 m apart and used for intensive sampling. Permanent plots were located in the middle of the railroad ROW and were marked with flagging and/or paint. A total of 40 permanent plots were located on 4 railroad sections. On transmission line ROW permanent plots were located on the edge of the corridor. Plots were placed on alternating sides of the corridor and marked with flagging and paint. A total of 30 plots were located on 3 transmission line sections.

Vegetation Analysis

The vegetation occurring on ROW and adjacent forests was analyzed using 2-m wide transects. Vegetation transects were located 5 m on either side of the permanent plot. Transects started at the forest edge and extended 20 m into the forest. When the forest was not 20 m wide, as often occurred in the river forest, the transect extended for the entire width of the forest. On the railroad ROW proper, transects were placed through the entire width of the river side of ROW (Fig. 2). On transmission lines the ROW transect extended from the forest edge to the middle of the ROW (Fig. 3). Data collected on all transects included, the number of woody stems, percentage of different ground covers, and common woody species (Appendix 1). Percent slope was obtained on the ROW transect. Canopy cover, number of overstory trees,

and common tree species were determined on the forest transects. Ground cover and canopy cover variables were measured through use of an ocular tube, while the percent slope was obtained with a relascope. The number of woody stems and the number of trees was determined by counting all stems in the 2-m transect.

Breeding Bird Surveys

Breeding birds were surveyed using sight and song at permanent plots. Each plot was visited 7 times during the breeding season from mid May until the end of June. Birds were surveyed in the early morning between dawn and 0945 hours on mornings with no rain. Upon arrival at each permanent plot a 1-minute equilibrium period was followed by a 7-minute count period. All birds seen or heard on the plot were counted. Birds which were flying over were not counted, however; swallows which were actively foraging in the ROW corridor were counted. On railroad ROW plots, birds were surveyed 30 m up and down the ROW and 30 m into the adjacent forests at each plot (Fig. 4). On transmission line ROW birds were surveyed 30 m up and down the ROW and 30 m into the forest. Birds were surveyed 1/2 the distance into the ROW corridor (Fig. 5). This distance ranged from 10 m to 16.5 m. Data collected included plot, date, start time, end time, species, sex, and habitat category. Railroad ROW were divided into 7 habitats while transmission line ROW were divided into 3 different habitat types (Appendix 2).

In 1988 birds were surveyed on 3 sections of each type of ROW. In 1989 birds were surveyed on the same 3 railroad ROW sections plus 1 additional railroad ROW section (Fig. 1). Additional surveys were conducted at many locations on other railroad and transmission line ROW throughout the NRGNR, with each line being visited 1 or 2 times during the breeding season.

Mammals

Mammals were surveyed through a variety of techniques. Small mammals were surveyed in July 1988 on all study areas. Sherman live traps were placed at each permanent point and opened for 5 nights. A mixture of peanut butter and oatmeal was used as bait. On railroad ROW 1 trap was placed 10 m into both the river forest and the upland forest. A trap was also placed on the river side of the ROW. Thus, a total of 3 traps were placed at each point. On transmission lines 1 Sherman live trap was placed on the ROW 1/4 the distance from the edge. A second trap was placed on the edge and a third was placed 10 m into the adjacent forest. All mammals captured were marked with permanent dye on the back. Data collected included date, plot, species, location, and identification mark.

Fecal counts were conducted in late February and early March 1989. A total of 7.5 km of railroad and 7.4 km of transmission line were searched at locations throughout the NRGNR. All feces of any species were noted. On railroads,

transects were located on the lip of the rail bed as it went down to the river and on the hill side of the ROW at the interface between bare ground and vegetation. Transects were 2 m wide and of varying lengths. On transmission line ROW transects were 2 m wide with one transect located in the middle of the ROW and a second located on the edge of the corridor just inside the maintained area.

General observations of mammals were made throughout the gorge. All species seen at any time on ROW or adjacent forest were noted. Carcasses and skeletal remains observed along ROW were identified. Tracks of mammals were also identified. Snow track counts were planned for the winter of 1988-89, but snow conditions were inadequate.

Reptiles and Amphibians

Reptiles and amphibians were surveyed using several methods. Drop boards were placed on all study areas in early July 1988. Drop boards were checked in mid August and early October of 1988. Drop boards which could be relocated were checked again in June 1989. Drop boards consisted of 41 x 41 cm square pieces of plywood placed on the ground to provide microhabitat for reptiles and amphibians.

Railroad ROW were searched in March and April 1989 to locate amphibian breeding ponds. Egg masses were identified and the general shape, size, and depth of the pond was noted. Discarded railroad ties, rocks, and other debris were flipped on the 4 study areas in 1989 to locate reptiles and

amphibians. General observations of all reptiles and amphibians seen at any time on ROW or adjacent forest were noted.

Statistical Methods

Both descriptive and inferential statistics were used to analyze data collected. Species richness, a total count of all species occurring on a ROW, was calculated for birds, mammals, reptiles, and amphibians. Species diversity of birds was calculated using both Simpson's diversity index and the Shannon-Wiener diversity index which use both species richness and the number of individuals of each species to describe diversity.

Simpson's Diversity Index $D = \frac{N(N-1)}{\sum n(n-1)} \quad (1)$

D = diversity index

N = total number of individuals of all species

n = number of individuals of a species

Shannon-Wiener Diversity Index $H' = - \sum_{i=1}^s \frac{n_i}{N} \log_{10} \frac{n_i}{N} \quad (2)$

s = the total number of species collected log 10

Breeding bird density indices were calculated for

commonly observed species on both railroad and transmission line ROW. Breeding bird densities were calculated using 2 different techniques. On each ROW the highest number of birds seen for each species during a visit was used to calculate the number of birds per ha.

$$\text{Birds per ha} = \frac{\text{highest count for species}}{\text{ha surveyed}} \quad (3)$$

Bird density indices were also calculated by using the number of breeding males observed on all visits.

$$\text{Breeding males per ha} = \frac{\text{number of males}}{\text{number of visits}} \quad (4)$$

ha surveyed

Habitat associations of commonly observed bird species were inferred using a mathematical model for analysis of utilization-availability data. This technique was first described by Neu et al. (1974) and later clarified by Byers et al. (1984). This technique evaluates the preference or avoidance of a given habitat and was first used to evaluate moose (Alces alces) distribution patterns in burned, unburned, and edge habitats (Neu et al 1974). First, the proportion of each habitat in the total area is calculated. Second, a chi square goodness of fit test is conducted to test the null hypothesis that the observed occurrence of a species in a habitat is proportional to the amount of that habitat available.

Chi Square Goodness of Fit

$$T = \sum \frac{(O-E)^2}{E} \quad (5)$$

O= observed number of occurrences

E= expected number of occurrences

Third, if chi square analysis indicates a significant difference from the expected, Bonferroni's inequality is used to construct simultaneous confidence intervals around individual habitat types.

Bonferroni's Confidence Interval

$$p_i \pm \frac{Z}{\sqrt{2k}} \sqrt{\frac{p_i(1-p_i)}{n}} \quad (6)$$

p_i = actual proportion of observations in habitat i

Z= tabular value from the normal distribution

k= number of categories tested.

n= total number of observations for that species

RESULTS

Vegetation

A wide variety of plants occur along railroad and transmission line ROW in the NRGNR. A list of common species is included in Table 1. Tree and stem densities were calculated for ROW and adjacent forests (Table 2). For the railroad, tree densities on the river forest ranged from 39 trees per ha to 95 trees per ha, whereas on the hill forest, the range was much smaller at 51 trees per ha to 64 trees per ha. There was also a wide range in stem densities in each habitat and between habitat types. On transmission lines, tree densities in the adjacent forests ranged from 79 to 91 trees per ha. Stem densities on the transmission line ROW and forest transects were quite high, ranging from 548 stems per ha to 1,247 stems per ha.

Measurements of ground cover indicated that herbaceous vegetation, rock, and litter were the most common types of ground covers on railroad ROW. However, there was wide variation from plot to plot (Table 3). Litter, shrub, and herbaceous vegetation were common ground covers on transmission lines. Canopy cover on forested areas along railroads ranged from 54% to 78.5% with river forests consistently having a more open canopy than adjacent hill forests. Canopy cover on all forests adjacent to transmission lines was similar, ranging from 76% to 85.5%.

Measurements of slope were taken on the river near ROW (Table 4). Slopes on the 4 railroad study areas ranged from 56% to 71.5%. The slope of each plot varied widely and slope varied in and between habitat types of the same plot. On transmission line study areas, slope was measured at the permanent plot marker and ranged from 14% to 28%, but again there was extreme variation similar to that on railroads.

Birds

A total of 19.39 ha of railroad ROW and 7.68 ha of transmission line ROW were used for breeding bird surveys. Table 5 provides an overview of the area of each ROW and habitat type surveyed.

Breeding bird surveys conducted in both 1988 and 1989 resulted in a total of 58 species being observed on railroad and transmission line ROW (Table 6). Of this total, 46 species occurred on the railroad and 35 on transmission lines. The railroad ROW had 23 species not observed on transmission lines whereas 12 species were observed only on transmission line ROW. The group which had the greatest species richness was the wood warblers with 17 species.

Diversity.- Although total species richness was 58, many species were represented by only a few individuals. Species diversity indices take into account both species richness and numbers of individuals (Table 7). For the different habitats which were surveyed on the railroad ROW, the river forest

habitat had the highest species richness with 33. Using the Simpson index, the river forest had the second highest species diversity with a value of 0.861 and using the Shannon-Wiener index the river forest had the highest value at 1.119. The river forest edge with a species richness of 29, had the highest Simpson index at 0.875, but the third highest Shannon-Wiener index at 1.104. The middle ROW, which includes the railroad tracks and gravel, had the lowest species richness, lowest Simpson index, and the lowest Shannon-Wiener index at 3, 0.135, and 0.133, respectively.

Species richness and diversity were calculated for each railroad ROW (Table 8). ROW 3, which was the widest railroad ROW, had the highest species richness and diversity using both methods at 33, 0.912, and 1.207, respectively. ROW 2, which was the narrowest ROW, had the lowest values for the diversity indices at 0.812 for Simpson and 0.984 for Shannon-Wiener.

On the transmission line ROW the forest had the highest species richness at 26 while the edge had the lowest species richness at 17. The edge had the highest Simpson index at 0.906 while the forest had the highest Shannon-Wiener index at 1.153. The ROW habitat had a species richness of 19 but had a Simpson index value of 0.830 and a Shannon-Wiener index value of 0.990, both of which were the lowest of the 3 habitat classifications.

On transmission lines, ROW 8, which was the widest ROW, had the highest species richness at 24. ROW 9 had the

highest values for both diversity indexes at 0.932 and 1.250. ROW 7 had the lowest species richness at 18 and the lowest Shannon-Wiener diversity index at 1.108. ROW 9 had the lowest Simpson diversity index at 0.898.

Density Indices.- Indices to the number of breeding birds was calculated for commonly observed species on both railroad and transmission line ROW. Species with >20 observations were used in this analysis for railroads on which 7 habitats were delineated. Table 9 provides an overview of bird abundance. Species with >15 observations were used in this analysis for transmission lines, on which 3 habitats were delineated. Two methods of obtaining a density index were used. The highest total count, which uses the highest number of individuals of a species observed on any one visit, and the number of breeding males.

On railroad ROW, the indigo bunting and the red-eyed vireo had the highest densities using the highest total count method (Table 10) and the number of breeding males (Table 11). For the highest total count the indigo bunting had the highest mean density index at 1.70 birds per ha whereas the red-eyed vireo was second with 1.60 birds per ha. This trend was reversed in the index of breeding males with the red-eyed vireo having the highest index value at 0.93 males per ha and the indigo bunting 0.70 males per ha. Using both methods other species had much lower index values. The rock dove and American goldfinch were third and fourth respectively, on the

total count index with mean values of 0.88 and 0.77 birds per ha. Based on the index to breeding males the song sparrow and American goldfinch came in third and fourth, respectively, with mean values of 0.21 males per ha and 0.17 males per ha. Railroad ROW 3 had the highest index using both the highest total count and the number of breeding males with values of 8.43 birds per ha and 4.51 males per ha, respectively. ROW 2 had the lowest index values for both methods at 5.13 birds per ha and 2.62 males per ha.

Bird density indices were calculated using both methods for habitat types (Tables 12, 13). The river forest edge had the highest density using both methods. The highest total count estimate was 52.49 birds per ha and the number of breeding males was 10.14 males per ha. The hill forest edge had the second highest using the total count method at 33.35 birds per ha. The river forest had the second highest value for the number of breeding males at 5.62 males per ha, whereas the hill forest edge was third at 5.20 males per ha. The river near ROW had the highest density of the 3 ROW habitats. River near ROW density estimates were 15.36 birds per ha and 3.01 males per ha.

Breeding bird densities were also calculated for commonly observed species on transmission line ROW (Tables 14, 15). The red-eyed vireo and the indigo bunting again had the highest index values using both methods. The red-eyed vireo had the highest values for both the highest total count and the number of breeding males at 1.72 birds per ha and

0.91 males per ha, respectively. The indigo bunting had the second highest values using both methods with index values of 1.69 birds per ha and 0.52 males per ha. ROW 9 had the highest index value for the highest total count at 19.92 birds per ha., but ROW 8 had the highest index value for the number of breeding males with 5.02 males per ha. ROW 7 had the lowest index values using both methods with 15.23 birds per ha and 4.41 males per ha.

Breeding bird densities were calculated for the habitats on transmission lines (Tables 16, 17). The edge had the highest density estimates using both methods with estimates of 19.98 birds per ha and 6.82 males per ha. The ROW habitat had the second highest density using the total count method with 13.60 birds per ha, while the forest had the second highest estimate using the number of breeding males with 4.82 males per ha.

Habitat Associations.- Chi-square goodness of fit tests and Bonferroni's Z tests were used to infer habitat associations of commonly observed bird species on ROW. For railroad ROW, data were first analyzed to compare the hill side of the ROW to the river side for each species, then habitat types were further split. On transmission lines the 3 different habitats were analyzed for each commonly observed species. Probability levels for all chi-square tests were ($p < 0.05$) and all Bonferroni's Z confidence intervals were determined at the $p = 0.05$ level. For chi-square tests the null

hypothesis states that birds were associated with each habitat in the proportion to that habitat's availability. Results of Bonferroni's Z confidence intervals were also compared to the same null hypothesis.

Railroad.- Chi-square goodness of fit tests indicated that there was a significant difference in the number of observations between the hill side and the river side of the ROW for the downy woodpecker, common grackle, American goldfinch, song sparrow, northern cardinal, indigo bunting, red-eyed vireo, tufted titmouse, Carolina chickadee, and the blue-gray gnatcatcher. Bonferroni Z confidence intervals concluded that for all the species except the blue-gray gnatcatcher the river side had significantly more observations than expected while the hill side had significantly fewer than expected. This result was reversed for the blue-gray gnatcatcher.

Rock doves were observed only on ROW 3, but several large flocks were observed on breeding bird surveys making it one of the more commonly observed species. Of the 30 individuals seen, 26 were located on the middle ROW and 4 on the river near ROW (Table 18). No rock doves were observed in any other habitat. Chi-square analysis indicated a significant difference between the observed and expected number of observations among habitat types in which the rock dove was observed. Bonferroni Z confidence intervals indicated that significantly more birds than expected were

observed in the middle ROW and significantly fewer in the river near ROW.

Downy woodpeckers were often observed in the forests adjacent to the railroad ROW, but were never observed on the ROW itself during breeding bird surveys. Chi-square analysis indicated a significant difference between the 4 habitats where observations occurred. Bonferroni Z confidence intervals indicated that significantly fewer downy woodpeckers than expected were observed in the hill forest and significantly more in the river forest edge. Other habitats did not show significant differences from expected.

Common grackles were observed in the hill forest edge, river near ROW, river forest edge, and river forest. Chi-square analysis indicated a significant difference from expected among habitats types for the number of observations. Confidence intervals indicated that significantly more observations occurred on the river forest while the ROW had significantly fewer observations than expected. Data from the ROW habitat types were pooled for this species.

The American goldfinch was observed in the hill forest edge, river near ROW, river forest edge, and river forest habitats. A chi-square test indicated a significant difference from the expected number of observations among habitat types. Bonferroni's Z confidence intervals indicated that the river near ROW and river forest edge had significantly more observations than expected and the river forest had significantly fewer observations than expected.

Song sparrows were observed in all habitats except the middle ROW. A chi-square test indicated a significant difference between the observed and expected number of observations among habitat types. There were significantly more observations than expected in the river forest edge and the river forest. In the hill forest and hill near ROW, significantly fewer individuals were sighted than expected.

The northern cardinal was the only species observed in all 7 habitat types. Chi-square analysis indicated a significant difference in the number of observations between habitat types, but confidence intervals indicated a significant difference from the expected number of observations for only the hill forest, which had significantly fewer observations than expected. Data from the hill near ROW, middle ROW, and river near ROW were pooled for this species.

Indigo buntings were observed in all habitats except the middle ROW. This was the most commonly observed species with a total of 230 observations. A chi-square test indicated a significant difference among habitats. Confidence intervals for the individual habitats indicated that the hill forest edge, river near ROW, and river forest edge had significantly more observations than expected while the hill forest had significantly fewer observations than expected.

The scarlet tanager was observed in all forested habitats, but was never observed on the ROW. Chi-square analysis and subsequent confidence intervals failed to detect

any significant pattern with habitat association among those habitats where observations occurred.

Red-eyed vireos were commonly observed in forested habitats, but only 1 observation occurred on the ROW in the hill near ROW habitat. Chi-square analysis indicated a significant difference between the observed and expected for the habitat types. Significantly more observations were made in the river forest edge and river forest than expected, while fewer observations than expected were made in the hill near ROW.

Carolina wrens were observed in all habitat types except the middle ROW. Chi-square analysis and confidence intervals failed to detect any significant pattern in habitat association.

Tufted titmice were observed in all habitat types except the hill near ROW and middle ROW. Chi-square analysis indicated a significant difference between the observed and expected number of observations among the habitat types. Confidence intervals for the individual habitats determined that the river forest edge had significantly more observations than expected, while the other habitat types in which the species was observed did not deviate significantly from expected.

Carolina chickadees were observed in all habitat types except the middle ROW. Chi-square analysis indicated significant differences between the observed and expected number of observations and subsequent confidence intervals

indicated that the river forest edge had significantly more observations than expected. The hill forest and river near ROW had significantly fewer observations than expected.

The blue-gray gnatcatcher was observed in all forested habitat types, but chi-square analysis and subsequent confidence intervals failed to indicate any pattern of habitat association.

Transmission Line.- Rufous-sided towhees were observed in all 3 habitat types on transmission lines (Table 19). Chi-square analysis indicated a significant difference between the observed and expected number of observations for the habitat types. Bonferroni's Z confidence intervals determined that the ROW habitat had significantly more observations than expected while the forest habitat had significantly fewer observations than expected. The number of observations did not deviate significantly from expected in the edge habitat.

Indigo buntings were observed in all habitat types and chi-square analysis indicated a significant difference between habitat types. Confidence intervals also indicated the number of observations were significantly more than expected in the ROW and significantly fewer in the forest.

Red-eyed vireos were observed in the forest and edge habitats, but never on the ROW. Chi-square analysis indicated a significant difference between habitats and confidence intervals indicated that the forest habitat had significantly more observations than expected.

Black and white warblers were observed in all habitat types on transmission lines, but both tests failed to detect any pattern for habitat association.

Ovenbirds were observed on the edge and forest habitats, but never on the ROW. A significant difference was detected in the chi-square test and confidence intervals indicated that the forest habitat had significantly more observations than expected.

The hooded warbler was observed in all habitat types. A significant difference from expected was observed in the chi-square test. Confidence intervals indicated that the forest habitat had significantly more observations than expected, while the ROW had significantly fewer observations than expected.

Carolina chickadees were observed in all habitat types. A chi-square test indicated a significant difference between the observed and expected number of observations among habitat types and subsequent confidence intervals indicated significantly more observations occurred in the edge habitat than expected.

Blue-gray gnatcatchers were observed in all habitat types. Both tests failed to indicate any pattern in habitat association.

Detection Categories.- Birds were identified and located by the use of both sight and sound. On the railroad 60% of observations were by song only and on transmission lines 61%

of observations were by song (Table 20). Birds seen came in a distant second at 20% of observations on the railroad and 13% on the transmission line. The call only, song/see, and call/see categories accounted for the remaining observations.

Mammals

A total of 13 species of mammals were observed on ROW in the NRGNR (Table 21). Of these 13 species, 11 were observed on the railroad and 8 on transmission lines. Eastern cottontails and cattle were observed only on transmission lines while gray and fox squirrels along with opossum, raccoon, and mink were observed only on the railroad ROW. Only 1 observation was made for both the raccoon and mink.

Small mammal trapping was conducted in July 1988. A total of 450 trap nights were obtained on each type of ROW and 150 trap nights for each habitat trapped. Three species of small mammals were captured in Sherman live traps (Table 22) . Captured individuals were marked using a permanent ink dye. This method, however, did not appear to permanently mark animals. Only 1 known recapture was made.

White-footed mice were the most commonly captured species. A total of 69 captures were made on the railroad and 12 on transmission lines. The river forest had the most captures on the railroad with 36 while the forest habitat had the most captures on the transmission lines with 7. The ROW had the second highest capture rate on the railroad with 28, but on the transmission line the ROW habitat had only 1

capture.

On the railroad 2 captures were made of the eastern woodrat. One capture occurred on the hill forest of ROW 1 and the other capture occurred on the ROW habitat of ROW 2. On transmission line ROW only 1 eastern woodrat was captured on ROW 8 in the edge habitat.

Eastern chipmunks were captured on the river forest habitat of railroad ROW. A total of 3 captures were made.

Fecal counts were conducted in late February and early March 1989. Feces of the opossum, dog, deer, cattle, eastern cottontail, and turkey were observed. Feces of foxes were observed, but could not be differentiated between red and gray. No deer feces were observed on the railroad and only 13 piles were observed on all transmission lines. Cattle and eastern cottontail feces were observed only on transmission lines, while dog feces were observed only on the railroad.

Observations of dead animals along the railroad tracks were made. Trains apparently hit these animals. In early spring several opossum carcasses and a dog carcass were observed on the railroad tracks. The skeletons of many opossums, which had been hit in the past, were observed. The remains of a deer located on the railroad tracks near Kaymoor was observed.

Reptiles and Amphibians

A total of 15 species of reptiles and amphibians were observed on both types of ROW (Table 23). On railroad ROW, 13 species were observed, while 7 species were observed on transmission line ROW. Egg masses of spotted and Jefferson salamanders were found in temporary pools on the hillside edge of the rail bed. Wood frog eggs were found in pools on both types of ROW. Drop boards provided little information on reptiles and amphibians. Only 1 wood frog and a northern water snake were found using these drop boards. Old discarded rail ties were flipped on the railroad study areas. Only five-lined skinks were located in this manner.

Discussion

Vegetation

The vegetation structure on railroad ROW is quite different from that of transmission lines. The middle ROW on the railroad is devoid of vegetation. The river forest is narrow and has a more open canopy than either the hill forest or the forest adjacent to transmission lines. Tree densities vary widely on the river forest, but are much more consistent on the hill forest. Tree densities were greatest on the forest habitat of transmission lines. Woody stem densities are generally greater in the ROW habitat on transmission lines than on railroads.

Herbaceous vegetation was the most common ground cover on the railroad. Rock cover was prevalent on the river forest. Fern and slash cover accounted for only a small percentage of ground cover on the railroad habitats. Shrub and herbaceous cover were greater on the ROW than in the adjacent forest on transmission lines. Litter cover was the primary ground cover in the transmission line forest, while rock and slash cover were minor components on both the ROW and forest.

Slopes were very steep on railroads, but since transmission lines are on top of the gorge wall, slopes there were less severe. Cliffs and rocky outcrops were common on both ROW types. The canopy was more open in the river forest, than in the hill forest allowing more sunlight to

reach the forest floor. The forest adjacent to the transmission lines had the most dense canopy, reducing sunlight penetration and increasing the moisture content of the forest floor.

Birds

Results of bird surveys indicate that a wide variety of birds use railroad and transmission line ROW in the NRGNR. Species richness on the railroad was 46, while on the transmission lines the species richness was 35. Much of the difference in species richness between the 2 types of ROW is an artifact of the differential amount of time spent on bird surveys between the 2 ROW types. Species for which there were only a few observations may not use ROW for their normal life requisites, but may have been detected on bird surveys as non-breeders passing through.

The important difference between bird use of railroads and transmission lines is in the commonly observed species which were observed on only one type of ROW. The rufous-sided towhee and the ovenbird were 2 common species observed on the transmission line, but not on the railroad. Stem densities on the railroad ROW were lower than that of the transmission line ROW and the middle of the railroad ROW was devoid of vegetation. This may have rendered the railroad ROW unsuitable for the rufous-sided towhee. The ovenbird is a forest interior species (Robbins et al. 1989). The narrow river forest probably does not provide adequate interior

habitat for the ovenbird. The ovenbird is a species of the forest floor and prefers areas of ground covered with litter (Bent 1953). Forests along transmission line had higher percentage of litter cover than hill forests, thus, hill forests may not provide the proper habitat for the ovenbird.

Common grackles and song sparrows were observed only on the railroad. These species were probably observed on the railroad due to the nearness of the railroad to water. Streamsides and marshlands are preferred habitats of these species (Peterson 1980). Carolina wrens are not common in dense, mature forests (Hall 1983). The forest along transmission lines may have been too dense for the Carolina wren, but the more open forests along the railroad may provide better habitat for this species. The rock dove was observed only on railroad ROW. Railroads provide large, open, rock-covered spaces for this species to obtain grit.

The golden-winged warbler is the only bird species observed on either type of ROW which may be having population problems. It is listed as a Species of Special Concern in West Virginia (WVDNR 1987). Hall (1983), however, describes the golden-winged warbler's status as uncommon to fairly common summer resident in West Virginia. Few golden-winged warblers were seen in the NRGNR. Since most of the NRGNR and adjacent lands consist of relatively mature forest, optimum habitat for this species, which requires large areas of brushy second growth (Bent 1940, Hall 1983), does not exist.

Diversity.- On railroad ROW, the river forest had the highest species richness (33), and the other forest habitats had a species richness of slightly fewer bird species. Species richness was greater in the forest because the multiple layers of forest vegetation provided more niches than did ROW areas. The middle ROW, which was devoid of vegetation, had the lowest species richness as expected (3). The river near ROW had a species richness of 19, the highest of the 3 ROW habitat types.

On transmission lines the forest habitat had the highest species richness (26). The edge had the lowest species richness (17) , however, this was only 2 species fewer than the ROW habitat.

Diversity indices provide a measure for community comparison (Smith 1980) and are used to judge relationships to environmental conditions (Pielou 1975). The Simpson's and Shannon-Wiener indices take into account the number of species and the number of individuals of each species to obtain a measure of diversity (Pielou 1974). The higher the index value the more diverse is the community. The chance of any 2 random observations being of the same species is lower with a higher index value. For example, the chances of 2 random observations being of the same species are greater in the middle ROW, with the lowest Simpson's index value, than in the river forest edge, with the highest Simpson's index value.

The river forest edge and hill forest edge had the highest species diversity indices as calculated by the Simpson index, whereas the Shannon-Wiener index indicated that the river forest and hill forest edge had the highest diversity, with the river forest edge third. This indicates the value of ecotonal habitats in promoting bird species diversity. The hill near ROW and middle ROW had the lowest diversity indices using both methods. These measures of diversity indicate that forest habitats, which are areas of greater structural diversity compared to the ROW habitats, had the highest bird species diversity. The river near ROW, which was wider than the hill near ROW, and contained more vegetation than the middle ROW, had the highest measures of diversity using both methods for ROW habitat types.

The Simpson's diversity index value for the edge habitat was the highest on transmission lines, but the Shannon-Wiener index gave the greatest index value to the forest. Both indexes indicated that the ROW habitat type was the least diverse. This again, is due to the lower structural diversity on the ROW.

Density.- Indices to bird density were calculated using both the highest total count method and the number of breeding males. It is important to note that these densities provide only an index to bird numbers, not an absolute density. These numbers are also not comparable to densities observed by Buhlmann and Vaughan (1987) because different habitats

were surveyed, and a different sampling technique was employed.

The indigo bunting was the most abundant edge species observed on both types of ROW, while the red-eyed vireo was the most common forest species observed on both types of ROW. The highest total count method assumes that any one visit underestimates the number of birds, therefore, only the highest number of observations on a visit is used to calculate density (Doehlert 1981). By this method, a species which was observed much less frequently, but had a large number of observations on one visit, would have the same density as a more frequently observed species. The black and white warbler on ROW 8 and the song sparrow on ROW 3 are examples of this. Counts of breeding males when doubled indicate the number of breeding pairs in an area. These counts, however, assume that all males are counted and that the sex ratio is 1:1 (Mayfield 1981).

All bird survey techniques which attempt to create a density estimate suffer some basic problems. Observer identification skills, observation conditions, screening effects of habitat, and conspicuousness of birds affect bird density estimates (Emlen 1971).

Because of the severe limitations with estimating bird densities, I believe that these are not absolute densities, but indices, and should be used accordingly. Indices to bird density when collected in the same manner over a period of time can show trends in bird numbers.

The point count technique was chosen as the best method to survey the bird population on ROW because point counts are more easily repeated (Verner and Ritter 1985). If the bird density estimates obtained in this study are used as part of an index, the sampling method employed can be repeated in the future and trends in bird numbers can be evaluated.

Habitat Associations.- No studies to date have compared the habitat associations of birds in the forest, edge, and ROW. Most studies look only at the ROW and possibly the edge. Some studies have also included forest interior plots in the same general area as the ROW. This study considered the ROW, edge, and adjacent forest as one interacting habitat complex. Kroodsma (1984) did look at birds in the edge and forest adjacent to transmission lines in Tennessee, but did not include data for the ROW. The actual effect of the ROW on birds may exceed the 5 m often defined as the edge (Kroodsma 1984). Different edge effects may extend varying distances into the forest interior. Predation pattern changes, weather alterations, and vegetation changes, caused by a ROW, may influence the forest environment for great distances.

The topography along railroad ROW in the NRGNR has strongly influenced the vegetation in all habitats as noted in the vegetation analysis. Also, the juxtaposition of the railroad to the river has influenced the vegetation, creating a narrow riparian zone. The vegetation occurring in an area influences the fauna occurring in that same area.

The river side of the ROW was the preferred habitat for 9 of the 13 common bird species observed along railroads in this study. Only the blue-gray gnatcatcher indicated a preference for the hill side of the ROW. Three species showed a preference for the river forest and 7 species showed a preference for the river forest edge, while no species showed a preference for the hill forest and only one for the hill forest edge. Additionally, the river forest and river forest edge had the highest overall number of observations for all species combined. This information indicates that the river forest and river forest edge habitats are of high value as bird habitat during the breeding season. Stauffer and Best (1980) also noted the value of riparian habitats to wildlife.

The river near ROW was a preferred habitat for 2 species, (indigo bunting and American goldfinch) both of which also had a preference for the river forest edge. The river near ROW had many more observations than the other ROW habitat types. This indicates that of the 3 ROW habitat types the river near ROW is the most valuable to birds during the breeding season.

On transmission lines, the forest habitat was preferred by 3 species, (red-eyed vireo, ovenbird, and hooded warbler) while the ROW habitat was preferred by 2 species (rufous-sided towhee and indigo bunting). Edge species preferred the ROW, while forest species, as expected, preferred the forest. No species indicated a preference for more than one habitat

type on the transmission lines. Only the Carolina chickadee showed a preference for the edge habitat. It is not clear which habitat is most valuable to birds in general on the transmission line ROW.

The indigo bunting is generally considered an edge species (Robbins et al. 1989). On the railroad it showed a preference for the edge habitats and the river near ROW. This agrees with other studies (Robbins et al. 1989). On the transmission line the indigo bunting did not show a preference for the edge, but for the ROW. This may be comparable to the species preference for the river near ROW. This preference would be expected if this species needs both brushy areas and the adjacent mature trees.

The red-eyed vireo is considered to be a forest interior species (Robbins et al. 1989). This species showed a definite preference for forest habitats. Only one observation occurred on railroad ROW habitats and none on the transmission line ROW habitat. This species did, however, show a preference for the river forest edge and the river forest, which do not generally provide adequate habitat for area sensitive species. This species may require mature forest trees, but will tolerate forest edges. On transmission lines, as expected, the red-eyed vireo preferred the forest habitat, but was also observed on the edge.

The Carolina chickadee preferred the river forest edge on the railroad and the edge on the transmission line. This consistency indicates that this is a true edge species and is

in agreement with Kroodsma (1984) .

The blue-gray gnatcatcher is also considered a forest interior species (Robbins et al. 1989). It was never observed on the railroad ROW habitats, but did occur on the ROW habitat along transmission lines. Other than avoiding the railroad ROW, the blue-gray gnatcatcher showed no preference for edge or forest on either type of ROW. This indicates that the blue-gray gnatcatcher does not shy away from forest edges and agrees with results obtained by Kroodsma (1984) .

The rock dove preferred the middle ROW over all other habitats. This species usually appeared to be collecting grit along the railroad tracks. The rock dove is a colonial species and the methods employed in all phases of this study were not ideal methods for studying this species. These findings, however, provide an indication of the species' presence along the railroad ROW in the NRGNR.

The downy woodpecker was observed on forested habitats along the railroad, but not on the ROW. This species preferred the river forest edge and avoided the hill forest. The lack of stems on which to forage probably limited this species' use of the ROW.

Common grackles prefer streamside habitats (Peterson 1980). This study also indicates that the RF which borders the New River is preferred by the common grackle.

The American goldfinch was commonly observed along the river side of the ROW. This species preferred the river

near ROW and river forest edge over all other habitats. Even though the goldfinch preferred the river near ROW it was absent from the middle ROW and hill near ROW. This species showed a preference for the river side of the ROW when compared to the hill side. The lack of vegetation probably made the MR unsuitable for this species, but no explanation can be found for its absence from the hill near ROW. Only one observation of this species occurred on transmission lines, indicating little use of this type of ROW.

Song sparrows were observed in all habitats except the middle ROW. This species can be found in a wide variety of habitats, but often prefers wetlands. The river forest and river forest edge were preferred by song sparrows in this study area.

The cardinal was observed in all 7 habitat types along the railroad. No preferred habitat was indicated in the analysis of this species, but an avoidance of the hill forest was indicated. Cardinals were observed on transmission lines, but were not common.

The scarlet tanager is considered a forest interior species (Robbins et al. 1989). This species was observed in all forest habitats along the railroad, but never ventured into the ROW habitats. No preference or avoidance of any forest habitat was observed for this species, indicating that the scarlet tanager is willing to come to the forest edge. This was also indicated in a study conducted in Tennessee (Kroodsma 1984). Scarlet tanagers were observed on

transmission lines, where a total of 15 observations occurred.

The tufted titmouse preferred the river forest edge in this study. The species was never observed in the middle ROW and hill near ROW. Kroodsma (1984) did note that this species did not avoid edge habitats. Only 3 birds were detected on transmission lines.

The rufous-sided towhee was commonly observed on transmission lines, but never on the railroad. This species, which prefers brushy habitats (Hall 1983), preferred the ROW habitat in this study. This species also was observed in the edge and forest habitats and may require these habitats for inclusion in its home range.

The hooded warbler showed a preference for the forest habitat and was observed on the edge. Kroodsma (1984) did note that this species did not avoid edge habitats. This species was observed on the ROW, but analysis indicated that this habitat was avoided. The hooded warbler was observed on the railroad, but few observations occurred.

The ovenbird is a forest interior species (Robbins et al. 1989). This species was never observed on the ROW, and only once on the edge. This species preferred the forest habitat. Kroodsma (1984) noted a similar pattern on his study area in Tennessee. No ovenbirds were observed on the railroad.

It is important to note that species which are field interior species such as the field sparrow were rare or

absent from both types of ROW. These species were not observed on the railroad due to the relatively narrow width of the ROW, which does not provide field interior conditions, and the lack of vegetation in the middle ROW. These species occurred more often on transmission lines, but again, the relatively narrow width of ROW on the NRGNR limited the amount of field interior habitat available.

Actual searches were not made for bird nests, however, several nests were located on transmission line ROW. One nest each of the indigo bunting, field sparrow, and cardinal were located and 2 wood thrush nests were observed on the forests adjacent to the transmission lines. No nests were located on the railroad ROW.

About 70% of all birds were not seen, but were identified by song or call. This was the trend on both types of ROW. Casual observers will visit ROW and often see few birds. Even though management may increase the number of birds in an area, their inconspicuous nature will often hinder a visitor's enjoyment. Certain species such as the indigo bunting and American goldfinch, however, are more conspicuous than other species.

Brown-headed cowbirds were observed in this study area. This species is a parasitic nester and uses over 200 species of birds as hosts (Friedmann 1971, Klein and Rosenberg 1986). Openings in the forest provide habitat for this species, which is native to central North America. Few cowbirds were observed in this study, indicating that this species is

still relatively rare in the NRGNR. Increasing the amount of open habitat in the NRGNR may lead to increased numbers of cowbirds and a corresponding increase in parasitism on host species.

Mammals

As with birds, the higher species richness of mammals on the railroad is in part an artifact of the differential amount of time spent on each type of ROW. Mammals are generally much more inconspicuous than birds, due to their secretive and often nocturnal habits. I can find no explanation why squirrels were observed on railroads, but not on transmission lines. The eastern cottontail was observed on transmission lines, but not on the railroad. This is probably due to the lack of vegetation in the middle ROW. Groundhogs, however, were often observed on railroads and probably occur on the transmission lines. No live opossums were ever observed, although the remains of numerous individuals were found on the railroad tracks. This species was not observed on transmission lines, but probably occurs in these areas. Cattle apparently escaped from a farm above the town of Thurmond on several occasions and grazed on the transmission line above the town. One set of raccoon tracks were observed on the railroad at Terry siding and discussions with local residents indicate that this species is common along railroad tracks. One mink was observed in the river forest north of Meadow Creek during a time of very high flows

in the river.

The white-tailed deer was observed occasionally on both types of ROW. No feces were found on the railroad ROW during early spring surveys. This indicates that this area is avoided during the winter. Hazardous slopes, which may limit deer movements in winter, may cause deer to avoid these areas near the river. Deer feces were rarely observed on transmission lines during the early spring surveys, also indicating very little use of these areas. Although fecal counts were not made in the forests adjacent to the transmission line, casual observations indicated large numbers of fecal piles in the forest. Since weather conditions during the winter of 1988-89 were very mild, deer may have had no need to go into the ROW in search of food.

Packs of dogs were observed on both types of ROW. Discussions with local residents, during which I described individual dogs, indicated that at least some of these dogs were family pets and farm animals. These dogs banded together and in one instance were observed chasing a deer. After disturbing wildlife, these dogs return to their homes.

White-footed mice, eastern woodrats, and eastern chipmunks were captured in Sherman live traps. The marking technique apparently failed to permanently identify individual animals. Only one recapture of a white-footed mouse occurred. Other studies have noted a recapture rate of up to 60% for this species during the summer months (Hirth 1959), so a large number of recaptures were expected. It is,

however, interesting to note that many more captures occurred on railroads than on the transmission lines. The river forest and ROW had many more captures than the hill forest. On transmission lines the forest habitat had the most captures followed by the edge. This indicates that white-footed mice may be avoiding the ROW.

Three eastern woodrats were captured on ROW in the NRGNR. This species has no special status in West Virginia, but is listed as threatened or endangered in adjacent states. One woodrat was captured in the hill forest of ROW 1 and a second was captured on the river near ROW of ROW 2. A third was captured in the edge habitat of ROW 8 in a large rock outcrop. Ladino and Gates (1981) noted that 92% of woodrat observations on their western Maryland study area occurred on the forest and the remaining 8% on the ROW edge. The Sherman live traps used were not ideally suited for capturing woodrats, so this species may not have been adequately sampled.

Eastern chipmunks were captured in the river forest. This species was commonly observed on both types of ROW, but appeared to be trap shy.

Reptiles and Amphibians

A variety of reptiles and amphibians occur on ROW. Old railroad ties along the railroad and refuse piles on transmission lines harbor many reptiles and amphibians. Small ponds on ROW provide breeding habitat for amphibians.

Box turtles and one wood turtle were observed on transmission lines. The wood turtle is of special note, because it is listed as a Species of Scientific Interest in West Virginia and the NRGNR is out of its normal range (WVDNR 1987). Box turtles and one small snapping turtle were observed on the railroad. The snapping turtle and several box turtles appeared to be unable to navigate the railroad tracks. Several dead box turtles were observed on the railroad bed, between the railroad tracks. Apparently trapped in between the tracks, they perished.

Snakes were commonly observed on both types of ROW. Northern copperheads were common on transmission lines, and one was observed on the railroad curled up against a Sherman live trap. Black rat snakes were observed on several occasions on both types of ROW. Only one observation each was made of the other species of snakes.

Five-lined skinks were observed along the railroad tracks and under old railroad ties. One fence lizard was observed on the railroad near Fayette Station.

Eggs of the wood frog were observed in temporary pools on both types of ROW. Egg masses of the spotted and Jefferson salamander were located in temporary pools on the hill side of the railroad bed. The Jefferson salamander has an Undetermined Status in West Virginia (WVDNR 1987). Egg masses of this species were observed in several pools on the hill side of the rail bed at Terry siding. One breeding pond was also located on the hill side of the rail bed on river

left 1 k south of Fayette station.

Conclusion

This study concentrated on railroad and transmission line ROW in forested areas of the NRGNR. Transmission line study sites were typical for this type of ROW. Transmission lines are in upland forests. They generally come to the top of the gorge wall, go half way down the wall, then swing across the river and up the other side. No unusual habitats were noted along transmission lines.

Most railroad ROW are bordered by forests. In some small areas there is little vegetation between the rail bed and the river, thus eliminating the river forest and river forest edge habitats. When the railroad passes through a town such as Meadow Creek, only the middle ROW is present. Forest habitats have been replaced by lawns and other urban habitats. These areas are dominated by activities not related to the railroad. The vegetation occurring in these areas is atypical and the wildlife using these areas may be different. Floodplains of larger streams, such as Mann's creek, create a unique habitat under the railroad trestle. This is often a rocky area without any wetland habitat.

The NRGNR contains over 300 km of ROW. These areas require special maintenance to control vegetation. Since habitat manipulation is necessary, it can be altered to improve the wildlife value of these areas, reduce herbicide use, and improve park visitor perceptions of ROW.

RECOMMENDATIONS FOR FUTURE RESEARCH

1. The single greatest unstudied threat to the environment caused by ROW management in the NRGNR is the effects of industrial chemical products placed on the railroad. All ties are soaked in creosote before placement on the track structure. With approximately 3,300 ties per mile this adds up to a large amount of creosote. Lubricators are used on curves to reduce the friction of train wheels on the track. This heavy grease is spread out over the ballast and may enter the ecosystem. Each lubricator uses about 300 pounds of grease per year. Trains themselves release diesel fuel and other petroleum products. The soil mixed in old ballast material under the track structure may actually be legally toxic waste. What amounts of these chemicals are entering the ecosystem? How can the amount of these chemicals being placed on the ROW be eliminated or reduced.

2. The flora and fauna of riparian zones have been well studied. The effects of separating the riparian forest from the adjacent upland forest has not. What effect does the separation of the riparian and upland forest, cause by the railroad ROW have on the flora and fauna of the riparian zone.

3. Much research has been done on the ecology of creating a stable plant community. However, with the complexity of ecosystems, much research is still needed. Which plants,

native to the NRGNR are best at inhibiting the growth of undesired vegetation? Additional research is also needed as to how to best promote the most desired vegetation. Which methods are economically feasible and ecologically sound?

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Table 1. Common woody plants observed on rights-of-way and adjacent forests.

Species	RR*	TL	Scientific Name
Blackberry		X	<u>Rubus spp.</u>
Greenbrier		X	<u>Smilax rotundifolia</u>
Great rhododendron		X	<u>Rhododendron maximum</u>
Black locust	X		<u>Robinia pseudoacacia</u>
White ash	X		<u>Fraxinus americana</u>
Red maple	X	X	<u>Acer rubrum</u>
Sugar maple	X	X	<u>Acer saccharum</u>
Box elder	X		<u>Acer neaundo</u>
Black cherry	X		<u>Prunus serotina</u>
Paulownia	X		<u>Paulownia tomentosa</u>
Tulip poplar	X	X	<u>Liriodendron tulipifera</u>
Red oak	X	X	<u>Quercus rubra</u>
White oak	X	X	<u>Quercus alba</u>
Chestnut oak	X	X	<u>Quercus prinus</u>
Sycamore	X		<u>Platanus occidentalis</u>
Sweet gum	X		<u>Licruidambar styraciflua</u>
River birch	X		<u>Betula nigra</u>
Flowering dogwood	X	X	<u>Cornus florida</u>
Ironwood	X		<u>Carpinus caroliniana</u>

* RR= railroad TL= transmission line

Table 2. Mean number of trees and woody stems per hectare on 4 railroad and 3 transmission line rights-of-way.

Railroad

	River forest	ROW	Hill forest
Trees per ha	66.3	0	59.3
(range)	(39-95)	(0-0)	(51-64)
Stems per ha	309.8	352	345
(range)	(132-465)	(113-870)	(264-570)

Transmission Line

	Forest	ROW
Trees per ha	84.7	0
(range)	(79-91)	(0.0)
Stems per ha	850.7	983.3
(range)	(640-1014)	(548-1155)

Table 3. Mean percentages for ground covers on 4 railroad and 3 transmission line rights-of-way.

<u>Railroad</u>			
	River forest	ROW	Hill forest
Herb	19.4	52.6	31
(range)	(10.0-32.5)	(42.5-60.0)	(22.0-44.5)
Fern	0.6	1.1	4.5
(range)	(0.0-1.5)	(0.0-3.5)	(0.0-10.0)
Slash	1.7	4.4	0.8
(range)	(0.5-3.5)	(0.0-9.0)	(0.5-1.5)
Shrub	17.8	6.4	12.1
(range)	(11.5-23.0)	(1.0-11.5)	(7.0-21.0)
Litter	17.1	10.1	36.6
(range)	(3.0-30.0)	(1.0-16.0)	(11.5-46.0)
Rock	43.4	24.6	15
(range)	(32.0-72.0)	(14.0-33.5)	(4.0-22.5)
<u>Transmission Line</u>			
	Forest	ROW	
Herb	10.7	34.7	
(range)	(5.0-14.5)	(29.0-41.5)	
Fern	3.2	5.2	
(range)	(1.0-4.5)	(3.5-6.5)	
Slash	0.8	0.7	
(range)	(0.5-1.0)	(0.0-1.5)	
Shrub	20	34.7	
(range)	(14.0-23.5)	(22.0-42.5)	
Litter	65	22.5	
(range)	(58.5-70.0)	(15.0-32.5)	
Rock	0.3	2.3	
(range)	(0.0-0.5)	(0.0-5.0)	

Table 4. Mean percentages for slope and canopy cover on 4 railroad and 3 transmission line rights-of-way.

<u>Slope</u>		
Railroad		Transmission line
60.9		21.1
(53.5-71.5) *		(14.0-28.5)
<u>Canopy cover</u>		
Railroad		Transmission line
River forest	Hill forest	Forest
65.4	76.6	81.0
(54.0-74.5)	(70.5-78.5)	(76.5-85.5)

* (range)

Table 5. Hectares of habitat surveyed for breeding birds on 3 transmission line and 4 railroad rights-of-way.

<u>Transmission line</u>		Forest	Edge	ROW	Total
		4.5	0.9	2.28	7.68

<u>Railroad</u>		HF	HFE	HNR	MR	RNR	RFE	RF	Total
		6	1.2	1.27	2.76	2.6	1.2	4.34	19.38

HF= hill forest HFE= hill forest edge HNR= hill near ROW
MR= middle ROW RNR= river near ROW RFE= river forest edge
RF= river forest

Table 6. Bird species observed on rights-of-way during breeding bird surveys.

Common Name	RR*	RL	Scientific Name
American kestrel	1		<u>Falco sparverius</u>
Green-backed heron	1		<u>Butorides striatus</u>
Mourning dove	1		<u>Zenaida macroura</u>
Rock dove	30		<u>Columba livia</u>
Ruby-th. Hummingbird		1	<u>Archilochus colubris</u>
Common flicker	7		<u>Colaptes auratus</u>
Pileated woodpecker	2	1	<u>Dryocopus pileatus</u>
Red-bellied woodpecker	3		<u>Melanerpes carolinus</u>
Hairy woodpecker	1		<u>Picoides villosus</u>
Downy woodpecker	33	8	<u>Picoides pubescens</u>
Eastern wood pewee	1	2	<u>Contopus virens</u>
Great crested flycatcher		1	<u>Myiarchus crinitus</u>
Acadian flycatcher	1		<u>Empidonax virescens</u>
Eastern phoebe	16		<u>Sayornis phoebe</u>
Rough-winged swallow	4		<u>Stelgidopteryx ruficollis</u>
American crow	7		<u>Corvus brachyrhynchos</u>
Blue jay	5	6	<u>Cyanocitta cristata</u>
Tufted titmouse	36	3	<u>Parus bicolor</u>
Carolina chickadee	65	17	<u>Parus carolinensis</u>
House wren	1		<u>Troglodytes aedon</u>
Carolina wren	27		<u>Thryothorus ludovicianus</u>
White-breasted nuthatch	6	3	<u>Sitta carolinensis</u>
Gray catbird	9	1	<u>Dumetella carolinensis</u>

Table 6. Continued

Common Name	RR*	RL	Scientific Name
American robin	2	1	<u>Turdus migratorius</u>
Wood thrush	1	9	<u>Hylocichla mustelina</u>
Cedar waxwing	3		<u>Bombycilla cedrorum</u>
Blue-gray gnatcatcher	42	21	<u>Polioptila caerulea</u>
Red-eyed vireo	225	44	<u>Vireo olivaceus</u>
White-eyed vireo	7	2	<u>Vireo griseus</u>
Solitary vireo	3		<u>Vireo solitarius</u>
Black and white warbler	11	16	<u>Mniotilta varia</u>
Blue-winged warbler	1		<u>Vermivora pinus</u>
Golden-winged warbler	7		<u>Vermivora chrysoptera</u>
Northern parula warbler	13		<u>Parula americana</u>
yellow warbler	7	3	<u>Dendroica petechia</u>
Yellow-throated warbler	3	1	<u>Dendroica dominica</u>
Blackburnian warbler	1		<u>Dendroica fusca</u>
Black-th. Blue warbler	1		<u>Dendroica caerulescens</u>
Cerulean warbler	1		<u>Dendroica cerulea</u>
Pine warbler	1		<u>Dendroica pinus</u>
Prairie warbler	1		<u>Dendroica discolor</u>
Ovenbird	22		<u>Seiurus aurocapillus</u>
Louisiana waterthrush	5	1	<u>Seiurus motacilla</u>
American redstart	1		<u>Setophaga ruticilla</u>
Kentucky warbler	14	4	<u>Oporornis formosus</u>
Hooded warbler	12	19	<u>Wilsonia citrina</u>

Table 6. continued

C	RR	TL	Scientific Name
Yellow-breasted chat		1	<u>Icteria virens</u>
Brown-headed cowbird	3	1	<u>Molothrus ater</u>
Common grackle	28		<u>Quiscalus quiscula</u>
Orchard oriole	1		<u>Icterus spurius</u>
Northern oriole	3		<u>Icterus galbula</u>
Scarlet tanager	24	15	<u>Piranga olivacea</u>
Northern cardinal	38	8	<u>Cardinalis cardinalis</u>
Rufous-sided towhee		34	<u>Pipilo erythrophthalmus</u>
Indigo bunting	230	37	<u>Passerina cyanea</u>
American goldfinch	50	1	<u>Carduelis tristis</u>
Field sparrow		4	<u>Spizella pusilla</u>
Song sparrow	50		<u>Melospiza melodia</u>

* RR= railroad ROW TL= transmission line ROW

Table 7. Species richness and diversity indices for habitats.

Spec. Richness Simpson* Shannon-Weiner			
<u>Railroad</u>			
Hill Forest	25	0.809	1.103
Hill Forest Edge	25	0.867	1.117
Hill Near ROW	7	0.445	0.444
Middle ROW	3	0.135	0.133
River Near ROW	19	0.725	0.801
River Forest Edge	29	0.875	1.104
River Forest	33	0.861	1.119
<u>Transmission Line</u>			
ROW	19	0.83	0.99
Edge	17	0.906	1.101
Forest	26	0.897	1.153

* Base 10

Table 8. Species richness and diversity indices for rights-of-way.

	Spec. Richness	Simpson*	Shannon-Weiner
<u>Railroad</u>			
ROW 1	28	0.837	1.044
ROW 2	28	0.812	0.984
ROW 3	33	0.912	1.207
ROW 4	24	0.903	1.153
All ROW	46	0.883	1.181
<u>Transmission Line</u>			
ROW 7	18	0.908	1.108
ROW 8	24	0.904	1.159
ROW 9	22	0.898	1.207
All ROW	35	0.923	1.250

* Base 10

Table 9. Bird abundance on railroad and transmission line rights-of-way.

Railroad

	HF	HFE	HNR	MR	RNR	RFE	RF	Total
Birds per ha	8.98	33.35	10.15	6.15	15.36	52.49	17.03	
Males per ha	2.30	5.20	1.04	0.47	3.01	10.14	5.62	
Total indiv.	186	102	34	28	138	208	332	1028
Total species	25	25	7	3	19	29	33	46

Transmission Line

	ROW	EDGE	Forest	Total
Birds per ha	13.60	19.98	12.89	—
Males per ha	3.70	6.82	4.82	—
Total indiv.	76	57	165	298
Total spec.	19	17	26	35

HF= hill forest HFE= hill forest edge HNR= hill near ROW
 MR= middle ROW RNR= river near ROW RFE= river forest edge
 RF= river forest

Table 10. Index to bird density on railroad rights-of-way using the highest total count.

Species	ROW	Birds per ha				Mean
		1	2	3	4	
Rock dove		0.00	0.00	3.29	0.00	0.82
Downy woodpecker		0.59	0.41	0.61	0.44	0.51
Common grackle		0.19	0.21	0.62	1.54	0.64
American goldfinch		0.78	0.41	1.23	0.66	0.77
Song sparrow		0.19	0.41	1.03	0.66	0.62
Northern cardinal		0.39	0.41	0.82	0.66	0.57
Indigo bunting		1.37	2.44	1.85	1.10	1.70
Scarlet tanager		0.39	0.21	0.21	0.66	0.37
Red-eyed vireo		1.56	1.64	1.44	1.77	1.60
Carolina wren		0.39	0.41	0.41	0.00	0.30
Tufted titmouse		0.59	0.41	0.62	0.44	0.51
Carolina chickadee		0.78	0.41	3.08	0.66	0.54
Blue-gr. gnatcatcher		0.78	0.21	0.62	0.44	0.51
All other species		4.10	4.93	5.34	2.65	4.25
Total		12.10	12.51	21.17	11.68	14.36

Table 11. Index to bird density on railroad rights-of-way using the number of breeding males.

Species	ROW	Birds per ha				Mean
		1	2	3	4	
Rock dove		0.00	0.00	0.22	0.00	0.05
Downy woodpecker		0.06	0.03	0.18	0.09	0.07
Common grackle		0.01	0.03	0.09	0.16	0.07
American goldfinch		0.10	0.07	0.25	0.13	0.17
Song sparrow		0.07	0.09	0.13	0.54	0.21
Northern cardinal		0.07	0.02	0.23	0.22	0.14
Indigo bunting		0.53	0.79	0.90	0.60	0.70
Scarlet tanager		0.13	0.04	0.03	0.22	0.11
Red-eyed vireo		1.14	0.79	0.81	0.98	0.93
Carolina wren		0.11	0.18	0.10	0.00	0.10
Tufted titmouse		0.08	0.15	0.13	0.10	0.11
Carolina chickadee		0.11	0.06	0.15	0.19	0.17
Blue-gr. gnatcatcher		0.18	0.04	0.32	0.13	0.16
All other species		0.73	0.53	0.97	0.58	0.70
Total		3.32	2.62	4.51	3.94	3.61

Table 12. Index to bird density on railroad habitats using the highest total count.

Species	Birds per ha						
	HF	HFE	HNR	MR	RNR	RFE	RF
Rock dove	0.00	0.00	0.00	5.43	1.54	0.00	0.00
Downy woodpecker	0.33	1.67	0.00	0.00	0.00	2.50	0.69
Common grackle	0.00	0.83	0.00	0.00	0.77	3.33	1.38
Am. goldfinch	0.00	1.67	0.00	0.00	1.92	3.33	0.46
Song sparrow	0.16	0.83	0.78	0.00	0.38	3.33	1.38
N. cardinal	0.50	2.50	0.78	0.36	1.15	2.50	0.46
Indigo bunting	0.50	4.17	5.47	0.00	3.85	5.00	1.38
Scarlet tanager	0.33	1.67	0.00	0.00	0.00	0.83	0.46
Red-eyed vireo	1.83	1.67	0.00	0.00	0.38	7.50	2.53
Carolina wren	0.16	1.67	0.78	0.00	0.38	0.83	0.46
Tufted titmouse	0.50	0.83	0.00	0.00	0.38	2.50	0.69
Carol. chickadee	0.33	2.50	0.78	0.00	1.15	5.00	1.84
Bl-g. gnatcatcher	0.67	1.67	0.00	0.00	0.00	1.67	0.46
All other species	3.67	11.67	1.56	0.36	3.46	14.17	4.84
Total	8.98	33.35	10.15	6.15	15.36	52.49	17.03

HF= hill forest HFE= hill forest edge HNR= hill near ROW
MR= middle ROW RNR= river near ROW RFE= river forest edge
RF= river forest

Table 13. Index to bird density on railroad habitats using the number of breeding males.

Species	Males Per ha						
	HF	HFE	HNR	MR	RNR	RFE	RF
Rock dove	0.00	0.00	0.00	0.44	0.00	0.00	0.00
Downy woodpecker	0.03	0.14	0.00	0.00	0.00	0.28	0.08
Common grackle	0.00	0.07	0.00	0.00	0.03	0.28	0.17
Am. goldfinch	0.00	0.20	0.00	0.00	0.47	0.61	0.06
Song sparrow	0.04	0.14	0.00	0.00	0.13	0.88	0.48
N. cardinal	0.07	0.14	0.00	0.00	0.35	0.28	0.11
Indigo bunting	0.14	1.70	0.89	0.00	1.63	3.00	0.70
Scarlet tanager	0.11	0.34	0.00	0.00	0.00	0.20	0.11
Red-eyed vireo	1.02	0.48	0.00	0.00	0.03	2.31	1.92
Carolina wren	0.05	0.34	0.07	0.00	0.06	0.07	0.23
Tufted titmouse	0.08	0.14	0.00	0.00	0.06	0.47	0.21
Carol. chickadee	0.04	0.28	0.04	0.00	0.06	0.47	0.23
Bl -g. gnatcatcher	0.31	0.41	0.00	0.00	0.00	0.07	0.19
All other species	0.41	0.82	0.04	0.03	0.13	1.22	0.77
Total	2.30	5.20	1.04	0.47	3.01	10.14	5.62

HF= hill forest HFE= hill forest edge HNR= hill near ROW
MR= middle ROW RNR= river near ROW RFE= river forest edge
RF= river forest

Table 14. Index to bird density on transmission lines using the highest total count.

Species	Birds per ha			MEAN
	ROW 7	ROW 8	ROW 9	
Rufous-sided towhee	1.24	2.51	0.81	1.52
Indigo bunting	1.24	1.79	2.03	1.69
Red-eyed vireo	1.65	1.07	2.44	1.72
Black and wh. warbler	0.82	1.65	0.41	0.96
Hooded warbler	0.82	1.65	0.41	0.96
Ovenbird	1.65	1.07	1.22	1.30
Carolina chickadee	0.82	0.72	2.44	1.33
Blue-gray gnatcatcher	1.65	0.36	0.81	0.94
All other species	5.76	8.96	8.94	7.89
Total of all species	15.65	19.78	19.51	18.31

Table 15. Index to bird density on transmission lines using the number of breeding males.

Species	Males per ha			Mean
	ROW 7	ROW 8	ROW 9	
Rufous-sided towhee	0.24	0.87	0.17	0.43
Indigo bunting	0.35	0.51	0.70	0.52
Red-eyed vireo	0.76	0.92	1.04	0.91
Black and wh. warbler	0.35	0.46	0.06	0.29
Hooded warbler	0.47	0.51	0.06	0.35
Ovenbird	0.53	0.26	0.29	0.36
Carolina chickadee	0.12	0.05	0.35	0.17
Blue-gray gnatcatcher	0.59	0.36	0.41	0.45
All other species	1.00	1.08	1.62	1.23
Total	4.41	5.02	4.70	4.71

Table 16. Index to bird density on transmission line habitats using the highest total count.

Species	Birds per ha		
	ROW	Edge	Forest
Rufous-sided towhee	2.19	2.22	0.44
Indigo Bunting	2.19	4.44	0.44
Red-eyed vireo	0.00	2.22	1.78
Ovenbird	0.00	1.11	1.11
Black and white warbler	0.88	1.11	0.89
Hooded warbler	0.44	1.11	1.11
Carolina chickadee	0.44	2.22	0.67
Blue-gray gnatcatcher	0.44	2.22	0.89
All other species	7.02	3.33	5.56
Total	13.60	19.98	12.89

Table 17. Index to bird density on transmission line habitats using the number of breeding males.

Species	Males per ha		
	ROW	Edge	Forest
Rufous-sided towhee	1.25	0.63	0.16
Indigo bunting	1.07	1.43	0.19
Red-eyed vireo	0.00	0.79	1.23
Ovenbird	0.00	0.16	0.67
Black and wh. warbler	0.13	0.48	0.35
Hooded warbler	0.06	0.16	0.54
Carolina chickadee	0.06	0.32	0.13
Blue-gray gnatcatcher	0.13	0.63	0.41
All other species	1.00	2.22	1.14
Total	3.70	6.82	4.82

Table 18. Total number of bird observations on railroad rights-of-way by habitat type.

Species	HF	HFE	HNR	MR	RNR	RFE	RF	T
Rock dove	0	0	0	26**	4*	0	0	30
Downy woodpecker	3*	4	0	0	0	12**	14	33
Common grackle	0	1	0	0	2*	7	18**	28
Am. goldfinch	0	4	0	0	25**	16**	5*	50
Song sparrow	3*	1	1*	0	5	15**	25**	50
N. cardinal	5*	5	2	1	15	5	6	39
Indigo bunting	10*	32**	25	0	65**	54**	44	230
Scarlet tanager	8	6	0	0	0	3	7	24
Red-eyed vireo	74	9	0	0	1*	36**	105**	225
Carolina wren	5	5	3	0	2	1	11	27
Tufted titmouse	7	2	0	0	2	12**	13	36
Carol. chickadee	6*	9	4	0	4*	18**	24	65
B-g. gnatcatcher	23	7	0	0	0	2	10	42
A	186	102	34	28	138	208	332	1028

*= fewer observations than expected (p=0.05)

**= more observations than expected (p=0.05)

HF= hill forest HFE= hill forest edge HNR= hill near ROW

MR= middle ROW RNR= river near ROW RFE= river forest edge

RF= river forest

Table 19. Total number of bird observations on transmission line rights-of-way by habitat.

Species	ROW	EDGE	FOREST	TOTAL
Rufous-sided towhee	21**	6	7*	34
Indigo bunting	22**	9	6*	37
Red-eyed vireo	0	6	38**	44
Black and white warbler	2	3	11	16
Ovenbird	0	1	21**	22
Hooded warbler	1*	1	17**	19
Carolina chickadee	2	8**	7	17
Blue-gray gnatcatcher	4	4	13	21
All species	76	57	165	298

*= fewer observations than expected (p=0.05)

**= more observations than expected (p=0.05)

Table 20. Percentage of breeding bird survey observations by detection category.

Type	%	
	Railroad	Transmission Line
Song	60	61
Call	9	11
See	20	13
Song/see	3	3
Call/see	8	12

Table 21. Mammal species observed on rights-of-way.

Common Name	RR*	TL	Scientific Name
White-tailed deer	X	X	<u>Odocoileus virginianus</u>
Cattle	X		<u>Bos taurus</u>
Gray squirrel	X		<u>Sciurus carolinensis</u>
Fox squirrel	X		<u>Sciurus niger</u>
Eastern chipmunk	X	X	<u>Tamias striatus</u>
White-footed mouse	X	X	<u>Peromyscus leucopus</u>
Eastern woodrat	X	X	<u>Neotoma floridana</u>
Woodchuck	X	X	<u>Marmota monax</u>
Eastern cottontail		X	<u>Sylvilagus floridanus</u>
Domestic dog	X	X	<u>Canis familiaris</u>
Raccoon	X		<u>Procyon lotor</u>
Mink	X		<u>Mustela vison</u>
Opossum	X		<u>Didelphis marsupialis</u>

* RR= railroad ROW TL= transmission line ROW

Table 22. Summary of small mammal trapping (number captured during 150 trap nights per habitat type).

White-footed Mouse				
<u>Railroad</u>			<u>Transmission</u>	<u>Line</u>
Hill forest	5		Forest	7
ROW	28		Edge	4
River forest	36		ROW	1
Eastern Woodrat				
<u>Railroad</u>			<u>Transmission</u>	<u>Line</u>
Hill forest	1		Forest	0
ROW	1		Edge	1
River forest	0		ROW	0
Eastern Chipmunk				
<u>Railroad</u>			<u>Transmission</u>	<u>Line</u>
Hill forest	0		Forest	0
ROW	0		Edge	0
River forest	3		ROW	0

Table 23. Reptile and amphibian species observed on rights-of-way.

Common Name	RR*	TL	Scientific Name
Box turtle	X	X	<u>Terrapene carolina</u>
Wood turtle		X	<u>Clemmys insculpta</u>
Snapping turtle	X		<u>Chelydra serpentina</u>
Northern black racer	X		<u>Coluber constrictor</u>
Northern copperhead	X	X	<u>Aqkistrodon contortrix</u>
Northern ringneck snake	X		<u>Diadophis punctatus</u>
Northern water snake	X		<u>Natrix sipedon</u>
Black rat snake	X	X	<u>Elaphe obsoleta</u>
Five-lined skink	X		<u>Eumeces fasciatus</u>
Fence lizard	X		<u>Sceloporus undulatus</u>
Wood frog	X	X	<u>Rana sylvatica</u>
American toad	X	X	<u>Bufo americanus</u>
Red-spotted newt		X	<u>Notophthalmus viridescens</u>
Spotted salamander	X		<u>Ambystoma maculatum</u>
Jefferson salamander	X		<u>Ambystoma jeffersonianum</u>

* RR= railroad ROW TL= transmission line

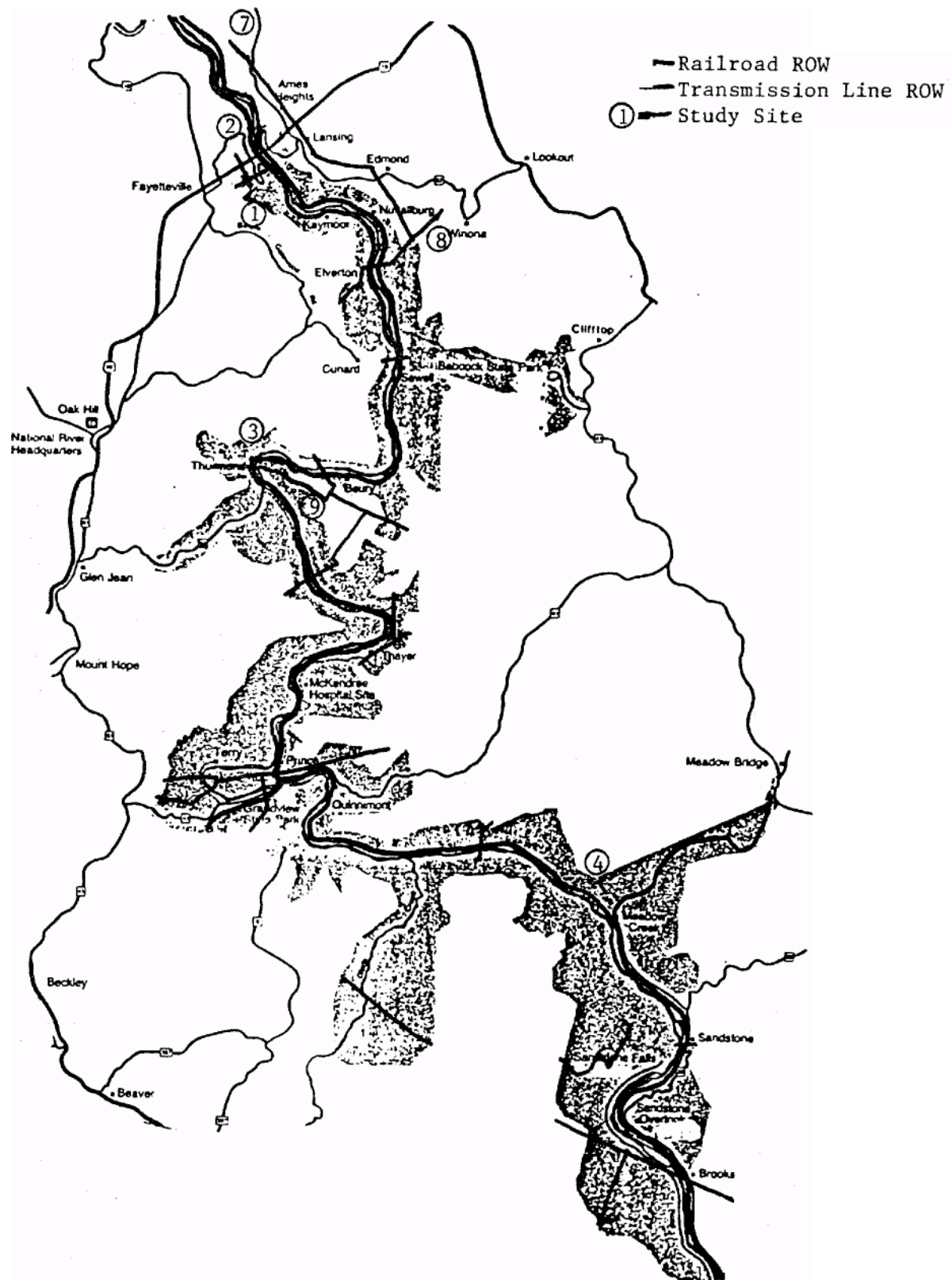


Figure 1. Location of railroad and transmission line rights-of-way on the New River Gorge National River.

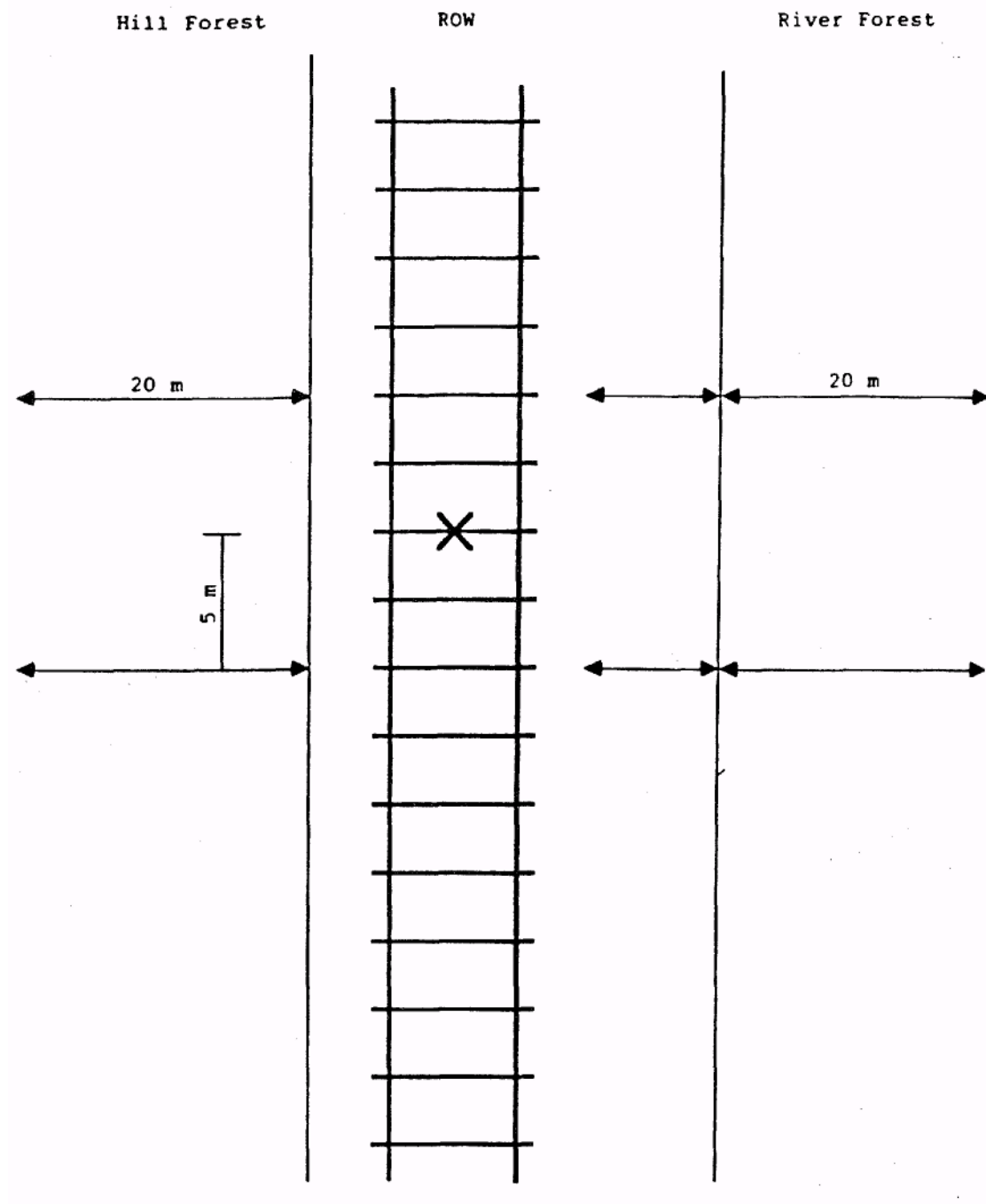


Figure 2. Location of transects used for vegetation analysis on railroad rights-of-way.

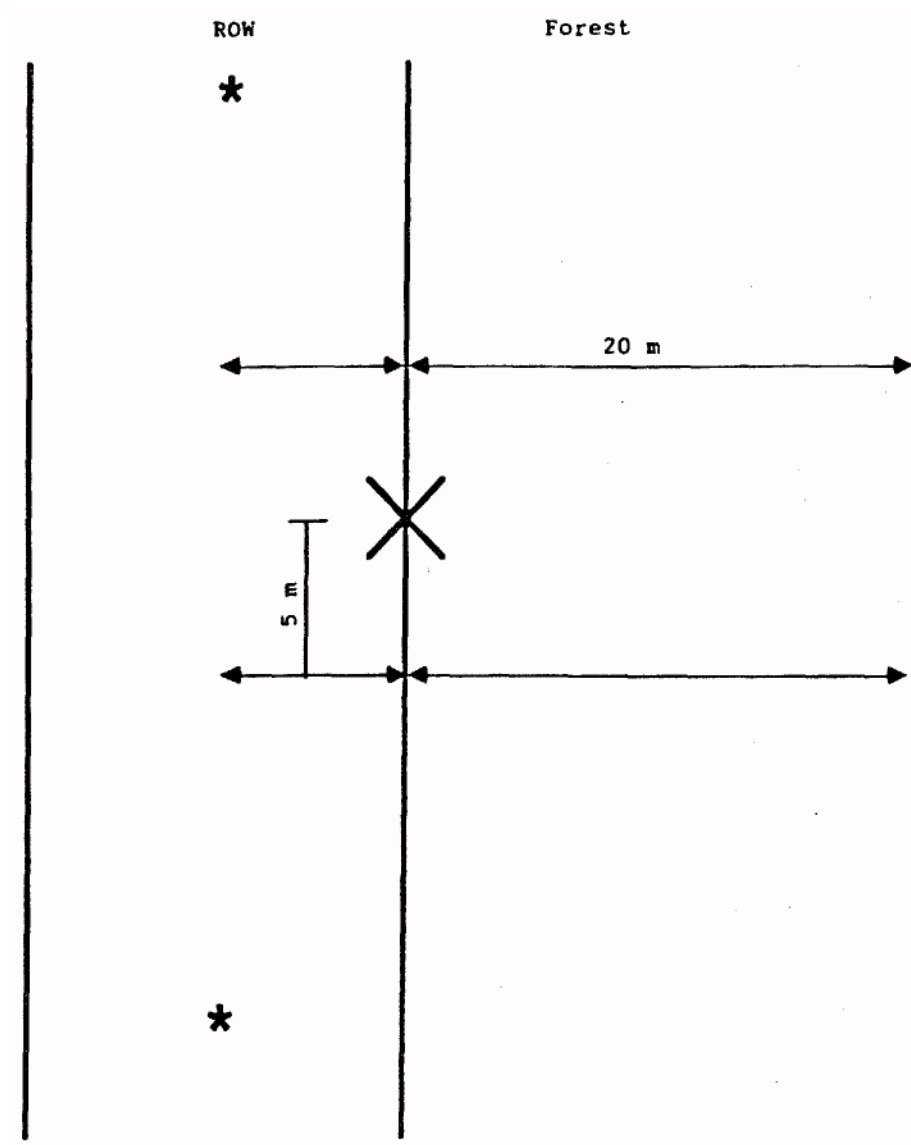


Figure 3. Location of transects used for vegetation analysis on transmission line rights-of-way.

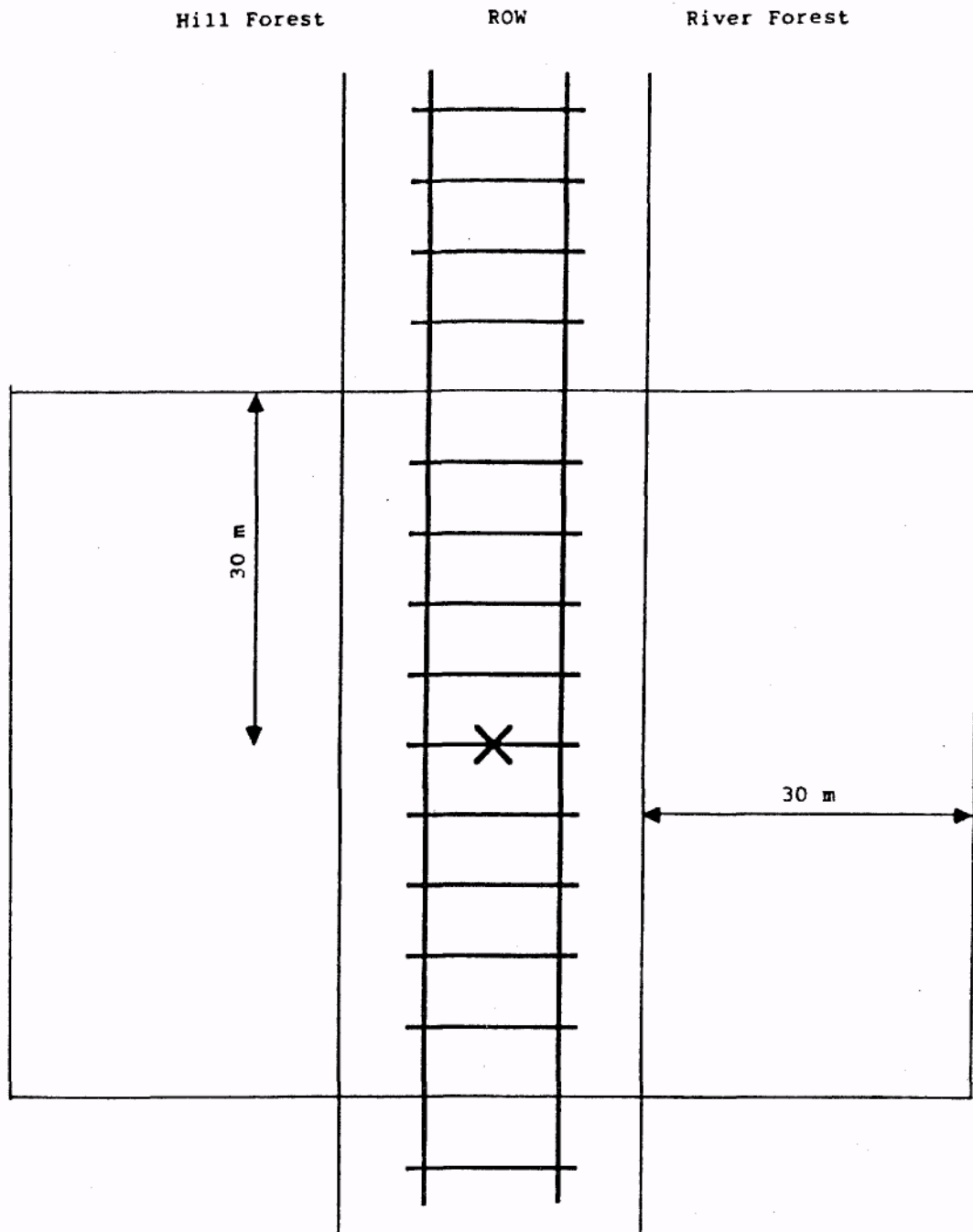


Figure 4. Plot location and dimensions for surveying breeding birds on railroad rights-of-way.

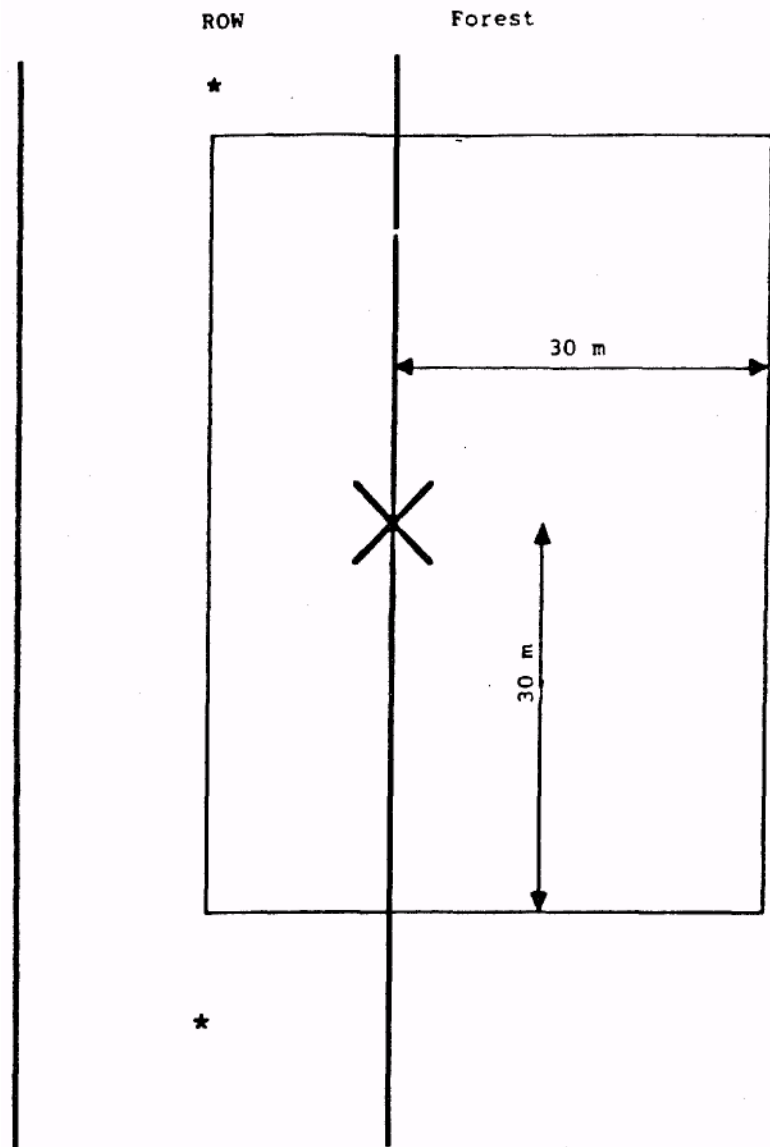


Figure 5. Plot location and dimensions for surveying breeding birds on transmission line rights-of-way.

Appendix 1. Description of vegetation variables collected on rights-of-way.

Woody	Stems <7.5 cm dbh
Tree	Stems >7.5 cm dbh
Herb	Percent of ground covered by non-woody vegetation
Fern	Percent of ground covered by ferns
Slash	Percent of ground covered by railroad ties or dead stems >7.5 cm dbh
Shrub	Percent of ground covered by stems or foliage of woody plants <1 m in height
Litter	Percent of ground covered by dead plant material
Rock	Percent of ground with exposed rock
Slope	Percent slope obtained by use of a relascope
Canopy	Percent of area covered by tree canopies

Appendix 2 . Definitions of habitats used for breeding bird surveys .

Railroad

HF= hill forest >5-30 m into the hill forest

HFE= hill forest edge Edge of mature trees to 5 m into hill forest

HNR= hill near ROW Edge of maintained vegetation on hill side to the edge of bare gravel

MR= middle ROW Bare gravel and railroad tracks in middle of the ROW

RNR= river near ROW Edge of maintained vegetation on river side to the edge of bare gravel

RFE= river forest edge Edge of mature trees to 5 m into river forest

RF= river forest >5-30 m into the river forest

Transmission Line

ROW Maintained area

Edge Edge of mature trees to 5 m into forest

Forest >5-30 m into the forest

MANAGEMENT

Introduction

Wise management of ROW can be a valuable part of the overall resource management of the NRGNR. Since these areas must be managed to provide for the needs of society, integrating management goals which increase the value of these areas for National Park Service objectives is possible.

Baseline research on the biological communities of the NRGNR and of its ROW specifically has been accomplished through the research of Buhlman and Vaughan (1987) and Michael and Voytko (1990). These studies describe the variety of biological communities occurring in the NRGNR and the species of plants and animals within these communities.

The goals of management will be to:

1. Increase wildlife species richness and diversity.
2. Reduce the amount of herbicides used to maintain ROW.
3. Improve park visitor perception of ROW.

Increase wildlife species richness and diversity through the creation of stable plant communities and the creation of a variety of vegetation succession stages. Reduce the amount of herbicides used to maintain ROW through the creation of stable plant communities, use of selective herbicide application methods, and through research to find alternative management methods and the safest and most effective herbicides. Improve park visitor perception of ROW by blending the ROW into the natural landscape as much as

possible and using ROW management as a vehicle for park visitor education.

Management will consist of 3 levels. The first level consists of small scale projects which can be accomplished by the National Park Service. The second level involves larger projects which require cooperative efforts between the "utility company" (railroad power, company, etc.) and the National Park Service. The third level consists of large scale projects which require long term management and cooperation between the utility company and the National Park Service.

Level I

Level I involves simple, small projects which the National Park Service can implement. These involve small areas which receive high visitor use and can be managed to promote management plan objectives. The National Park Service can assume responsibility for management of small areas, eliminate the use of herbicides and use selective cutting, mowing and planting to implement management plan objectives.

An example of Level I management opportunity which occurs along the railroad is a section of the railroad ROW adjacent to the town of Sewell (Fig. 1). The middle ROW must be maintained devoid of vegetation, which can be accomplished by CSX Transportation. However, the National Park Service can maintain the sides of the railroad ROW to promote

management plan objectives. To promote management objectives, implement the following 4 activities. First, remove trees only when they threaten the overhead communication lines or safe train passage. Second release and promote the native shrubs so they occupy a larger portion of the area and inhibit the growth of undesirable trees. Third, plant other native shrubs and wildflowers (Table 24). Forth remove refuse, old ties, and other debris. Although this refuse provides habitat for some species of wildlife, removing it will improve the aesthetic quality of the area and reduce the amount of creosote and other harmful chemicals entering into the ecosystem. Place a sign here to describe how the Park Service is managing this area and the objectives of management . This area receives high visitor use from white-water rafters and others who stop to visit Sewell. Visitors trespass on the ROW so an agreement on management of these visitors must first be reached between CSX Transportation and the National Park Service.

An excellent example of a Level I management opportunity exists on the Thurmond to Mindin trail. This area receives high use from day hikers. A transmission line comes down off the mountain and provides an overlook of the town of Thurmond. The area immediately visible to hikers will receive special management. To better manage this area to promote management plan objectives implement the following 3 activities. First, remove trees only when they begin to threaten the overhead transmission lines or interfere with

the view from the overlook. Second, release and promote the dogwood and rhododendron which already grow in this area so they can spread out and occupy a larger percentage of the ROW. Third, plant additional flowering shrubs and wildflowers to improve this area for visitors, especially for spring wildflower hikes. Promote park visitor perception of ROW by using this area for environmental education. Place a sign at this overlook which informs the public of ROW management techniques used in this area and the objectives of management.

Implement small projects similar to those mentioned here in other areas. When the hiking trail system is put into place, manage areas where the trains intersect the transmission line ROW similar to the example. Along the railroad, manage other small areas which receive high visitor use. These areas include the areas below Kaymoor and below Beury.

Level II

Level II involves larger projects which will work best through cooperative efforts of the utility company and the National Park service. Implement these projects in larger areas which receive high visitor use or are particularly environmentally sensitive.

Along the railroad 3 activities must be implemented to obtain management plan objectives. First, implement a non-chemical method of removing vegetation from the middle ROW.

Second, selectively remove woody vegetation through manual cutting and selective herbicide treatment on the river side of the ROW so as to increase the area controlled by desirable low growing vegetation. Third, remove refuse as stated previously. The area on both sides of the Fayette Station bridge is an excellent example of this type of management opportunity. Non-chemical removal of vegetation is possible in the middle ROW. Control vegetation in the middle ROW by hand removal. Hand removal is feasible in small areas. Treat individual plants to enable desired plants to flourish at the expense of the undesirable. Use basal spraying or cut stump treatment to reduce the amount of herbicide used and allow for the selection of individual plants for treatment. Use a modified brush hog to control vegetation on the side walls of the ROW.

On transmission lines implementation of 3 activities is needed. First, manage the central portion of the ROW to remove all vegetation except herbaceous vegetation and low growing shrubs such as blueberry while maintaining the sides of the ROW in larger shrubs and small trees. Second, maintain vegetation through the use of selective low volume herbicide techniques on the side of the ROW and through careful broadcast application from the ground in the middle of the ROW. Third, although it should rarely be necessary due to the large number of desirable, naturally growing species, plant desirable species in areas where natural regeneration is not acceptable. On ROW <20-m wide the middle

ROW should be maintained in shrubs and small trees, but on ROW >20-m wide maintain the middle ROW in herbaceous vegetation and low growing shrubs.

An example of this management opportunity occurs on the transmission line which spans the Glade Creek area. This ROW is greater than 30-m wide and contains a wide variety of plants. Maintain the sides of the ROW to promote the desired small trees which already occur in the area. When individual trees become too large, remove them. Promote herbaceous vegetation and low growing shrubs, which are already present in the middle ROW (Fig. 6). A broadcast spray may be needed to remove undesirable vegetation in the middle ROW at the beginning of the management program. Accomplish this through a ground foliar herbicide application. On the side of the ROW cut or chemically treat individual trees with a selective herbicide application as needed. If desirable plants are unable to colonize an area, completely remove the undesirable vegetation and plant desired species.

A number of areas are potential locations for Level II management. On the railroad, in addition to Fayette Station, include the area adjacent to the Prince rail station, the area north of Meadow Creek, and the area north of Thurmond. On transmission lines the transmission line ROW which crosses the river near Nuttallburg and the ROW on the mountains west of Sandstone Falls provide management opportunities.

Level III

Level III involves park-wide management of ROW. Through long term planning, management plan objectives can be accomplished. First, a trend toward safer and more effective herbicides. Second, a move toward a change in management of all ROW throughout the NRGNR in addition to those mentioned previously. Third, long range planning. Fourth, a commitment to decrease the overall amount of herbicides used to maintain ROW with a goal of completely eliminating their use. Fifth, the removal of all above ground communication line along the railroad. Sixth, the National Park Service must assume leadership for all ROW management.

Staying abreast of the latest research into safer and more effective herbicides is a key to long range management. The ideal herbicide is one which:

1. Breaks down into safe products soon after application.
2. Contains carriers and adjuvants which also break down into safe products soon after application.
3. Has low toxicity (both acute and chronic) to both man and wildlife.
4. Effectively kills target vegetation on the first treatment with a minimum dose.
5. Does not move from the side of application.

Table (25) provides a current list of the safest herbicides. Review this list annually and add or remove herbicides as new research indicates.

A change in the way all ROW are managed is a key to

successful implementation of management objectives. Manage ROW as part of the entire ecosystem. Manage all areas with the goal of creating a stable plant community which will resist invasion by undesirable species. Not all areas in the NRGNR were mentioned previously, but as resources and technology permit, implement changes in management in all areas to obtain management plan objectives.

ROW will be with us for a long time and ecosystems last for thousands of years. Therefore, long rang planning is vital. Vegetation types occurring on all ROW should be inventoried and mapped. Inventories and mapping should be redone at least once every 5 years. Plan which plant communities are desired in each area in 20 years. Then implement the necessary management programs needed to create the desired plant community. The desired plant community must be ecologically and technically feasible, while allowing for the safe and effective use of the ROW by the utility company.

There must be a commitment by all parties to reduce and eventually eliminate the use of herbicides. A goal of reducing herbicide use by 25% every 10 years until no herbicides are used is a realistic and achievable goal. Through ecologically sound management which creates stable plant communities and research into alternatives to herbicides, this goal can be achieved.

Removal of communication lines along the railroad will greatly lessen the need for vegetation management. Burying

communication lines is feasible and has been done in many areas of the country. Encourage CSX Transportation to make the removal of overhead communication lines in the NRGNR a high priority.

The National Park Service must make a serious commitment of leadership in managing all ROW. Since the National Park Service is responsible for protecting the natural environment of the NRGNR they must be the leader in the management of the natural environment.

Other Types of ROW

Telephone and road ROW are less common in the NRGNR than transmission line or railroad ROW. No herbicides are currently used to maintain telephone ROW. Manual cutting is done on an as needed basis. Many telephone line ROW contain tall woody vegetation and are not maintained in a clear ROW. This makes alternative management unnecessary.

Adjacent to roads, vegetation must be cleared to maintain visibility for motorists. On local roads, such as the road to Fayette Station, this is done with a mower mounted on a backhoe. On route 19 and I 64 mowing and herbicide application are used. Use mowing to maintain vegetation in most areas. Herbicides are usually used around guard rails. Maintain the guard rails by hand removal of vegetation.

Future Alternatives to Herbicides

New methods of managing vegetation are constantly being developed. Growth regulators are being developed which suppress plant hormones to reduce the growth of trees while still keeping them healthy. Growth regulators are currently being used in the field to maintain street trees in urban areas. New research has provided a means to apply growth regulators to the soil thus permitting their use on ROW. Lasers are being developed which will trim trees from a distance. This technology is currently feasible, but has safety problems and is extremely expensive. Very recently a new mower which walks on 5 legs and can be used on extreme terrain has come onto the market. It could potentially be used in the NRGNR. In the long term, research into ecological succession will eventually enable ROW managers to eliminate the need for chemical or mechanical vegetation maintenance. Promising research is occurring in the areas of allelopathic plants and stable plant communities. Ecological research is the key to better management of ROW. The National Park Service should promote this type of research on the NRGNR. Current technology is available to maintain the middle of the railroad ROW without the use of herbicides. Vegetation could be burned in the middle ROW. A burner could be placed on a rail car and sent down the tracks. Research into fire prevention and the best times to burn the ROW are necessary. A ballast regulator can clean the rock base of

dirt and plants, however, to use it to maintain vegetation would be expensive as this machine will damage the ties and other track structures. Research into design modifications may enable its use for vegetation management.

Educational Opportunities

ROW provide many opportunities for educating the public on a wide range of environmental topics. Basic ecological principles such as succession, edge, forest fragmentation, and community stability can be discussed. Opportunities exist to educate the public on the various methods used to manage ROW. Inform the public of the positive and negative aspects of management and the ecological principles used in ROW management. Opportunities also exist to inform the public of how specific management practices benefit or hinder the wildlife of the New River Gorge. Place signs describing these ecological and management principles wherever hiking trails cross ROW. When park rangers are giving guided hikes, discuss these same topics.

Evaluation

For a management plan to be effective it must be evaluated at regular intervals to determine if modifications are needed. Evaluate the first management objective, and increase in wildlife species richness and diversity, by repeating segments of this study at 5-year intervals after implementation of the management plan. Future inventories

should show a rise in the number of species and the number of individuals of birds, mammals, reptiles, and amphibians. To evaluate this objective, repeat the breeding bird survey and the mammal trapping as was done in the wildlife inventory. Survey breeding ponds for amphibian eggs noting the species, number of egg masses, and number of ponds used. Maintain records of the amount of herbicides used and the amount of ROW treated to evaluate if the second management objective is being reached successfully. Management will have been successful if a 25% reduction in the use of herbicides is obtained every 10 years. Evaluate the third management objective by conducting interviews and surveys of park visitors to determine if their perception of ROW is more positive. Conduct surveys at least every 5 years. Surveys should indicate that ROW on the NRGNR are less noticeable and are less intrusive on park visitor enjoyment.

With long range goals and a commitment to the implementation of a ROW Management plan as part of the overall resource management of the NRGNR the value of ROW can increase. Management of ROW is a long term project which will not see substantial benefits in only a few years. With the leadership of the National Park Service and the positive cooperation of the utility companies, ROW management on the NRGNR can be improved to benefit both man and the environment.

LITERATURE CITED

- Buhlman, K., and M. Vaughan. 1987. Biological survey of the New River Gorge National River Volume 2. NFS Resource Protection Mid-Atlantic region. 120pp.
- Michael, E. D., and R. A. Voytko. 1990. Wildlife inventory of railroad and transmission line rights-of-way on the New River Gorge National River. Unpublished.

Table 1. General list of plants to be promoted on all types of ROW.

Common Name	Scientific Name
Aster	Aster
Blackberry	<u>Rubus spp.</u>
Dogwood	<u>Cornus spp.</u>
Eastern Redbud	<u>Cereis canadensis</u>
Eastern redcedar	<u>Juniperus virginiana</u>
Elderberry	<u>Sambucus spp.</u>
Ericaceus shrubs	Ericaceae
Goldenrod	Solidago
Grape	<u>Vitis spp.</u>
Greenbrier	<u>Smilax rotundifolia</u>
Hawthorn	<u>Crataegus spp.</u>
Hercules club	<u>Aralia spinosa</u>
Hophornbeam	<u>Ostrya virginiana</u>
Holly	<u>Ilex spp.</u>
Hydrangea	<u>Hydrangea arborescens</u>
Mountain maple	<u>Acer spicatum</u>
Native apples	<u>Malus spp.</u>
Native roses	<u>Rosa spp.</u>
Scrub oak	<u>Quercus ilicifolia</u>
Serviceberry	<u>Amelanchier spp.</u>
Spicebush	<u>Lindera benzoin</u>
Striped maple	<u>Acer pensylvanicum</u>
Sumac	<u>Rhus spp.</u>

Table 1. continued.

C	Scientific Name
Viburnums	<u>Viburnum spp.</u>
Virginia creeper	<u>Parthenocissus quinquefolia</u>
Which-hazel	<u>Hamamelis virginiana</u>

Table 2. List of recommended herbicides for use in the New River Gorge National River.

Active Ingredient	Trade Name
Dicamba	Banvel CST
Fosamine ammonium	Krenite S
Glyphosate	Accord, Rodeo, Roundup
Imazapyr	Arsenal
Metsulfuron methyl	Escort

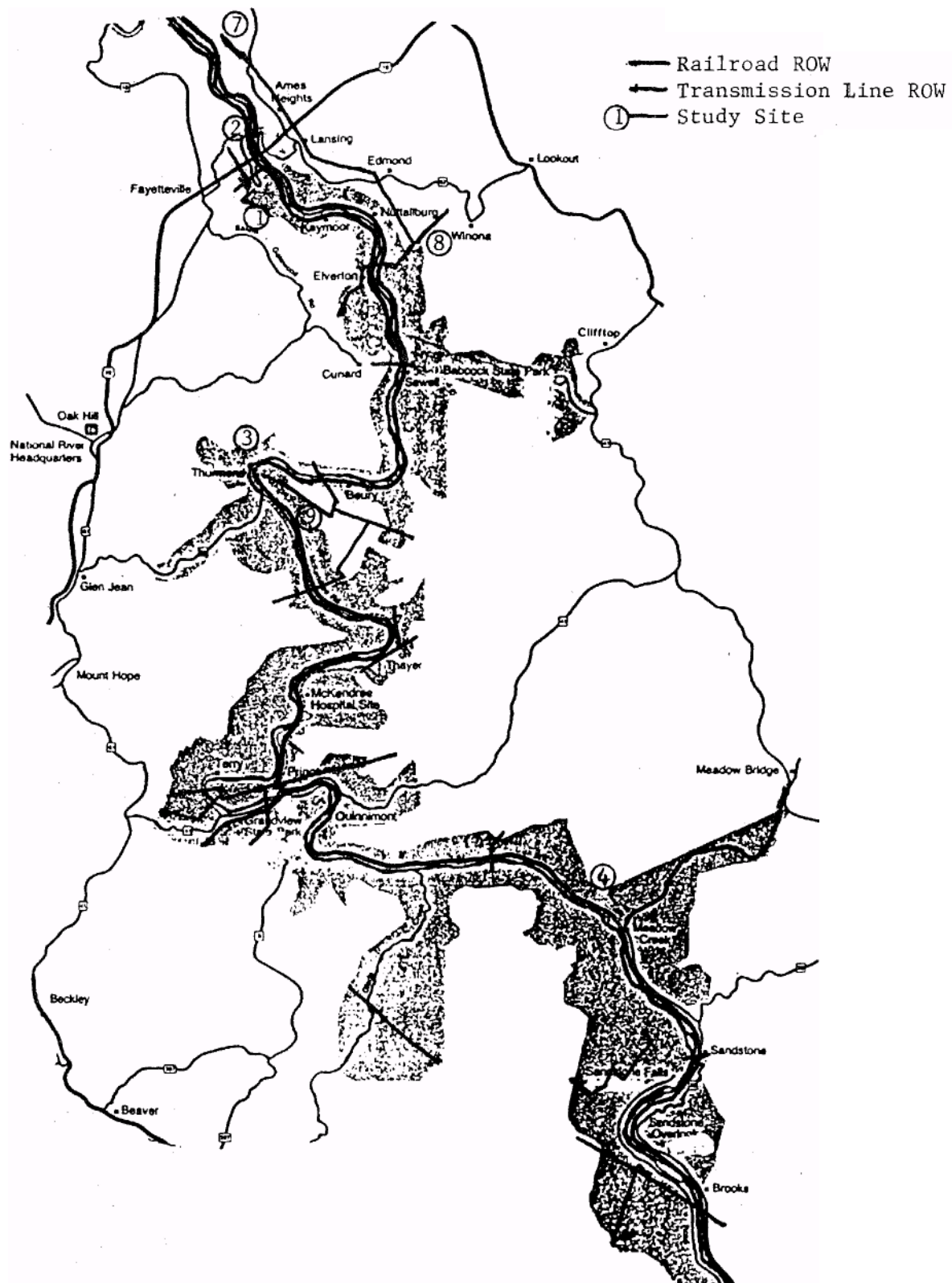


Figure 1. Location of railroad and transmission line rights-of-way on the New River Gorge National River.

Forest 

Shrub 

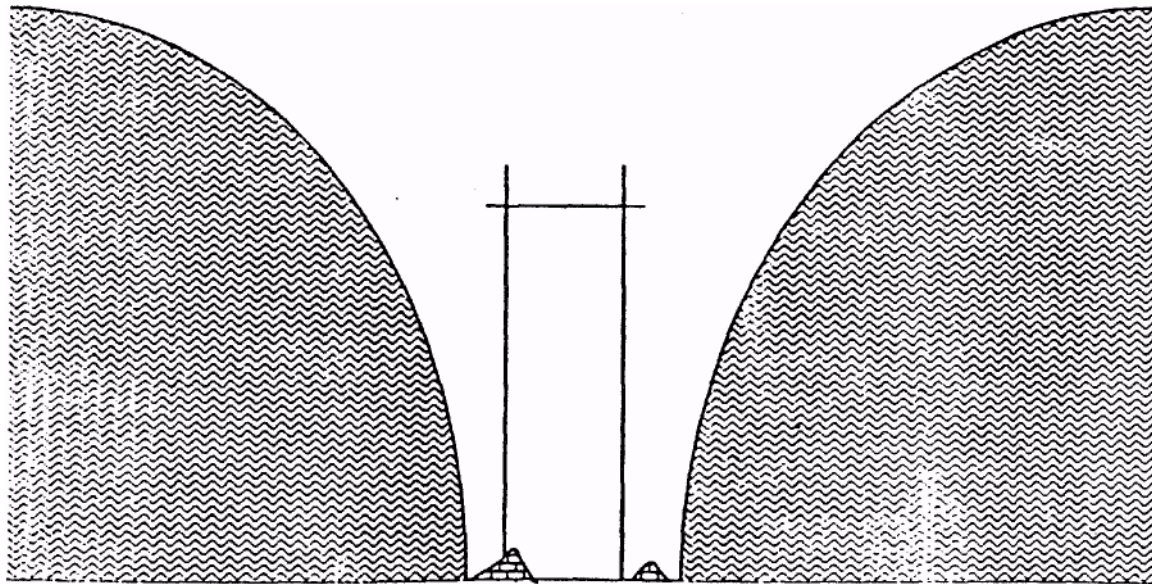


Figure 2. A cross section of the Glade Creek transmission line ROW 20 years after the beginning of management. Shrubs and grasses dominate the middle ROW while on the sides small trees gradually give way to mature forest.