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Effects of wildland development on forest bird communities☆

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Abstract

The rapid urbanization of rural landscapes for primary and secondary homes can significantly affect bird populations as wildlands are developed. To study this effect, we conducted bird counts within the Lake of the Ozarks region of central Missouri in three different landscape types: wildlands, dispersed single homes, and cluster development. For each landscape type, we selected five 100 ha forested sites and conducted bird counts during May and June for 2 years. Forest interior migrant species were most abundant in wildland sites and least abundant in cluster development sites. In contrast, cluster development sites were dominated by species generally found in urban residential neighborhoods, and nest predators and brood parasites were more prevalent on these sites than wildland sites.

Keywords: Birds; Urbanization; Wildland development

1. Introduction

During the last two decades, non-metropolitan areas have increased in population as people moved out of cities and into rural areas (Frey, 1990). Also, during this period, development around remote recreational areas has expanded (Knox, 1987). These activities create patches of urbanization within wildlands producing a variety of boundary effects (Ambrose and Bratton, 1990). The potential impacts of wildland development include loss of regional diversity (Mott, 1988), degradation of the ecological integrity of parks and preserves (Stubbendieck and Willson, 1987), and changes in the social values of local residents (Lee, 1984; Berris, 1987).

Most studies of the effect of development and land use change on bird communities have focused on residential neighborhoods (Geis, 1974; DeGraaf and Wentworth, 1981; DeGraaf and Wentworth, 1986; Mills et al., 1989) and isolated forest patches surrounded by suburban and urban landscape matrices (Whitcomb et al., 1981; Wilcove, 1985; Tilghman, 1987; Robbins et al., 1989; Dowd, 1992). These studies have documented declines in species richness and a decrease in abundance of forest interior migrant species associated with habitat fragmentation and isolation.

Previous studies have not considered the effects of wildland development. Consequently, there is little information for planners and land managers on the types of wildland development

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that have the least effect on forest birds. This paper examines the effect of wildland development on forest bird species in two landscape types: dispersed single homes built on large lots (at least 1 ha); cluster developments with homes built on small lots (less than 1 ha) or grouped together. These sites were compared with wildland areas with no development. We investigated three hypotheses: (1) wildland development results in bird communities that are similar in species composition and abundance to those described in previous studies of residential developments; (2) wildland development results in a decline in the abundance of forest interior migrant species; (3) wildland development results in an increase in the abundance of nest predator and nest parasite species.

2. Methods

2.1. Study area

The study was located in Camden, Miller, and Morgan Counties, Missouri, part of the Lake of the Ozarks region, a well-known recreation area in the midwestern US (Fig. 1). Although it is 53% forest covered, the population of the three-county region increased by 105% between 1960 and 1990, resulting in a mixture of scattered developments in forested areas (Giessman et al., 1986; Missouri Cooperative Extension Service, 1990).

The study area is within the Upper Ozark Section of the Ozark Natural Division of Missouri, a region composed of oak–hickory forest, oak savannas, and bottomland hardwood communities (Thom and Wilson, 1980). Forests in the study area were part of the area dominated by oak (*Quercus* spp.) with flowering dogwood (*Cornus florida*), ash (*Fraxinus* spp.), and maple (*Acer* spp.) in the understory. Eastern red cedar (*Juniperus virginiana* L.) dominated the oldfield and oldfield/forest transitional habitats (Evans and Kirkman, 1981).

Using 1:20 000 aerial photographs taken in 1981, we defined three landscape types: wildlands, forested areas without roads or development; dispersed single home, forested areas with roads and houses on lots of at least 1 ha; cluster development, forested areas with roads and houses on lots of at least 1 ha. Five 100 ha study sites, each with a minimum of 50% forest cover, were randomly located within each of the two developed landscape types. Five wildland study sites were located within undeveloped areas of Lake of the Ozarks State Park. Two hundred and eleven bird survey points were randomly located on forest stands larger than 1 ha within these study sites.

2.2. Landscape characteristics

Using the USGS Landuse Landcover classification system (Lillesand and Kiefer, 1987), each study site was classified according to eight land cover variables: forest (FOREST), agriculture (AGRIC), pasture (PASTURE), forest openings (FOROPEN), lawns (GRASS), water (WATER), roads and buildings (BUILT) and roads (ROADS). Contiguous areas of at least 1 ha were classified and digitized using ARC/INFO, a geographic information system. The mean area of each land cover variable was calculated for each landscape type.

In addition, the number of forest patches (PATCH), edge length and edge type were determined for each study site using ARC/INFO. Forest edge was defined as the ecotone between forest and adjacent land cover types. Edge type referred to the different types of ecotones (e.g. forest–agriculture). Mean values for these variables and for the total length of all forest edges (TOTLEN), and number of forest patches were determined for each landscape type.

2.3. Bird counts

Bird counts were conducted during May and June of 1990 and 1991, using a modified variable circular plot technique (Reynolds et al., 1980). Visual and auditory detection of all observed species were recorded on these unbounded plots. Counts were done three times at each of the 211 survey points during each field season. Each count was 6 min in length and was

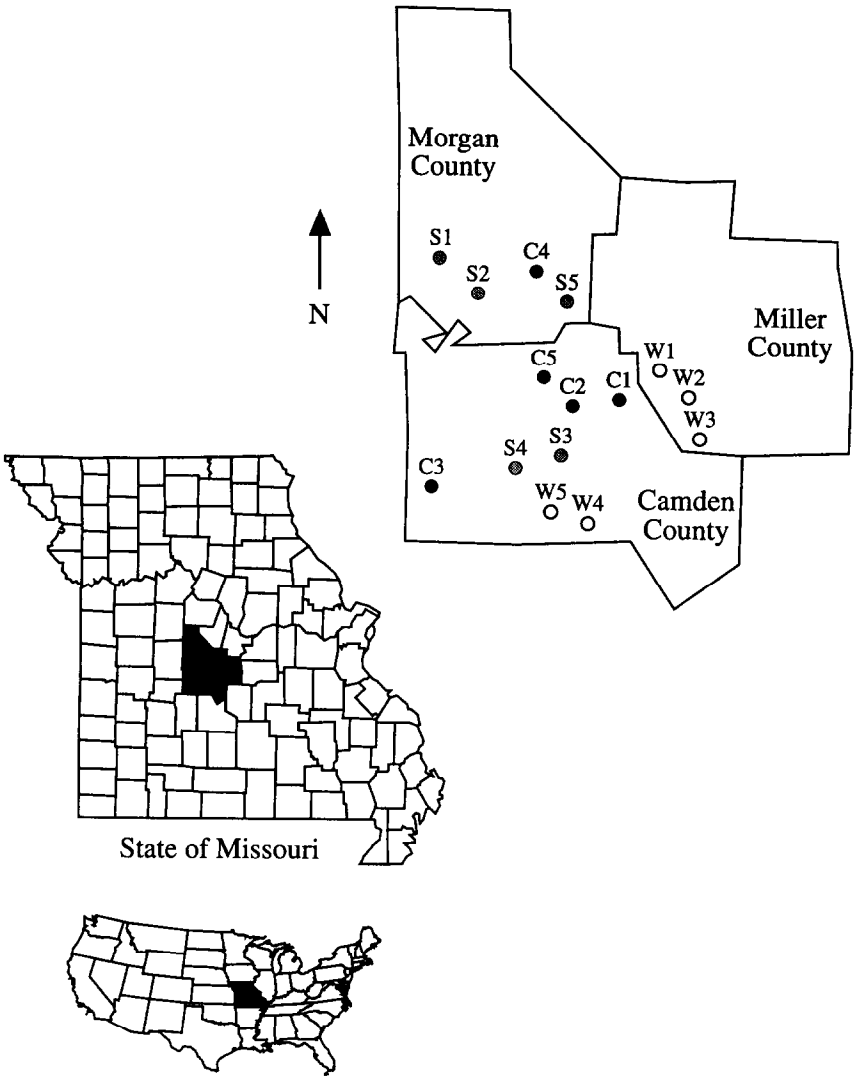

Fig. 1. Wildland (W1–W5), single home (S1–S5), and cluster (C1–C5) study sites, Lake of the Ozarks Region, Missouri, USA.

done between 05:30 and 10:00 h. Three observers were trained in bird survey techniques. Each observer received 5 days training in bird survey procedures and completed one count at each sample point.

2.4. Bird community analysis

The mean number of detections per study site was used as a measure of abundance for seven forest interior species associated with Ozark forests (scarlet tanager, red-eyed vireo, black-and-white warbler, ovenbird, northern parula, Kentucky warbler, and wood thrush), three nest predator species (American crow, blue jay, common grackle), and one brood parasite species (brown-headed cowbird) (Thompson et al., 1992). Preliminary analysis of our results, using a repeated measures analysis of variance, showed between-year differences in the abundance of some species. Because of these between-year differences, we analyzed abundance data for both

1990 and 1991 sites. A Kruskal–Wallis one-way analysis of variance test was used to test for differences in species abundance among development types. We correlated the mean total detections of forest interior species and nest predator and nest parasite species with forest edge and number of forest patch values, to determine the relationship between the landscape pattern of the study sites and the abundance of these species groups.

Canonical correspondence analysis was used to identify patterns in bird community composition and abundance and to identify environmental gradients that may explain differences among landscape types (ter Braak, 1986). This procedure combines ordination analysis with a canonical correlation of species abundance and environmental data, allowing direct analysis of environmental gradients (ter Braak, 1986). Because bird counts in urban areas are often dominated by a small number of species with a large number of detections (Beissinger and Osborne, 1982), we used mean prominence value per study site as a measure of species abundance for the canonical correspondence analysis (Beals, 1960). Prominence value weights the mean number of detections of each species by the number of counts per site that contained that species. Mean land cover values for each study site were used as environmental variables.

3. Results

3.1. Species richness and composition

Sixty-six breeding bird species were detected on the study area during 1990 and 1991 (Appendix). No differences in species richness were found among landscape types during the 2 years (Table 1).

Mean total detections of the seven selected forest interior migrants were different ($P<0.05$) among the three landscape types in 1990 (Table 1). More ($P<0.05$) forest birds were present in wildland sites than in cluster sites. Differences ($P<0.05$) also existed in nest predator/parasite species among landscape types. More ($P<0.05$) were observed within cluster sites than in wildland sites. In 1991, we found no differences in total detections of forest interior species or of nest predator/parasite species among landscape types.

Two of seven forest interior migrant species showed differences among the landscape types (Tables 2 and 3). In 1990, ovenbirds were more abundant ($P<0.05$) in wildland sites than in

Table 1
Breeding bird species richness numbers and selected composition data for wildland, single home, and cluster landscape types, 1990 and 1991

Community characteristic	Landscape type		
	Wildland	Single home	Cluster
Species richness			
1990	32.8 ± 1.7	33.6 ± 1.0	32.2 ± 1.5
1991	36.6 ± 1.2	41.2 ± 1.4	38.2 ± 2.4
Mean total detections forest interior migrants			
1990*	3.6 ± 0.4a	2.4 ± 0.5ab	1.0 ± 0.6b
1991	2.5 ± 0.1	1.7 ± 0.2	1.2 ± 0.6
Mean total detections nest predator/parasite			
1990*	2.3 ± 0.4a	4.7 ± 0.5ab	7.4 ± 1.7b
1991	3.8 ± 0.5	5.0 ± 0.7	6.2 ± 1.0

*Kruskal–Wallis analysis of variance significant at $P<0.05$.
Different letters indicate differences ($P<0.05$) between landscape types.

Table 2
Mean detections/count for selected species in three landscape types for three counts in 1990

	Landscape type		
	Wildland	Single home	Cluster
Forest interior migrants			
Scarlet tanager	0.5±0.2	0.0±0.2	0.1±0.0
Red-eyed vireo	0.9±0.1	0.8±0.2	0.3±0.2
Black-and-white warbler*	0.2±0.0a	0.0b	0.1±0.5b
Ovenbird*	0.7±0.1a	0.0b	0.2±0.2ab
Northern parula	0.7±0.1	0.7±0.2	0.2±0.2
Kentucky warbler*	0.3±0.1	0.3±0.2	0.0±0.0
Wood thrush	0.8±0.3	1.0±0.4	0.2±0.2
Nest predators/brood parasite			
Blue jay*	1.1±0.4a	2.2±0.5ab	4.2±0.7b
American crow	0.8±0.1	1.0±0.4	1.7±0.8
Common grackle	0.0±0.0	0.9±0.5	1.0±0.5
Brown-headed cowbird	0.4±0.1	0.7±0.2	0.6±0.1

*Kruskal–Wallis analysis of variance significant at $P<0.05$.
Different letters indicate differences ($P<0.05$) between landscape types.

Table 3
Mean detections/count for selected species in three landscape types for three counts in 1991

	Landscape type		
	Wildland	Single home	Cluster
Forest interior migrants			
Scarlet tanager*	0.5±0.2a	0.2±0.1ab	0.1±0.1b
Red-eyed vireo	0.5±0.1	0.6±0.2	0.2±0.1
Black-and-white warbler*	0.3±0.1a	0.0b	0.1±0.0ab
Ovenbird	0.5±0.0	0.2±0.1	0.4±0.2
Northern parula	0.3±0.0	0.5±0.1	0.2±0.1
Kentucky warbler	0.1±0.0	0.2±0.1	0.1±0.1
Wood thrush	0.5±0.1	0.3±0.1	0.3±0.2
Nest predators/brood parasite			
Blue jay*	1.5±0.4a	1.7±0.4ab	3.7±0.5b
American crow*	1.9±0.4	2.0±0.5	0.7±0.1
Common grackle	0.0	0.8+0.6	1.4±0.6
Brown-headed cowbird	0.3±0.1	0.6±0.2	0.5±0.2

*Kruskal–Wallis analysis of variance significant at $P<0.05$.
Different letters indicate differences ($P<0.05$) between landscape types.

other landscape types. In 1991, scarlet tanagers were more abundant on wildland sites ($P<0.05$) than on cluster sites. Among nest predators, blue jays were more abundant ($P<0.05$) on cluster sites than on wildlands both in 1990 and 1991. The American crow was more abundant ($P<0.05$) on cluster sites in 1990 and on single home sites in 1991.

Forest interior migrants and nest predator/parasite species also responded differently ($P<0.05$) to forest edge types (Table 4). Mean total detection of migrants was negatively corre-

Table 4
Correlation between mean detections of nest predator/parasite (NPP), mean detections of forest interior migrants (FOR) and length of forest edge and number of forest patches

Forest edge type	Year			
	1990		1991	
	FOR	NPP	FOR	NPP
AGRIC	−0.3	−0.1	−0.2	0.1
BUILT	−0.6*	0.8*	−0.7*	0.7*
GRASS	−0.4	0.2	−0.3	0.4
FOROPEN	−0.1	−0.2	−0.1	−0.2
PASTURE	−0.2	0.2	−0.2	0.3
ROAD	−0.2	0.3	−0.1	0.0
WATER	−0.6*	0.8*	−0.7*	0.7*
TOTLEN	−0.4	0.4	−0.4	0.2
PATCH	−0.4	0.3	−0.3	0.1

*Bartlett χ^2 statistic correlation significant at $P<0.05$.

Table 5
Mean land cover values per study site for wildland, single home and cluster landscape types

Cover type	Landscape type		
	Wildland	Single home	Cluster
FOREST*	96.8 ± 1.7a	80.8 ± 2.9ab	65.9 ± 10.6b
AGRIC	0.0	4.9 ± 3.1	0.9 ± 0.5
PASTURE	0.0	0.4 ± 0.2	0.1 ± 0.1
FOROPEN	2.6 ± 1.6	2.2 ± 0.8	0.9 ± 0.5
GRASS	0.0	0.0	0.4 ± 0.4
WATER	0.0	0.5 ± 0.4	4.5 ± 2.5
BUILT*	0.0a	2.1 ± 1.3ab	19.4 ± 7.5b
ROAD*	0.4 ± 0.2a	9.1 ± 1.9b	7.9 ± 1.1b

*Kruskal–Wallis analysis of variance significant at $P<0.05$.
Different letters indicate differences ($P<0.05$) between landscape types.

lated ($P<0.05$) with forest–development and forest–water edges in 1990 and 1991, and mean total detection of nest predator/parasite species was positively correlated ($P<0.05$) with these variables in both years. Neither numbers of forest interior migrants nor nest predator/parasite species were related to the number of forest patches per site (Table 4).

3.2. Landscape characteristics

Landscape types differed ($P<0.05$) in mean amount of cover by forest, roads, and built areas (Table 5). Wildlands and single home study sites had more ($P<0.05$) forest cover and fewer ($P<0.05$) built areas than cluster study sites. Single home and cluster study sites had more ($P<0.05$) roads than wildland areas. Landscape types also differed ($P<0.05$) with respect to mean number of forest patches, total edge length and type of edge (Table 6). Wildlands had less edge and fewer forest patches ($P<0.05$) than single home and cluster developments. Cluster study sites had more ($P<0.05$) forest edges associated with built areas than wildland and single home sites. Single home developments had more forest edges ($P<0.05$) associated with roads than wildland areas.

Table 6
Mean length of forest edge type (m) and number of forest patches per study site for wildland, single home and cluster landscape types

Edge type	Landscape type		
	Wildland	Single home	Cluster
AGRIC	109.0±66.8	1233.0±767.5	205.0±137.3
PASTURE	0.0	378.2±126.6	364.0±283.5
FOROPEN	1428.0±1349.6	706.0±347.9	590.0±376.9
GRASS	0.0	0.0	237.4±237.4
WATER	0.0	189.4±159.6	798.2±380.5
BUILT*	0.0a	510.0±344.2ab	1852.6±789.2b
ROAD*	0.0a	11868.2±2408.4b	7424.0±1006.4ab
TOTLEN*	1537.0±1392.1a	14885.2±1974.1b	11471.2±432.9b
PATCH*	1.6±0.4a	18.6±5.6b	15.2±2.4b

*Kruskal–Wallis analysis of variance significant at $P<0.05$.
Different letters indicate differences ($P<0.05$) between landscape types.

Table 7
Bird species scores for canonical correspondence analysis

Species	Axis 1	Axis 2
Axis 1 > 0.50		
House finch	1.7	−0.6
Rock dove	1.5	−1.0
Belted kingfisher	1.3	−0.2
European starling	1.2	−0.7
American goldfinch	1.1	−0.7
House sparrow	1.0	−0.3
Common grackle	1.0	−0.3
American robin	0.9	−0.2
Red-winged blackbird	0.7	0.1
Black-capped chickadee	0.5	0.1
Eastern kingbird	0.7	−0.1
Common yellowthroat	0.6	−0.1
Eastern meadowlark	0.6	0.5
Axis scores < −0.5		
Black and white warbler	−1.1	−0.7
Scarlet tanager	−1.0	−0.5
Ovenbird	−0.9	−0.5
Blue gray gnatcatcher	−0.9	−0.4
Yellow billed cuckoo	−0.7	−0.2
Red-eyed vireo	−0.7	−0.1
Northen parula	−0.7	−0.2
White-eyed vireo	−0.7	0.2
Summer tananger	−0.7	0.0
Rufous sided towhee	−0.6	−0.2
Pileated woodpecker	−0.6	−0.3
Kentucky warbler	−0.6	0.1
Yellow breasted chat	−0.5	0.2

Table 8
Canonical correspondence analysis scores for study area land cover variables

Variable	Axis 1	Axis 2
FOREST	−1.0	0.1
AGRIC	0.2	0.2
PASTURE	−0.0	0.8
FOROPEN	0.3	0.2
GRASS	0.3	−0.2
WATER	0.7	−0.4
BUILT	0.9	−0.4
ROAD	0.6	0.7

3.3. Community analysis

Thirty-eight percent of the variation in bird species composition and abundance can be accounted for by the first two canonical correspondence analysis ordination axes. The first axis separated forest interior and edge species from avian species associated with residential areas (Table 7). The second axis separated forest interior species from forest-opening and early successional species. Of the 11 focus species, one nest predator species (common grackle) had an axis 1 score of at least 0.5 and five forest interior migrants had axis 1 scores up to −0.5 (Table 7). Scores of at least 0.5 or up to −0.5 indicated that the species was important in defining the ordination axes.

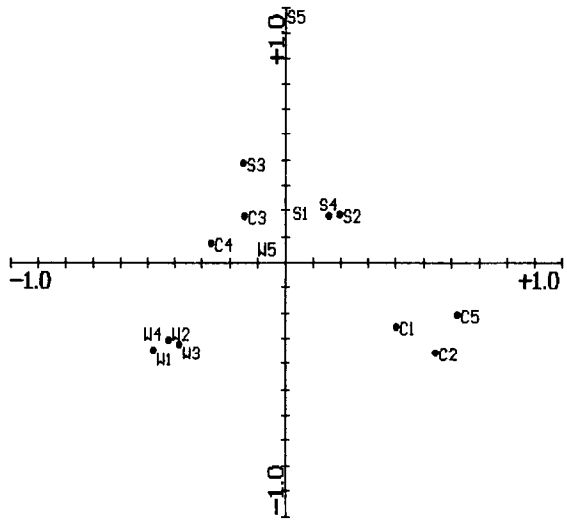

Fig. 2. Ordination of wildland (W1–W5), single home (S1–S5), and cluster (C1–C5) study sites on species axes.

The two axes explained 69.5% of the variation between mean species prominence value and land cover variables. Correlations between the canonical correspondence analysis axis scores and the original land cover variables indicated that the first axis, accounting for 54% of the variation in species scores, was positively correlated with developed areas, roads, and water and negatively correlated with forest. The second axis, accounting for an additional 15% of the variation in bird species scores, was positively correlated with pasture and roads, and negatively correlated with development (Table 8). Plotting the study site scores, weighted means of the species scores, showed a spatial separation between the majority of wildland, dispersed single home and cluster study site (Fig. 2).

4. Discussion

Our analysis revealed that wildland development can affect the composition and abundance of avian fauna in an area. This finding is similar to other studies in that bird abundance and community composition change with increased urban development. We had hypothesized this change for forest interior migrants. Six of the seven selected migrant species (black-and-white warbler, scarlet tanager, ovenbird, red-eyed vireo, northern parula, and Kentucky warbler) had low scores on the urbanization axis in the canonical correspondence analysis. Four species (black-and-white warbler, scarlet tanager, ovenbird, and Kentucky warbler) were more abundant in wildland areas than in the two development types during at least one counting period.

We also hypothesized that nest predator/parasite species abundance would increase with development. Although the common grackle scored high on the urbanization axis, the blue jay was the only species to be more abundant on cluster sites than wildland sites. In 1990, the brown-headed cowbird was approximately equally abundant across landscape types, but in 1991, it was more abundant on the dispersed single home and cluster sites. However, the American crow was more abundant on dispersed single home and wildland sites. Between-year differences in bird abundance values may be due to a relatively late migration season in 1990. The species list for that year includes several species that are spring migrants in the Lake of the Ozarks region (Appendix).

Unlike previous studies which identified forest patch size to be a critical factor in determin-

ing species abundance (Robbins et al., 1989), we found forest edge type to be a more important landscape feature influencing species composition in a forest matrix. As the amount of forest–development edge and of forest–water edge increased, the abundance of forest interior migrants decreased and nest predator and brood parasite species increased. These results suggest that urbanizing areas may result in a wide range of edge habitats with a different effects on avian nest predators (Middleton, 1988). This indicates a need for additional research on the relationship between forest edge and nest predation and brood parasitism on the breeding success of forest interior migrants in midwestern urbanizing regions.

4.1. Implications for planners and land managers

Since wildland development will continue to occur as individuals build primary and secondary homes in wildlands, a basic question that remains to be addressed is: What is the best development pattern to minimize the effects on breeding birds? Results from this study suggest that the dispersed single home development may be the best pattern to minimize effects on bird communities in the Missouri Ozarks. Although the presence of development and roads had negative effects on the abundance of forest interior migrants, this effect appears to be less than that observed with cluster development. However, these results are based solely on species abundance and do not take into account breeding success or other indications that viable populations remain in these developments (Gibbs and Faaborg, 1990).

Dispersed single-home developments in the Lake of the Ozarks region are characterized by small, permanent openings and an extensive road network. Although the extent of deforestation may be small, this landscape type may have a greater effect on non-avian wildlife than cluster development. Because homes are dispersed across the landscape, the exposure of wildlife to humans and their activities, to non-native species, and to harassment by domestic pets may be maximized (Janzen, 1983; Noss, 1987) compared with cluster development. Likewise, the high road density may affect large mammals and other area-sensitive wildlife species (Brocke et al., 1989). Research is clearly needed to address issues concerning breeding success of the avian fauna and the effects of development on other species.

Acknowledgments

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Appendix

Table A1
Bird species detected on wildland, single home, and cluster sites in 1990 and 1991

Species[a]	Wildland		Single home		Cluster	
	1990	1991	1990	1991	1990	1991
Rock dove (*Columba livia*)					X	X
Mourning dove (*Zenaida macroura*)	X	X	X	X	X	X
Yellow-billed cuckoo (*Coccyzus americanus*)	X	X	X	X	X	X
Ruby-throated hummingbird (*Archilochus colubris*)			X		X	X
Belted kingfisher (*Ceryle alcyon*)		X		X	X	
Northern flicker (*Colaptes auratus*)	X	X	X	X	X	X
Pileated woodpecker (*Dryocopus pileatus*)	X	X	X	X	X	X
Red-headed woodpecker (*Melanerpes erythrocephalus*)	X	X	X	X	X	X
Red-bellied woodpecker (*Melanerpes carolinus*)	X	X	X	X	X	X
Downy woodpecker (*Picoides pubescens*)	X	X	X	X	X	X
Hairy woodpecker (*Picoides villosus*)	X	X	X	X	X	X
Eastern wood-pewee (*Contopus virens*)	X	X	X	X	X	X
Acadian flycatcher (*Empidonax virescens*)	X	X	X	X	X	X
Eastern phoebe (*Sayornis phoebe*)	X	X	X	X	X	X
Great crested flycatcher (*Myiarchus crinitus*)	X	X	X	X	X	X
Western kingbird (*Tyrannus verticalis*)				X		
Eastern kingbird (*Tyrannus tyrannus*)		X	X	X	X	X
Blue jay (*Cyanocitta cristata*)	X	X	X	X	X	X
American crow (*Corvus brachyrhynchos*)	X	X	X	X	X	X
Black-capped chickadee (*Parus atricapillus*)	X	X	X	X	X	X
Carolina chickadee (*Parus carolinensis*)	X	X	X	X	X	X
Tufted titmouse (*Parus bicolor*)	X	X	X	X	X	X
White-breasted nuthatch (*Sitta carolinensis*)	X	X	X	X	X	X
Brown creeper (*Certhia americana*)		X		X		X
Carolina wren (*Thryothorus ludovicianus*)		X	X	X	X	X
Bewick's wren (*Thryomanes bewickii*)	X	X	X			X
House wren (*Troglodytes aedon*)			X	X		X
Blue-gray gnatcatcher (*Poliopotila caerulea*)	X	X	X	X		X
Eastern bluebird (*Sialia sialis*)	X	X	X	X	X	X
Wood thrush (*Hylocichla mustelina*)	X	X	X	X	X	X
American robin (*Turdus migratorius*)	X	X	X	X	X	X
Gray catbird (*Dumetella carolinensis*)	X	X	X	X	X	X
Brown thrasher (*Toxostoma rufum*)	X	X	X	X	X	X
European starling (*Sturnus vulgaris*)	X		X		X	X
White-eyed vireo (*Vireo griseus*)	X	X	X	X		X
Red-eyed vireo (*Vireo olivaceus*)	X	X	X	X	X	X
Blue-winged warbler (*Vermivora pinus*)	X	X	X	X	X	
Northern parula (*Parula americana*)	X	X	X	X	X	X
Yellow warbler (*Dendroica petechia*)		X				
Prairie warbler (*Dendroica discolor*)	X	X		X	X	X
Black-and-white warbler (*Mniotilta varia*)	X	X			X	X
Worm-eating warbler (*Helmitheros vermivorus*)	X	X	X	X	X	X
Ovenbird (*Seiurus aurocapillus*)	X	X		X	X	X
Louisiana waterthrush (*Seiurus motacilla*)				X		
Kentucky warbler (*Oporornis formosus*)	X	X	X	X	X	X
Common yellowthroat (*Geothlypis trichas*)		X	X	X	X	X
Hooded warbler (*Wilsonia citrina*)				X		
Yellow-breasted chat (*Icteria virens*)	X	X	X	X	X	
Summer tanager (*Piranga rubra*)	X	X	X	X	X	X

Species[a]	Wildland		Single home		Cluster	
	1990	1991	1990	1991	1990	1991
Scarlet tanager (*Piranga olivacea*)	X	X	X	X	X	X
Northern cardinal (*Cardinalis cardinalis*)	X	X	X	X	X	X
Rose-breasted grosbeak (*Pheucticus ludovicianus*)			X	X		
Blue grosbeak (*Guiraca caerulea*)		X		X		
Indigo bunting (*Passerina cyanea*)	X	X	X	X		X
Rufous-sided towhee (*Pipilo erthorophthalmus*)	X	X	X	X	X	X
Chipping sparrow (*Spizella passerina*)			X	X	X	X
Field sparrow (*Spizella pusilla*)	X	X	X	X	X	X
Grasshopper sparrow (*Ammodramus savannarum*)	X	X	X	X	X	X
Song sparrow (*Melospiza melodia*)	X		X		X	X
Red-winged blackbird (*Agelaius phoeniceus*)	X		X	X	X	X
Eastern meadowlark (*Sturunella magna*)						
Common grackle (*Quiscalus quiscula*)	X		X	X	X	X
Brown-headed cowbird (*Molothrus ater*)	X	X	X	X	X	X
Northern oriole (*Icterus galbula*)	X		X		X	
House finch (*Carpodacus mexicanus*)						X
House sparrow (*Passer domesticus*)			X	X	X	X

[a]Scientific names follow American Ornithologists Union (1983).

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