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RAILROAD RIGHTS-OF-WAY AS WILDLIFE HABITAT IN IOWA

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ABSTRACT.--Populations and habitat associations of birds and mammals were evaluated from September 1977 through August 1978 on about 5 percent of the railroad rights-of-way (ROWs) in Story County, Iowa, where land use is typical of the northern half of the state. About 85 percent of the county's 368,640 acres (149,299 ha) was in cultivation, whereas only 9 percent of rural Story county was in permanent vegetation. About 5 percent [1,535 acres (622 ha)] of this permanently vegetated cover was on railroad ROWs. In the most intensively farmed part of the county, about 10 percent of the permanently vegetated cover and 30 percent of the shrubby habitat occurred on the ROWs. An estimated 81 percent of the prairie remnants in rural Story County occurred on railroad ROWs. The numbers of shrubs, trees, and annual forbs were important habitat components that affected densities and diversities of animal populations on ROWs. The ROWs were used by several locally scarce species. At least four mammal species utilized the railroads as travel corridors.

Intensive agriculture has caused serious decreases in wildlife habitat in the midwestern United States (Graber and Graber 1963, Mohlis 1974, Vance 1976). Often the habitat that is left is confined to narrow stream margins and transportation corridors. With the increasing intensification of agriculture and current abandonment rate of railroad lines, information on the value of railroad ROWs to wildlife is needed.

We investigated habitat structure relative to bird and mammal use along railroad ROWs in Story County, Iowa. Story County is typical of intensively farmed central and northern Iowa, and an extensive land-use study of the county has been completed (Taggart 1974). Our specific objectives were

to: (1) inventory the kinds and numbers of birds and mammals that utilized habitats found along railroad ROWs in Story County, (2) associate bird and mammal use with specific ROW habitats, and (3) assess the relative importance of railroad ROWs as wildlife habitat in Story County.

STUDY AREA AND METHODS

All of the county's active (railroads in use) and abandoned ROWs, except those segments passing through towns, were considered. These rural ROWs were stratified into active and abandoned categories for the purpose of selecting sampling plots. In each sampling stratum, the ROWs were divided into 0.25 mi (0.4 km) segments and were numbered serially. Sampling plots were then selected by generating random numbers on a programmable electronic desk calculator. Additional plots were selected to sample unique habitats: exceptional relict prairie (1 plot), ROWs with adjacent wetlands (2 plots), and ROWs with adjacent woodlands (1 plot). A total of 20 plots [in area about 5 percent of the 103 miles (155 km) of rural railroad ROWs in the county] were sampled for bird and mammal use. Each sampling plot occupied the width of the ROW [typically 100 ft (30.5 m)], and all but one were 0.25 mi (0.4 km) in length. The single exception was about 300 ft (92 m) wide and 500 ft (152 m) long, and the change was made because of the very large ROW width.

A cover map, on which vegetational patches were outlined, was made of each ROW plot during summer 1977, and the patches were rechecked during summer 1978 for phenological changes. The common plant species of each patch were identified but not quantified. Locations of shrubs, trees, and other large objects were marked on maps. Vegetative cover types of the land adjacent to the plots and the amount of snow cover and train activity on the plots were also recorded. Vegetation percentages on each plot were determined by placing a grid, with 436 evenly spaced line intersections per acre, randomly over each cover map. The ratios of intersections in each vegetation type to the total number of intersections in the plot were then calculated. Indices to the numbers of shrubs and trees on the plots were formulated by counting the number of grid squares [scale = 4 yd

by 4 yd (3.6 m by 3.6 m)] which contained woody vegetation.

Bird and mammal censuses were initiated in September 1977 and continued through August 1978. The bounded count method (Robson and Whitlock 1964) was used to estimate population densities for bird species seen on the plots. On each count, the researcher walked through the plot and recorded on a copy of the vegetation cover map the species and location of each bird observed. Aerial-foraging birds, such as swallows, were also recorded. Efforts were made to spend approximately 45 min in each plot during a count. Five or six counts (replicates) per plot were obtained in each sampling period. Replicate counts on each plot were made at different times of the day. Shannon and species richness diversity indices (Poole 1974) were calculatd for the bird communities of each plot for each census period.

Raptor surveys were conducted by slowly driving highways nearest to all the rural railroads. Raptors observed were identified and recorded as being either on or off the railroad ROW. Binoculars and a 20-power spotting scope were used.

Small mammal populations were sampled by snap-trapping during autumn when numbers for most species were probably high. Methods generally followed those described by Smith et al. (1975). Trapping stations were placed approximately 50 ft (15 m) apart with 12 stations per sampling plot along a line roughly parallel to the tracks. Three snap traps were placed at each station. Except on three plots, the side of the tracks to be trapped was decided by a coin flip. The exceptions included two plots where one side of the tracks was avoided because of a narrow ditch. In a third instance, one side of the plot was selected to sample an exceptionally good stand of native prairie. Traps were set for a 5-day period and checked daily.

Accurate estimates of small mammal density require more sophisticated approaches than our trapping design (Smith et al. 1975). Thus, the results of our small mammal trapping should be considered as relative rather than absolute measures of density. Shannon and species richness indices (Poole 1974) were calculated for the small

mammal communities.

Eastern cottontails (Sylvilagus floridanus) were censused simultaneously with the bird counts by the bounded count method. Presence of ground squirrels (Spermophilus spp.) was determined by live-trapping during summer. Plains pocket gopher (Geomys bursarius) populations were estimated on each study plot by counting the number of sets of fresh mounds and assuming one gopher per each set of mounds (Mielke 1977, Reid et al. 1966). Dens, droppings, trails, and other signs of mammal activity on the plots were recorded in the course of other field work.

Analyses of variance, Duncan's multiple range tests, and Pearson's correlation coefficients were used to test the various relationships of population densities and community diversities versus ROW habitat characteristics. Level of significance for all tests was $P \leq 0.05$.

RESULTS

Censusing

A total of 119 bird species was recorded on the railroad ROW study plots, amounting to 47 percent of the species normally found in Story County. Of these, 66 species (26 percent of the number normally found in the county) occurred consistently in one or more of the study plots for at least one census period. Bird density was highest on the ROWs during fall with the lowest numbers occurring in spring (Table 1). Winter densities were influenced by large numbers of snow buntings (Plectrophenax nivalis), pheasants (Phasianus colchicus), and quail (Colinus virginianus).

The pheasant, rock dove (Columba livia), flicker (Colaptes auratus), downy woodpecker (Picoides pubescens), blue jay (Cyanocitta cristata), crow (Corvus brachyrhynchos), black-eyed chickadee (Parus atricapillus), starling (Sturnus vulgaris), house sparrow (Passer domesticus), meadowlark (Sturnella spp.), cardinal (Cardinalis cardinalis), and song sparrow (Melospiza melodia) were recorded on at least one of the study plots during every census period (Table 2). Many of these species occurred on the fewest number of plots in winter,

Table 1. Numbers of bird species and estimated densities by taxonomic order and season of the year along a typical 10 miles (16.1 km) of railroad right-of-way in Story County, Iowa.

	Fall		Winter		Spring[a]		Summer	
	Spp.	Density	Spp.	Density	Spp.	Density	Spp.	Density
Falconiformes	2	8	0	--	1	9	0	--
Galliformes	1	130	2	172	2	92	2	40
Columbiformes	2	136	1	88	2	37	2	102
Cuculiformes	0	--	0	--	1	4	2	56
Strigiformes	2	8	0	--	1	4	0	--
Apodiformes	1	16	0	--	1	11	1	40
Piciformes	4	58	4	18	3	57	5	88
Passeriformes	25	3490	15	2679	42	1974	35	2288
Other[b]	2	20	0	--	2	15	3	28
TOTALS	39	3866	22	2957	55	2203	50	2642

[a]Estimates made from 3 separate censuses in early spring, mid-spring and late spring.

[b]Includes Ciconiiformes, Gruiformes, Charadriiformes, Caprimulgiformes, and Coraciiformes.

Table 2. Frequency of occurrence of principal bird species on railroad ROWs in Story County, Iowa, 1977-1978[a].

	Frequency of occurrence (%) by census period			
	Fall	Winter	Spring[b]	Summer
American kestrel	5	0	10	0
Ring-necked pheasant	75	30	55	20
Mourning dove	5	0	15	55
Rock dove	10	10	15	20
Cuckoo spp.	0	0	5	45
Chimney swift	5	0	10	40
Common flicker	25	5	25	35
Red-headed woodpecker	0	0	15	35

Table 2. (continued)

	Frequency of occurrence (%) by census period			
	Fall	Winter	Spring[b]	Summer
Downy woodpecker	30	5	15	15
Eastern kingbird	0	0	10	55
Horned lark	0	15	20	10
Tree swallow	0	0	10	5
Barn swallow	5	0	35	95
Blue jay	5	5	10	10
Common crow	5	5	25	10
Black-capped chickadee	10	25	15	15
House wren	5	0	10	10
Gray catbird	0	0	10	35
Brown thrasher	0	0	20	45
American robin	35	0	45	65
Starling	10	15	25	35
Yellow-rumped warbler	20	0	10	0
Common yellowthroat	0	0	20	90
House sparrow	55	40	55	85
Meadowlark spp.	10	15	45	35
Red-winged blackbird	20	0	80	100
Northern oriole	0	0	10	30
Common grackle	0	0	30	70
Brown-headed cowbird	0	0	55	75
Cardinal	20	20	20	15
Rose-breasted grosbeak	0	0	5	15
Indigo bunting	0	0	5	35
Dickcissel	0	0	5	50
American goldfinch	50	15	15	70
Savannah sparrow	35	0	5	0
Grasshopper sparrow	0	0	10	5
LeConte's sparrow	25	0	0	0
Vesper sparrow	25	0	30	55
Dark-eyed junco	75	25	25	0
Tree sparrow	65	25	20	0
Harris' sparrow	40	0	5	0
White-crowned sparrow	35	0	5	0
White-throated sparrow	30	0	10	0
Fox sparrow	30	0	15	0
Lincoln's sparrow	20	0	10	0
Swamp sparrow	25	0	5	0
Song sparrow	90	20	70	85
Snow bunting	0	30	5	0

[a]Only species which occurred on 4 or more of the 20 study plots in at least one census period are listed. Five or six replicate counts were made in each plot in each census period. Values given are percentages (number of plots a species occurred on divided by number of plots censused x 100).

[b]Estimates made from 3 separate censuses in early spring, mid-spring, and late spring.

but frequency of the chickadee was highest during winter. The house sparrow, pheasant, and snow bunting occurred on the largest number of plots in winter. The snow bunting, which usually occurred in large flocks, had the highest winter densities.

Migrant species, which occurred on at least 20 percent of the plots during at least one census period, were the American kestrel (Falco sparverius), yellow-rumped warbler (Dendroica coronata), savannah sparrow (Passerculus sandwichensis), LeConte's sparrow (Ammospiza leconteii), Harris' sparrow (Zonotrichia quercula), white-crowned sparrow (Z. leucophrys), white-throated sparrow (Z. albicollis), fox sparrow (Passerella iliaca), Lincoln's sparrow (Melospiza lincolni), and swamp sparrow (M. georgiana) (Table 2.)

During summer, the red-winged blackbird (Agelaius phoeniceus), barn swallow (Hirundo rustica), common yellowthroat (Geothlypis trichas), house sparrow, and song sparrow occurred on the largest number of plots (Table 2). The red-wing also had the highest density. Although the pheasant was recorded on fewer plots and at lower densities in summer than at other times of the year, the species was possibly underestimated because of the very secretive nature of nesting hens.

The nests of 17 bird species were discovered on the study plots, and cowbirds (Molothrus ater) parasitized at least 34 percent of 50 red-winged blackbird nests found. Ten other species had singing males with territories limited largely to the ROWs. Another seven species had territories which included the ROW and much of the adjacent habitat.

Raptors were most numerous in early spring. There were 0.8 raptor observed per 10 mi (16.1 km) of railroad and 1.0 "nonrailroad" raptor per 10 mi of highway driven. Since much more nonrailroad habitat was surveyed than railroad habitat, there were an estimated 40.0 raptors per 10 mi^2 (259 km^2) of railroad ROW while only 1.3 per 10 mi^2 of nonrailroad habitat. Kestrels and red-tailed hawks (Buteo jamaicensis) were equally abundant on the ROWs. Although marsh hawks (Circus cyaneus) were fairly common in the county during spring, none were observed on railroad ROWs. Marsh hawks hunt in flight whereas red-tailed hawks and kestrels usually hunt from a perch (Heintzelman 1964, Zarn 1975). Possibly the narrow

ROWs were suitable hunting sites for perching birds-of-prey but not for marsh hawks.

A total of 28 mammal species, of which three were domestic, were recorded in the study plots (Table 3). Excluding bats, this was 66 percent of the nondomestic species expected to occur in Story County (Bowles 1975). The domestic dog (*Canis familiaris*), plains pocket gopher, deer mouse (*Peromyscus maniculatus*), and Eastern cottontail rabbit were each found on at least 90 percent of the plots. Seventeen other species occurred on 20 to 90 percent of the plots.

Table 3. Frequencies (number of plots the species occurred on divided by number of plots censused x 100) of all mammals observed on 20 railroad ROW study plots, Story County, Iowa.

Species	Frequency
Opossum	5
Eastern mole	30
Short-tailed shrew[a]	55
Masked shrew[a]	30
Raccoon	50
Weasel	15
Striped skunk	30
Badger	35
Domestic dog	90
Red fox	30
Domestic cat	25
Woodchuck	20
Franklin's ground squirrel	20
Thirteen-lined ground squirrel	45
Fox squirrel	20
Pocket gopher	95
Beaver	5
Muskrat	5
House mouse[a]	85
White-footed mouse[a]	85
Deer mouse[a]	95
Harvest mouse[a]	75
Meadow vole[a]	70
Prairie vole[a]	5
White-tailed jackrabbit	5
Cottontail rabbit	95
White-tailed deer	55
Domestic cow	10

[a]Captured in snap traps

Eastern cottontail rabbits were found year-round with frequency of occurrence varying from 25 to 65 percent of the plots in any one census period (Table 4). Density remained close to one rabbit per plot throughout the study.

Table 4. Frequency of occurrence and density ($\hat{N}$) of cottontail rabbits occurring on railroad ROWs in Story County, Iowa 1977-1978.

Census period	Frequency[a]	Density[b] $\hat{N}$ (80% C.L.)
Fall	65	72 ± 18
Winter	40	46 ± 19
Spring[c]	30	47 ± 24
Summer	40	40 ± 16

[a]Frequency is the percent of 20 study plots on which rabbits are recorded.

[b]Density was estimated by the bounded count method and is the number of individuals per 10 mi (16.1 km).

[c]Estimates made from 3 separate censuses in early spring, mid-spring and late spring.

The deer mouse was the most common of eight species of small mammals captured on the study plots (Table 3). Shrews were less commonly taken than most other species, but this may have been due to the difficulty in capturing shrews with snaptraps (Smith et al. 1975). Only one prairie vole (Microtus ochrogaster) was captured. In contrast, meadow voles (M. pennsylvanicus) were common.

There was an average of 3.2 pocket gophers per study plot during the summer, and all except one of the 20 study plots contained gophers. The thirteen-lined ground squirrel (Spermophilus tridecemlineatus) was captured on 45 percent of the plots whereas the Franklin's ground squirrel (S. franklinii) was captured on 20 percent of the plots.

Winter distributions of 12 species of animals were evaluated by recording relative track density

and frequency (Table 5). Pheasant tracks were regularly recorded on 35 percent of the plots. This closely agreed with the 30 percent frequency of occurrence estimated by the bounded count census (Table 2). Cottontail tracks occurred regularly on 60 percent of the plots as compared to 40 percent frequency estimated by the bounded count (Tables 4 and 5). Since deep snow probably inhibited the flushing of rabbits from burrows dug into the snow, the track distribution was the more accurate analysis. The only other species with a high frequency of tracks was the domestic dog (Table 5). The striped skunk (Mephitis mephitis), badger (Taxidea taxus), and white-tailed jackrabbit (Lepus townsendii) were common on one or two plots each. Other species whose tracks were regularly seen were the weasel (Mustela spp.), the red fox (Vulpes fulva), fox squirrel (Sciurus niger) and white-tailed deer (Odocileus virginianus). The regular use of one plot by raccoons (Procyon lotor) may have been incidental to the plot's proximity to a corn stubble field and wetland.

Table 5. Frequency of occurrence of tracks and other signs of pheasants and mammals observed on railroad ROWs in Story County, Iowa, winter 1977-1978.

Species	Frequency[a] of Occurrence[b]			
	Very Common	Common	Uncommon	Absent
Ring-necked pheasant	5	30	35	30
Raccoon	0	5	0	95
Weasel	0	5	10	85
Striped skunk	10	0	5	85
Badger	5	0	0	95
Domestic dog	15	35	40	10
Red fox	0	5	20	75
Domestic cat	0	0	5	95
Fox squirrel	0	15	5	80
White-tailed jackrabbit	5	0	0	95
Cottontail rabbit	35	25	15	25
White-tailed deer	0	5	0	95

[a] Frequency is the percent of 20 study plots on which a species' sign was recorded.

[b] Very common--sign observed over most of plot and during several replications; common--sign observed only in limited area of plot but seen during several replications; uncommon--sign observed only in limited area of plot and during one or two replications; Absent--no sign observed.

Habitat Relationships

Classification of sampling plots. Sampling plots were classified according to four habitat types based on results of the grid-overlay analysis of the cover maps (Table 6). These were grass (7 plots), grass-annual (7 plots), shrub (5 plots), and woodland (1 plot). Plots classified as grass-annual had annual forbs covering greater than 20 percent of the plot. Plots with at least 10 percent of the plot in woody growth not over 12 ft (3.7 m) tall were classified as shrub.

Table 6. Vegetative cover found on railroad ROW study plots with each assigned to one of 4 habitat types.

Vegetative Classes	Habitat Types[a]			
	Grass (7)	Grass-annual (7)	Shrub (5)	Woodland (1)
Alien grasses	55.6	72.2	47.2	25.2
Native grasses	36.4	35.5	33.2	33.0
Annuals[b]	11.2	33.5	34.6	33.4
Forbs[c]	15.2	9.0	9.6	0.2
Shrubs	1.6	1.2	20.2	4.4
Trees	0	0	2.4	32.2
Wetland	1.6	1.0	1.1	5.2
Barely vegetated	20.4	7.8	8.4	15.7
Other	14.0	17.4	12.5	3.4

[a]The number of plots in each habitat type is in parentheses. Values represent means of percent areal coverage of each vegetative class relative to total plot area.

[b]Annuals are largely early successional nongrass herbs.

[c]Forbs are largely nongrass herbs not typical of early succession.

Land adjacent to the study plots was planted chiefly in corn and soybeans. Except during the growing season, this cropland was usually without

vegetative cover. Legume hay and grass made up 16 to 17 percent of the adjacent land use. Native vegetation (woodland, shrub, prairie, and wetland) was uncommon. Adjacent land use was least varied in May when bare ground comprised 73 percent of the plots' perimeters.

Birds and habitat. Bird species diversity indices tended to be higher in the woodland and shrub plots than in the grass and grass-annual plots (Table 7). Indices were always highest in the woodland plot except during fall when shrub plots had a higher average Shannon index. This was due to a large population of juncos (Junco hyemalis) in the woodland plot. A decline in diversity from fall to

Table 7. Bird species diversity and richness on railroad ROWs in Story County, Iowa, 1977-1978, by census period and habitat type.

Habitat	N	Census Period[a]					
		Fall	Winter	Early Spring	Mid-Spring	Late Spring	Summer
Shannon Index:							
Grass	7	A 0.544	A 0.169	A 0.342	A 0.776	A 0.912	A 0.953
Grass-annual	7	A 0.738	A 0.193	A 0.489	AB0.912	A 0.950	A 1.018
Shrub	5	B 1.020	A 0.539	A 0.827	B 1.011	AB1.153	B 1.248
Woodland	1	A 0.697	A 0.810	A 0.936	C 1.337	B 1.547	B 1.362
S.D.		0.194	0.285	0.247	0.130	0.199	0.120
Species Richness:							
Grass	7	A 5.4	A 2.1	A 3.4	A 7.8	A 10.3	A 10.7
Grass-annual	7	A 8.6	A 2.1	A 4.7	A 9.8	A 11.3	A 13.7
Shrub	5	B17.0	A 6.2	B11.0	B15.2	B 23.8	B 23.[illegible]
Woodland	1	B20.0	A 8.0	B14.0	C24.0	C 38.0	B 28.0
S.D.		3.3	2.7	3.1	2.3	4.8	3.7

[a]Mean values for each census period are based on the number of plots (N) in each habitat type; standard deviations are estimated for the entire sample. In any one census period, means with the same letter are not significantly different (Duncan's multiple range test $P \leq 0.05$).

winter was followed by a gradual rise in spring with the largest values recorded during summer. The diversity indices generally were positively correlated with the numbers of shrubs, trees, and annual forbs. In fall and early spring, species richness was negatively correlated with the amount of alien grass on the plots.

During fall, species richness was negatively correlated ($r = -0.44$) with the amount of bare ground adjacent to the plots. During winter, species richness was positively associated with a lack of deep, drifted snow. Heavy snow cover was negatively correlated with the number of trees ($r = -0.52$) or shrubs ($r = -0.62$) on the plots. In each census period, population densities of several bird species were also positively correlated with the number of shrubs, trees and/or annual forbs on the study plots.

Mammals and habitat. When all mammals were considered, the woodland habitat contained a significantly lower number of species (9.0 per plot) than did shrub (13.0 per plot) and grass (11.7 per plot) habitats but was not significantly different from the grass-annual habitat (11.0 per plot). The woodland habitat, occupied almost entirely by white-footed mice (Peromyscus leucopus), had the lowest small mammal diversity indices (Table 8). The Shannon index for small mammals was

Table 8. Small mammal species diversity and richness on railroad ROWs in Story County, Iowa, fall 1977.

Habitat[a]	N	Shannon Index	Species Richness
Grass	7	0.600 A	5.8 A
Grass-annual	7	0.518 A	4.8 A
Shrub	5	0.500 A	4.8 A
Woodland	1	0.054 B	2.0 B
S.D.		0.126	1.0

[a]Mean values for each index are based on the number of plots (N) in each habitat type. Within each index, means sharing the same letter are not significantly different (Duncan's multiple range test, $P \leq 0.05$). Standard deviations are based on the entire sample of 20 plots.

positively correlated ($\underline{r}$ = 0.48) with the amount of alien grasses on the study plots. The white-footed mouse was the only small mammal to vary significantly in numbers trapped among the habitat types (Table 9). Larger numbers were caught in the two woody habitats than in the two herbaceous habitats.

Table 9. Variation in mean numbers of small mammals trapped relative to habitat type on railroad ROWs in Story County, Iowa, fall 1977.

Species	Habitat Type[a]				S.D.
	Grass (7)	Grass-annual (7)	Shrub (5)	Woodland (1)	
Deer mouse	10.1 A	8.4 A	4.6 A	1.0 A	6.1
White-footed mouse	2.6 A	1.6 A	14.8 B	36.0 C	4.4
House mouse	5.0 A	6.4 A	7.6 A	0.0 A	8.0
Harvest mouse	2.6 A	2.4 A	1.8 A	0.0 A	2.3
Meadow vole	3.3 A	3.6 A	1.2 A	0.0 A	3.8
Short-tailed shrew	1.4 A	0.6 A	0.6 A	0.0 A	1.0
Masked shrew	2.0 A	0.4 A	0.6 A	0.0 A	1.6
Prairie vole[b]	0.0	0.1	0.0	0.0	--

[a]Number of plots in each habitat type on which means are based is given in parentheses. Within each species, means with the same letter are not significantly different (Duncan's multiple range test $P \leq 0.05$). Standard deviations are based on entire sample of 20 plots.

[b]Prairie vole results were not tested for significance.

Some researchers have reported that herbaceous habitats supported greater densities of small mammals than woodlands (Golley et al. 1965, Hirth 1959). However in our study, the number of small mammals trapped was highest in the woodland plot. Means of 26.8, 23.6, 31.2, and 37.0 small mammals per plot were caught in the grass, grass-annual, shrub, and woodland habitats respectively. Cottontail rabbit numbers were also consistently highest in the woodland plot. However, only during fall were differences significant, with the woodland and shrub types having higher numbers than the grass-annual type. In most census periods, rabbits had a significant positive correlation with the number of shrubs in the plots.

Although not statistically significant, pocket gophers were more common in the two herbaecous

habitats (3.9 per grass plot; 3.4 per grass-annual plot) than in the woodland and shrub plots (1.8 per shrub plot; 2.0 per woodland plot). Highest numbers of ground squirrels were captured in grass-annual habitat. The woodland plot was not surveyed due to time constraints and the unlikelihood of the occurrence of ground squirrels in that habitat. All adult Franklin's ground squirrels (N = 3) were trapped in grass-annual habitat. The two individuals captured in the grass type were juveniles. The distribution of this species is local in Iowa and it is usually associated with tall grass (Bowles 1975).

DISCUSSION

Species Diversity

The degree of use of the railroad ROWs for breeding by birds can be evaluated by inspection of the diversity indices. Species richness and the relative abundance of these species (equitability) are both incorporated into the Shannon index (Lloyd and Ghelardi 1964). Pearson's correlation coefficients were computed for each census period among the Shannon indices, species richness and equitability as measured by J = Shannon index/log species richness (Odum 1971). The correlations between the Shannon and species richness indices were always higher than the correlations between the Shannon index and J. The Shannon and species richness indices were significantly correlated during every census period except fall, whereas the Shannon index correlated significantly with J in winter only. Changes in species richness, thus, had more impact on the Shannon index than equitability did. When differences in avian species diversity are affected greatly by species richness, territoriality will cause an increase in the diversity indices (Kricher 1972). Since the highest diversity indices occurred during May and June (Table 7), this was added evidence that the ROWs were utilized as territorial breeding areas.

Avian diversity indices tended to be significantly greater in the shrub and woodland habitats than in the two herbaceous habitats (Table 7). This is consistent with the findings of other researchers that bird species diversity increases with an increase in foliage structure diversity (Cody

1974, Karr 1968, MacArthur and MacArthur 1961, Tramer 1969). During each census period, Shannon and species richness indices were positively associated with the number of shrubs and (or) trees and the number of annual forbs. These plants added diversity to the foliage structure. Avian species richness was negatively correlated in some census periods with the amount of alien grasses. These grasses often formed thick mats with little vegetative variety, but these areas seemed to attract a variety of small mammals.

Vose and Dunlap (1968) found more small mammals where protection from the wind was provided. They believed this was related to the accumulation of snow and litter caused by the windbreak. We found that the railroad bed acted as a windbreak and the resulting buildup of snow on either side probably protected small mammals.

Value of ROWs to Winter Birds. Most avian species using the study plots in winter were positively associated with the number of shrubs and (or) trees in the ROWs. Several species were also correlated positively with the amount of annual forbs. The amount of snow cover in the plots was negatively correlated with the numbers of shrubs ($r = -0.62$) and trees ($r = -0.52$) while positively correlated with the amount of adjacent bare land ($r = 0.46$). Thus, shrubs and trees increased the value of ROWs for winter birds by reducing the amount of drifted snow, but adjacent bare ground reduced the value of ROWs as winter bird habitat. The correlation of several bird species with the number of annual forbs probably reflected the value of this vegetation as a food source.

Pheasant density on the study plots was highest in winter, but pheasants were concentrated on fewer plots (6 of 20). Highest numbers occurred in shrub habitat. The distribution of pheasant tracks was also positively correlated ($r = 0.47$) with the number of shrubs on a plot. Our estimates of pheasant density are probably more accurate for winter than for other seasons because pheasants are more easily detected and are more sedentary in winter (Lyon 1967). However, railroad ROWs undoubtedly provided critical habitat in some areas. The largest pheasant flock observed used a grass-annual plot. The center of activity of this flock was a patch of dogwood (Cornus sp.) on the leeward side of the tracks. The

ROW was surrounded by plowed land, and no crop stubble was within at least 0.5 mile (0.8 km) of the plot. Apparently, the presence of good cover was more important than easy access to food. The importance of wooded cover to wintering pheasants, when herbaceous cover was lacking, was noted in Wisconsin (Kabat and Thompson 1963).

Snow buntings appeared to center their activity on the ROWs where the birds fed on plant seed heads protruding above the snow near the rails and fences. In contrast, horned larks (Eremophila alpestris) were rarely observed on the ROWs during winter, although large flocks were often seen on adjacent bare land.

Value of ROWs to Breeding Birds

Woodland and shrub habitats on ROWs contained significantly more species of breeding birds than herbaceous habitats, and bird density was two to three times higher in woody habitats. Graber and Graber (1963) found that many breeding bird species preferred to use edge shrubbery similar to that on railroad ROWs. The vegetation and breeding bird communities on an Ohio railroad (Claugus 1978) were similar to those we found in Story County.

Three grassland species, the grasshopper sparrow (Ammodramus savannarum), bobolink (Dolichonyx oryzivorus), and upland sandpiper (Bartramia longicauda) were largely absent from railroad ROWs during the breeding season. The grasshopper sparrow and bobolink were often observed in pastures and hayfields including some adjacent to study plots. The upland sandpiper, one of the rarest birds in Iowa (Roosa 1977), was only found on one study plot near pastures and oatfields. We believe that possibly too much vegetative litter occurred on railroad ROWs for grasshopper sparrow breeding and that the bobolink and upland sandpiper need larger areas of grassland than are found on railroad ROWs (Braband 1979).

Dickcissels provided an example of how some species may rely on railroad ROWs for second nesting efforts. During May, dickcissels were present on 20 percent of the ROW study plots. In June, the species was found on 50 percent of the plots. Probably many dickcissels originally chose other habitat,

especially hayfields, for initial nesting efforts. After the first hay harvest in late May, they were displaced to railroad ROWs and other borders.

Several bird species, which are rare or scarce in central Iowa, used railroad ROWs during the breeding season. The black-billed cuckoo (Coccyzus erythropthalmus) was on at least 25 percent of the plots, while the yellow warbler (Dendroica petachia) occurred on one of the shrubby plots. Both species are listed as status "undetermined" (which means that they may become threatened in the foreseeable future, but more information is needed) on the Iowa endangered species list (Roosa 1977). Breeding willow flycatchers (Empidonax trailli) occurred in a shrubby ROW near a stream, and a warbling vireo (Vireo gilvus) territory existed in tall trees of another shrub plot. Both species may have declining or low populations in the Midwest (Arbib 1978, Claugus 1978).

Value of ROWs to Mammals

The lowest number of mammal species occurred on the woodland plot. Absence of ground cover on this plot was probably responsible for the low species richness.

The highest number of meadow voles occurred in a large dense stand of brome grass (Bromus sp.). Meadow vole numbers and the amount of alien grass on the study plots were weakly correlated ($r = 0.43$). Burt (1946) reported that meadow voles preferred rank growth of grass. Thompson (1965) found that the species chose alien forbs and grasses over native. Meadow vole numbers were also positively correlated ($r = 0.54$) with the amount of corn adjacent to the ROWs although voles are not grain eaters.

The cottontail was one of the most common mammal species on ROWs. It was recorded on all but one of the study plots and was found on 25 to 65 percent of the plots depending on the time of year. Cottontail distribution was strongly correlated with the number of shrubs and, to a lesser degree, the amount of annual forbs. The trend was for the highest rabbit population to be on the woodland plot, followed by the shrub habitat, with the lowest numbers in the two herbaceous habitats. During winter, rabbits tended to frequent ROWs that had plentiful

woody cover. In Illinois in winter, cottontails used dense woody cover and weed and grass stands while tending to avoid areas which lacked woody overstory (Hanson et al. 1969). Rabbits on herbeceous study plots were usually seen near brushpiles or (on one plot) under standing railroad cars.

Relative Value of Railroad ROWs

County-wide perspective. Information on land use including wildlife habitat in Story County is available from Taggart (1974) and Anderson et al. (1975). Over 90 percent of the 368,640 acres (149,299 ha) in the county lack suitable wildlife cover, especially in winter and early spring. The county is approximately 85 percent cultivated. Urban vegetation comprises about 2.5 percent of the land area, whereas less than 5 percent of the county is timbered. Marsh and prairie vegetation (off of railroad ROWs) comprises only about 0.1 percent of the area. Pasture, which is usually overgrazed, constitutes approximately 5 percent of Story County. Dense tall grass cover, which is found on interstate and other four-lane highway ROWs constitutes 0.5 percent of the county's land area. In much of the county, farmsteads plus highway and railroad ROWs provide the only vegetative diversity.

ASCS aerial photos (scale 1:20,000; 1972) were analyzed to determine the total area of herbaceous and shrub-woodland railroad ROWs in Story County. Rural railroad ROWs comprised 1,535 acres (622 ha). Of this, 31 percent was shrub or woodland. This information was compared to a computerized analysis of the major land cover types in the county (excluding incorporated areas) obtained from the Iowa State University Land Use Analysis Laboratory (Table 10). Railroad ROWs contained four percent of the county's grassland. If grazed or frequently mowed habitats (predominantly pastures and parkland) were excluded, railroad ROWs contained 13 percent of the county's grassland. A large proportion of the county's grass habitat was in verges along unpaved highway ROWs. These verges were narrow (usually 30 ft [9.1 m]), usually included a drainage ditch, and were subject to occasional mowing and other disturbances. If mowing is restricted to late summer, these narrow ROWs may provide nesting cover for pheasants and a few other species, but relative to other wider ROWs, they are of limited value as

Table 10. The relative value of railroad ROWs as wildlife habitat in Story County, Iowa.

Habitat	Rural area - ac (ha)	Area on railroad ROWS - ac (ha)	Percent
TOTAL COUNTY	355,719 (144,066)	1,535 (622)	
Grassland	23,687 (9,593)	1,068 (432)	4
USM[a]	8,226 (3,332)	1,068 (432)	13
(Excluding unpaved highways)	5,267 (2,133)	1,068 (432)	20
Shrub	3,988 (1,615)	471 (191)	12
Adequate habitat[b]	32,886 (13,319)	1,535 (622)	5
(Excluding unpaved highways)	29,927 (12,120)	1,535 (622)	5

[a]USM: Ungrazed, seldom-mowed grassland.

[b]Adequate habitat: Includes prairies, railroad and highway ROWs, pioneer vegetation on quarry spoils, old fields, savannahs, woodlots, tree plantings, and marshes.

general wildlife habitat. If these ROWs along unpaved highways are omitted from the analysis, railroad ROWs comprised 20 percent of the county's grassland. Railroads also comprised 12 percent of all the county's shrub habitat. If "adequate" wildlife habitat was defined as a substantial permanent vegetative cover which excluded such areas as cropland and pastures, five percent of Story County's "adequate" habitat occurred on railroad ROWs.

Coverage of native prairie (including wetland) vegetation on the study plots varied from 4 to 78 percent with an average of 36 percent (Table 6). By extrapolation an estimated 550 acres (223 ha) of prairie occurred on railroad ROWs in Story County. About 130 acres (53 ha) of prairie remnants occurred elsewhere in the county (analysis by Iowa State University Land Use Analysis Laboratory).

The vast majority of the land use in the vicinity of railroad ROWs was agricultural. Usually this land was planted to row crops (corn and

soybeans) or was without vegetative cover. Both row crops and bare land are "poor" wildlife habitats (Graber and Graber 1963; Gusey and Maturgo 1973; Guth 1966, 1967a, 1967b, 1968a, 1968b; Houtcooper 1978). Most of the Story County farmland is plowed in fall. Thus, from November to May, ROWs become long, narrow "islands" of vegetation largely surrounded by wide expanses of fallow land. Because of this isolation, ROWs are reduced in value as wildlife habitat. However, they still receive high use by such species as the snow bunting and pheasant and may be critical to the survival of a variety of species in certain areas.

Wildlife travel corridors. Animals often use narrow strips of vegetation as travel corridors between isolated and larger tracts of habitat (Getz 1978, Getz et al. 1978, MacClintock et al. 1977, Taggart 1974). At least four species (raccoon, striped skunk, red fox, deer) used at least half of our railroad ROW study plots as travel corridors. A plot was considered a corridor if tracks were observed paralleling the ROW. These tracks were either in the ROW or immediately adjacent to it. Tracks which crossed the ROW at an angle or criss-crossed back and forth on the ROW (interpreted as hunting behavior) were excluded. These estimates of the number of species and the number of study plots used as corridors are conservative because animals which walked on vegetation or rails would have left few tracks.

Wildlife habitat in Story County is fragmented (Taggart 1974), and stream valleys, highways, and railroads provide a network of corridors to connect habitat patches. For small mammals in grasslands, (Getz (1978) felt that interstate highways provided better travel corridors than railroads because grass cover on railroads was interrupted by nongrass vegetation and towns. Interstate ROWs had a practically continuous cover of dense grasses and bypassed towns. Due to differences in habitat quality, railroad ROWs are probably better wildlife travel corridors than verges of unpaved highways.

CONCLUSIONS

Railroad ROWs provide habitat for a large variety of birds and mammals in north-central Iowa. Because of the continued loss of wildlife habitat in

the Midwest, these corridors should be managed to increase their value to wildlife. Especially in intensively farmed areas, abandoned ROWs should be preserved in order to maintain the numbers and diversity of wildlife.

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