



Bird Community Monitoring at Pea Ridge National Military Park, Arkansas

Status Report 2008–2021

Natural Resource Report NPS/HTLN/NRR—2022/2445



ON THE COVER
Bird habitat at Pea Ridge National Military Park
Photography by NPS/Heartland Inventory and Monitoring Network

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David G. Peitz

National Park Service
Heartland Inventory and Monitoring Network
Wilson's Creek National Battlefield
6424 West Farm Road 182
Republic, Missouri 65738

Editing and Design by
Tani Hubbard

National Park Service &
Northern Rockies Conservation Cooperative
12661 E. Broadway Blvd.
Tucson, AZ 85748

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Executive Summary

Breeding bird surveys were initiated on Pea Ridge National Military Park, Arkansas in 2008 to assess temporal changes in the species composition and abundance of birds on the park. These data also improve our understanding of relationships between breeding birds and their habitat and the effects of management actions, such as invasive plant species control and tree thinning, on bird populations. Birds were sampled using point counts with 99 variable circular plots located on a systematic grid of 400 x 400-m cells (originating from a random start point). All birds seen or heard on a plot during a 5-minute sampling period were recorded.

We surveyed for breeding birds in eight of the last 14 years on as many of the 99 variable circular plots as possible each year, resulting in 592 cumulative plot visits. Surveys have yielded records for 111 different species of birds. Ninety-three of the species recorded are classified as permanent or summer residents to the area, 11 as winter residents to the area, six as transients in the area, and one as a migrant through the area. Nine breeding species recorded are considered species of conservation concern for the Central Hardwoods Bird Conservation Region, the bird conservation region Pea Ridge National Military Park is located in. Of the 93 breeding species recorded, 4 species occurred in grassland and 11 in woodland habitats in numbers large enough to calculate annual abundances with some degree of confidence. However, only the Blue-gray Gnatcatcher (*Polioptila caerulea*), Eastern Wood-pewee (*Contopus virens*), Red-eyed Vireo (*Vireo olivaceus*), and Tufted Titmouse (*Baeolophus bicolor*) in woodland habitats demonstrated any trends (moderate to strong increases) in abundance. Trends in abundance were classified as uncertain for the rest of the species in both grassland and woodland habitats, which means that no significant increases or decreases occurred, but it is not certain that trends were < 5% per year.

Comparisons of population trends on the park with regional trends for the Central Hardwoods Bird Conservation Region suggest that the bird community at Pea Ridge National Military Park is faring similarly to or slightly better than that of the region as a whole. Stable diversity, richness, and evenness values suggest that the park's habitat has remained consistent in its ability to meet the requirements of many of the park's breeding bird species. Any increase or decline in species richness could reflect habitat management practices but could also reflect the influences of larger-scale factors such as weather or climatic conditions on vegetation. Therefore, continued monitoring of birds and their habitats on Pea Ridge National Military Park as management and climatic conditions change is essential for park management.

Acknowledgments

We would like to thank the staff of Pea Ridge National Military Park, Arkansas, for allowing us access to the park during our site visits. We would also like to thank park staff and volunteers Candice S. Canady, Gregg J. Wolcott, Vicky A. Olson, Nolan W. Moore, J. Mitch Cockrill, Lorraine Heartfield, Steve P. Munch, Kristian A. Bolin, and Chloe P. Stillings who assisted with bird surveys on the park.

Introduction

Birds are an important component of park ecosystems. Their high body temperature, rapid metabolism, and high ecological position in most food webs make them good indicators of the effects of local and regional changes in ecosystems. It has been suggested that management activities aimed at preserving habitat for bird populations (e.g., habitat for neotropical migrants) can have the added benefit of preserving entire ecosystems and their attendant ecosystem services (Karr 1991; Maurer 1993). Birds also have a tremendous following among the public, and many parks provide information on the status and trends of birds through their interpretive programs.

Pea Ridge National Military Park, Arkansas, is in the western edge of the Ozark Highland section of the Central Hardwoods Bird Conservation Region (Figure 1). This bird conservation region is one of 67 regions identified in the North American Bird Conservation Initiative (NABCI). Started in 1999, the NABCI is a coalition of government agencies and private organizations in the U.S. working to ensure the long-term health of North America's native bird populations (NABCI 2020).

Topography of the area in and around Pea Ridge National Military Park is dissected, with local relief over 100 m common (Fitzgerald and Pashley 2000). However, broad flat ridges can be found throughout. Historically, the landscape contained a habitat of oak-hickory forest with a prairie grass understory in ravines and grass savanna habitat on ridges. Approximately 114 species of birds are known to breed in the area (James and Neal 1986). Widespread

habitat loss to agriculture and urban and industrial development threatens the integrity of the area for birds.

Data collected during the annual U.S. Geological Survey (USGS) North American Breeding Bird Survey (BBS) between 2008 and 2019 indicate that several bird species potentially breeding at Pea Ridge National Military Park show evidence of population decline (Sauer et al. 2020). In fact, 23% of the species have populations reported to be in decline, with species such as the Bewick's Wren (*Thryomanes bewickii*), Grasshopper Sparrow (*Ammodramus savannarum*), and Northern Bobwhite (*Colinus virginianus*) declining at alarming rates.

Long-term trends in community composition and abundance of breeding bird populations provide one measure for assessing the ecological integrity and sustainability of this system. We use trends in the composition and abundance of bird populations as long-term indicators of ecosystem integrity at Pea Ridge National Military Park. *Ecosystem integrity* is defined as the system's capability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitats of the region (Karr and Dudley 1981). Research has demonstrated that birds serve as good indicators of changes in ecosystems (Cairns et al. 2004; Mallory et al. 2006; Wood et al. 2006). Therefore, changes in bird community abundance and composition may reflect the effectiveness of restoration and bird habitat management actions at Pea Ridge National Military Park.



Hairy Woodpecker (*Leuconotopicus villosus*). NPS

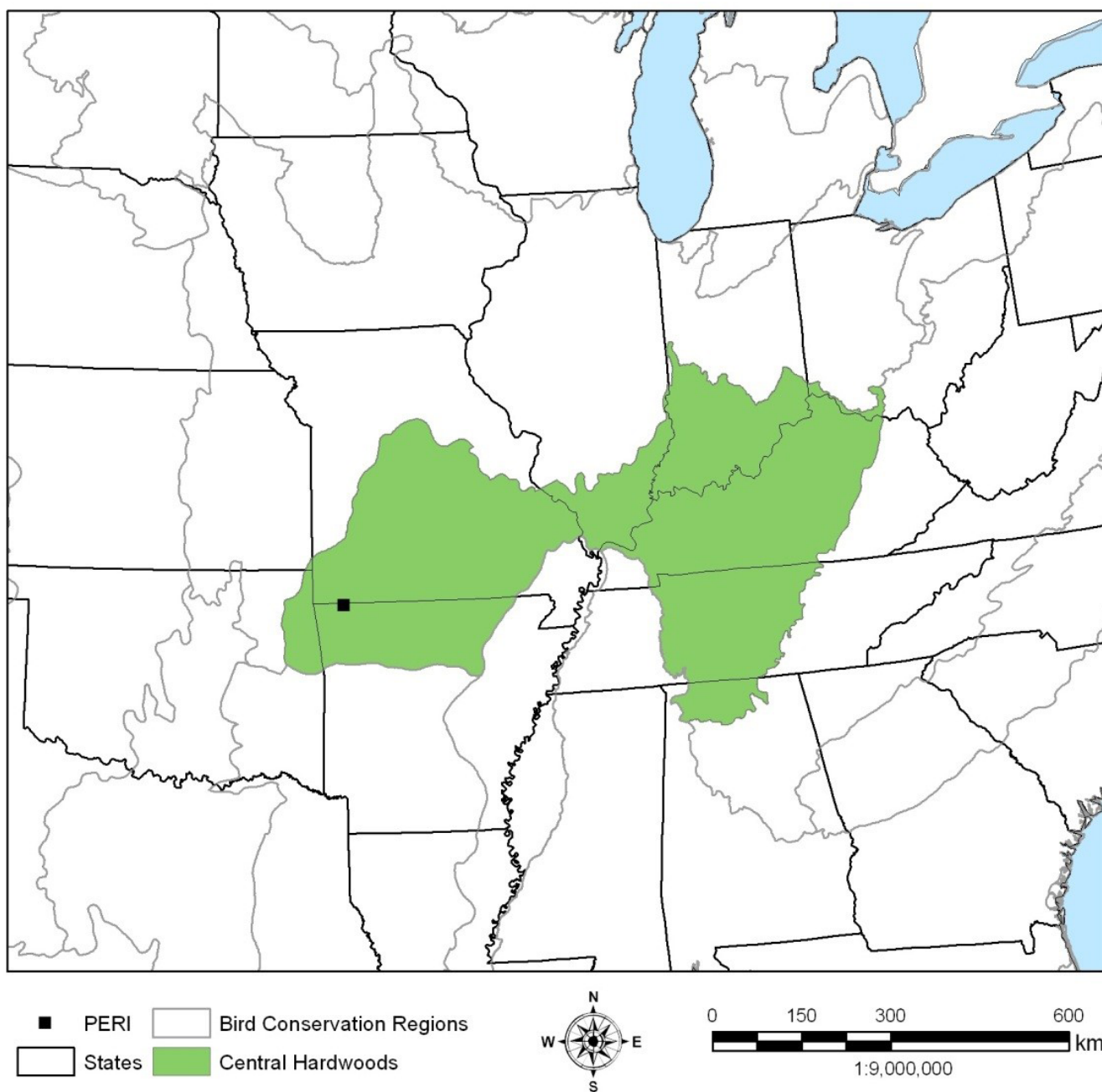


Figure 1. Location of Pea Ridge National Military Park, Arkansas, within the Central Hardwoods Bird Conservation Region.

Objectives

There are two primary objectives for monitoring breeding birds at Pea Ridge National Military Park:

- Identify significant temporal changes in the species composition and abundance of bird communities that occur on Pea Ridge National Military Park during the breeding season.
- Improve our understanding of relationships between breeding birds and their habitat and

the effects of management actions (such as stand thinning or prescribed fire) on bird populations, by examining potential correlations between changes in specific habitat variables (e.g., vegetation structure and ground cover) and changes in bird community composition and abundance.

This report summarizes species composition and population trends for birds recorded during 8 years of monitoring between 2008 and 2021.

Methods

Site Selection

Permanent monitoring locations or *plots* were selected by overlaying a systematic grid of 400 x 400-meter cells (originating from a random start point) on a park map. The orientation of the grid was rotated 45 degrees to prevent monitoring sites from being influenced by man-made features (roads, fences, etc.) located along cardinal directions. We established 99 permanent plots: 73 in woodland habitat, 16 in grassland habitat, and 10 in grassland-shrubland habitat (subsequently grouped with grassland plots for analysis; Figure 2). Monitoring occurred on 24 to 99 sites in each of the eight years when surveying occurred (Table 1; Appendix A).

During bird surveys in 2008 and 2012, monitoring plots were located using navigation waypoints (Peitz 2009) in a Trimble Geo XT GNSS unit and temporarily marked with 36-inch pin flags to aid in relocating the plots for habitat assessment, eliminating the need for permanent plot markers. We collected pin flags from each plot once the habitat work was completed. In 2009, 2010, 2013, and 2017 (years when habitat assessments were not conducted) and 2016 and 2021 (years when the habitat assessment crews and the birder worked separately), monitoring plots were located using a GNSS unit and were not marked with pin flags.

Bird Surveys

Bird surveys followed methods outlined in the bird monitoring protocol by Peitz et al. (2008) and summarized in this report. Variable circular plot counts, a point count methodology that incorporates a measure of detectability into population estimates, were used to survey birds present (Fancy 1997). All birds seen or heard at plots during 5-minute sampling periods were recorded along with their corresponding distance from the observer. For most species, we recorded each individual bird as a separate observation. For species that usually occur in clusters or flocks, the units recorded were cluster or flock size rather than the individual bird. During analysis, each individual in a cluster or flock was treated as a separate observation. After completing a count at a plot and filling out the data sheet, the observer navigated to the next plot using a GNSS unit. While traveling between plots, the observer was vigilant for the presence of species not recorded during timed surveys. These species help formulate a more complete species list for the park by identifying species missed during timed surveys. However, these observations were not included in any analysis as they did not directly relate to any individual plot. We sampled birds from when it was light enough to observe birds in the morning to approximately four hours after sunrise.

Table 1. Number of plots sampled and sampling dates for breeding bird surveys conducted at Pea Ridge National Military Park, Arkansas, by year. Also listed are observer(s) who conducted the surveys and whether habitat data were collected during the survey year. See Appendices B–E for the number of grassland and woodland plots sampled in each year.

Year	Sampling Dates	Number of Plots Sampled	Observer(s)	Habitat Data Collected
2008	May 12–May 18	99	D. G. Peitz*	Yes
2009	May 20–July 1	97	C. S. Canady, G. J. Wolcott, V. A. Olson, and N. W. Moore	No
2010	May 11–June 4	36	J. M. Cockrill, L. Heartfield, and S. P. Munch	No
2012	May 14–May 23	98	D. G. Peitz*	Yes
2013	June 6–June 25	24	K. A. Bolin	No
2016	May 16–May 23	99	D. G. Peitz*	Yes
2017	May 15–June 20	40	C. P. Stillings	No
2021	May 10–May 18	99	D. G. Peitz* and J. M. Williams*	Yes

*Heartland I&M Network staff.

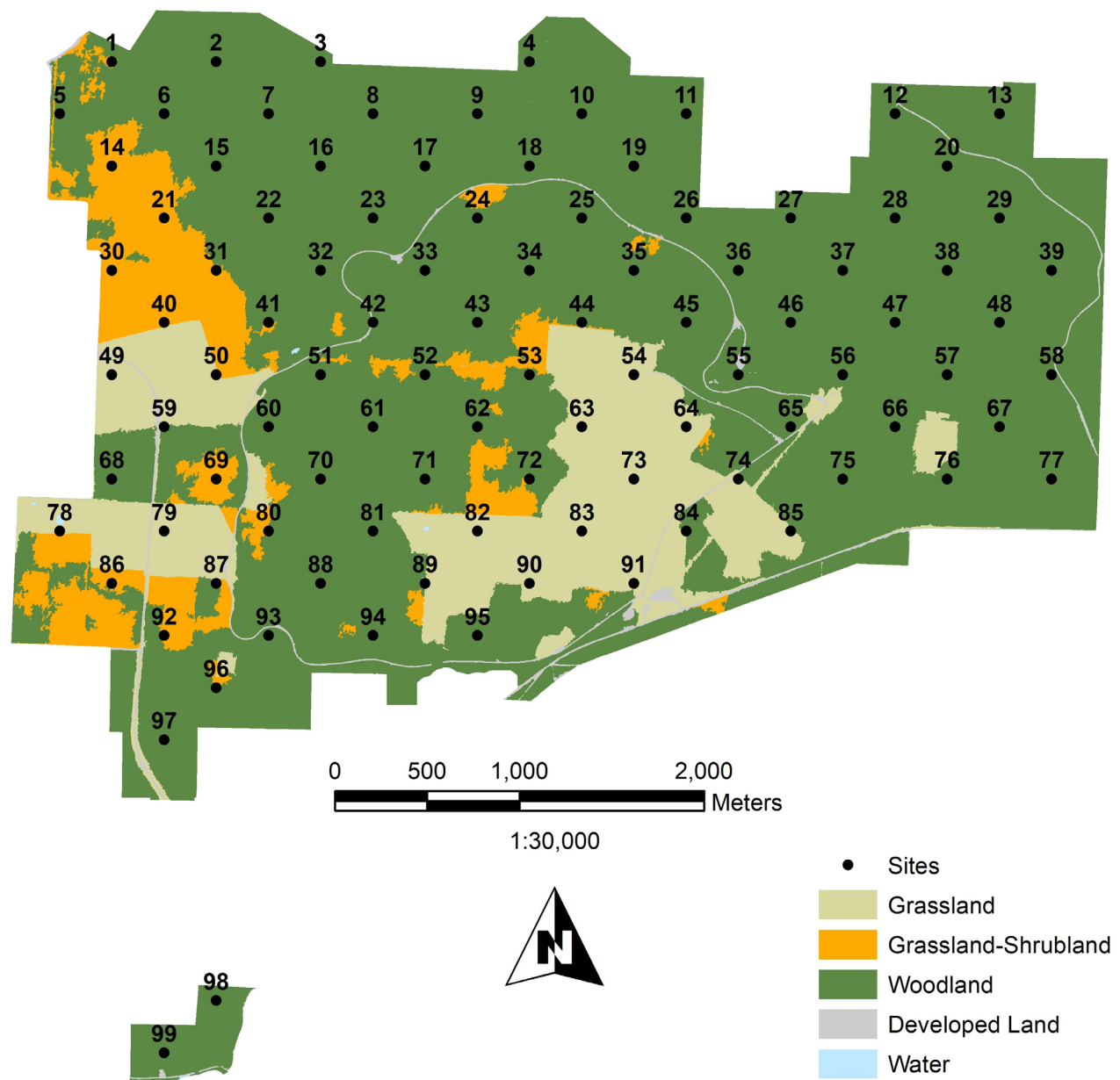


Figure 2. Bird plot locations on Pea Ridge National Military Park, Arkansas. Vegetation mapping and classification provided by Diamond et al. (2013).

Variable circular plot counts were conducted with an attempt to get an *instantaneous count* of all birds present. The observer recorded birds flushed from a plot when approached and the counts were started as soon as the observer reached plot center. We recorded all birds seen or heard, including flyovers, along with distance from the observer when possible. For this report, all birds seen or heard during the 5-minute survey are included.

Habitat Assessment

The collection of habitat data followed methods outlined in the bird monitoring protocol by Peitz et al. (2008) and summarized in this report. Habitat data were collected in 2008, 2012, 2016, and 2021. During years when habitat assessments occurred, plots were visited in generally the same order they were surveyed for birds to avoid disturbing birds on a plot prior to sampling. Once the habitat crew arrived at a plot, they completed all habitat measures for a 5-m radius subplot, a nested 1.78-m radius sample plot, and a larger 50-m radius plot.

Slope, slope variability, aspect, aspect variability, and topographic position of each 50-m radius plot were recorded during the first visit to a plot and not remeasured in subsequent years. The amount of various vegetation types (drainage, old field/prairie, shrub, woodland) and road and water cover on each 50-m plot were recorded. As 5-m subplots were sampled, horizontal vegetation cover was estimated in 0.25-m intervals from 0.0 to 2.0 meters above ground surface using a 0.15-m-wide cover board. Area of the cover board obscured by vegetation was estimated at a distance of 15 m north of plot center. Using a graduated measuring rod, vertical vegetation structure was measured in 1-m increments up to 7.5 meters in height at four locations around the perimeter of the subplot. Locations were in the four cardinal directions. Vertical structure was recorded for deciduous, coniferous, and herbaceous vegetation. Trees were tallied by species and diameter size class (<1.0 cm, 1.1–2.5 cm, 2.6–8.0 cm, 8.1–15.0 cm, 15.1–23.0 cm, 23.1–38.0 or >38.0 cm) on subplots. Lastly, at a 1.78-m sample plot nested within the subplot, ground and foliar cover were estimated. Ground cover classes included deciduous and grass litter, bare soil, rock, woody debris (>2.5 cm diameter), and unvegetated. Foliar cover was estimated for six plant guilds, including warm-season and cool-season grasses, forbs, moss and lichens, shrubs and vines, tree seedlings, and total foliar cover (<1.5 m tall).

Data Analysis

Prior to summary analysis, the residency status (migrant, permanent resident, summer resident, transient, winter resident) of each bird species recorded was determined. Identifying the residency of each species helps to exclude migrants, transients, and winter residents from analysis of breeding birds in Pea Ridge National Military Park. Proportion of plots occupied by each bird species was calculated (total number of plots occupied by a species/ plots surveyed) by habitat type and reported in Appendices B through E.

For species with greater than 60 observations recorded, Distance software (Distance 6.0 Release 2) was used to determine habitat-wide abundance (Buckland et al. 2001). A central part of the analysis in Distance is the modeling of a detection function to account for individuals present but not observed before calculating species abundance. Four candidate

functions plus series expansion—Half-normal + Cosine, Uniform + Cosine, Half-normal + Hemite polynomial, and Hazard-rate + Simple polynomial—were considered in determining the detection function of each species, and the most robust models were selected by Distance based on the lowest Akaike Information Criteria (AIC) values.

In grassland habitat the Hazard-rate + Simple polynomial function was selected for three species: Dickcissel (*Spiza americana*), Indigo Bunting (*Passerina cyanea*), and Northern Cardinal (*Cardinalis cardinalis*). The Uniform + Cosine function was chosen for one species: Field Sparrow (*Spizella pusilla*). Abundances for these species are reported in Appendix B.

In woodland habitat the Hazard-rate + Simple polynomial function was chosen for nine species: Blue-gray Gnatcatcher (*Poliophtila caerulea*), Eastern Wood-pewee (*Contopus virens*), Indigo Bunting, Northern Cardinal, Northern Parula (*Setophaga americana*), Red-bellied Woodpecker (*Melanerpes carolinus*), Red-eyed Vireo (*Vireo olivaceus*), Summer Tanager (*Piranga rubra*), and Yellow-throated Vireo (*Vireo flavifrons*). The Uniform + Cosine function was chosen for one species: Great Crested Flycatcher (*Myiarchus crinitus*). The Half-normal + Cosine was chosen for one species: Tufted Titmouse (*Baeolophus bicolor*). Abundances for these species are reported in Appendix D.

For species with fewer than 60 observations, habitat-wide abundance was calculated by first deriving a species density from observations recorded within a 200-m radius (12.57 ha) around each plot center and then calculating abundance based on average plot densities. Habitat-wide abundances for species with less than 60 observations are reported in Appendix C (grassland) and Appendix E (woodland).

For species with adequate abundance (those with greater than 60 observations) trends were calculated by regressing abundance against survey years in the statistical package “rtrim” (built under R version 3.6.3) and reported in Appendix F. Rtrim is the R version of the statistical software package “TRIM,” a program developed for the analysis of count data obtained from wildlife population monitoring (Pannekoek and Van Strien 2005). It analyzes time series of counts using Poisson regression and produces estimates of yearly indices and trends. We

employed a linear trend model with changepoints selected by a stepwise procedure. Serial correlation in count data among years and overdispersion are accounted for with this software.

For this report, we additionally obtained regional breeding bird trends for the Central Hardwoods Bird Conservation Region during the period 2008–2019 from the Breeding Bird Survey (BBS) website of the USGS Patuxent Wildlife Research Center (Appendix G; Sauer et al. 2020). It is possible to determine trends for many bird species and many regions of interest for periods ranging from 1966 to 2019 by using the [USGS breeding bird interactive calculator](https://www.mbr-pwrc.usgs.gov/bbs/trend/tf19.html) available at <https://www.mbr-pwrc.usgs.gov/bbs/trend/tf19.html>. We chose the last 12-year period of available data to maximize the comparability of regional trend results. We compared regional trends with those calculated using rtrim for the habitats of Pea Ridge National Military Park. Regional trends with a confidence interval that straddled zero were classified as uncertain for comparison with results from Pea Ridge National Military Park. It should be noted that trends determined by the BBS were calculated using a different methodology. Due to limitations in the BBS field data collections, hierarchical modeling was used to produce an annual index of abundance, and trends were then estimated as constant annual rates based only on the first and last years of the intervals selected. Since all but the first and last year indices are ignored in this approach, trends based on BBS data tend to display variability when compared among different broadly overlapping intervals, and interpretation of BBS results should be made with caution.

Trends in the diversity, richness, and species distribution evenness of the breeding bird community on the park were assessed by regressing each metric against survey years in the add-in statistical software of Microsoft Excel and then graphing the results. Prior to trend analysis, bird community diversity values were calculated annually using the Shannon Diversity Index:

$$H' = -\sum(n_i/N)\ln(n_i/N)$$

where n_i/N is the proportion of the total number of individuals in a population consisting of the i^{th} species (Shannon 1949). Species richness values were

determined as the total number of bird taxa recorded annually. Species distribution evenness values were calculated using Pielou's evenness index (J'):

$$J' = H'/H_{max}$$

where H' is the Shannon Diversity Index and H_{max} is the maximum possible diversity for a given number of species if all species are present in equal numbers ($\ln(\text{annual species richness})$). J' is a measure of how evenly individuals are distributed within a community when compared to the equal distribution and maximum diversity a community can have (Pielou 1969).

Because not all species occurring in an area may actually be observed in a survey (i.e., rare species may be missed), recorded species richness is often an underestimate. Statistical species richness estimators utilize the information in species distribution and abundance patterns to produce an estimate of true species richness. Species richness estimators are also useful in comparing surveys with unequal sampling effort (e.g., different numbers of plots) since more species are usually discovered with greater sampling effort. Different species richness estimators will produce varying estimates, however, and no single estimator is consistently superior to others. Nonparametric statistical estimators have generally performed better than parametric types (Walther and Moore 2005). Reese et al. (2014) recently reviewed nonparametric species richness estimators, and found that two coverage-based estimators, the Abundance Coverage-based Estimator (ACE) and Incidence Coverage-based Estimator (ICE), provided less biased and more accurate estimates than many of the others. Thus, we employed these two species richness estimators and report estimated species richness along with observed species richness. The software application EstimateS (Colwell 2013) was used to calculate the ACE and ICE estimators.

Location and permanent abiotic measures on each plot were reported by Peitz (2009). Annual averages ($\pm$ std dev) for semi-permanent plot data, including road and water cover, were calculated from plot estimates (Appendices H and I). Averages ($\pm$ std dev) for horizontal vegetation cover between 0–0.25, 0.25–0.50, 0.50–0.75, 0.75–1.00, 1.00–1.25, 1.25–1.50, 1.50–1.75, and 1.75–2.00 m were calculated

and reported. Average ($\pm$ std dev) annual vertical structure diversity was estimated and reported as well. Vertical structural diversity was calculated as

$$\text{Vertical Structure Diversity Index} = \frac{((\sum p_i / 8) + a) \cdot 100}{2}$$

where p_i is the observed frequency for vegetation in the i^{th} interval touching a measuring rod out of twelve measuring events, and a is the percent of intervals with recorded vegetation in eight height increments. Vertical structure diversity values are weighted equally to represent both the vertical height of vegetation and how dense the vegetation is within each height increment.

Within each plot, ground cover, including deciduous and grass litter, bare soil, rock, woody debris (>2.5 cm DBH), and unvegetated, were averaged ($\pm$ std dev) across plots and reported (Appendices H and I). Foliar cover by guild of warm-season and cool-season grasses, forbs, mosses and lichens, shrubs and vines, tree seedlings, and total foliar cover (<1.5 m tall) were averaged ($\pm$ std dev) across plots as well. Trees were identified to family and size class before summing stems per hectare for the park (Appendix J).



Bald Eagle (*Haliaeetus leucocephalus*). NPS

Results

Bird Surveys

During the eight surveys conducted between 2008 and 2021, 592 cumulative plots were surveyed, and 111 different bird species were recorded, 93 of which are species with the potential to breed within the park (Table 2; James and Neal 1986). One breeding species, Chuck-wills-widow (*Antrostomus carolinensis*), was only observed outside 5-minute survey periods. Nine of the breeding species recorded, Bald Eagle (*Haliaeetus leucocephalus*),

Bewick's Wren (*Thryomanes bewickii*), Blue-winged Warbler (*Vermivora cyanoptera*), Eastern Whip-poor-will (*Antrostomus vociferus*), Kentucky Warbler (*Geothlypis formosa*), Prairie Warbler (*Setophaga discolor*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Wood Thrush (*Hylocichla mustelina*), and Worm-eating Warbler (*Helmitheros vermivorum*) are considered species of regional concern for the Central Hardwoods Bird Conservation Region (USFWS 2008).

Table 2. Bird species recorded during breeding bird surveys at Pea Ridge National Military Park, Arkansas, from 2008 through 2021. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System website (ITIS 2021).

Common Name	Species Name	AOU Code	Residency ¹
Acadian Flycatcher	<i>Empidonax virescens</i>	ACFL	SR
American Crow	<i>Corvus brachyrhynchos</i>	AMCR	R
American Goldfinch	<i>Spinus tristis</i>	AMGO	R
American Kestrel	<i>Falco sparverius</i>	AMKE	R
American Redstart	<i>Setophaga ruticilla</i>	AMRE	SR
American Robin	<i>Turdus migratorius</i>	AMRO	R
American Tree Sparrow	<i>Spizelloides arborea</i>	ATSP	WR
American Woodcock	<i>Scolopax minor</i>	AMWO	R
Bald Eagle²	<i>Haliaeetus leucocephalus</i>	BAEA	R
Baltimore Oriole	<i>Icterus galbula</i>	BAOR	SR
Barn Swallow	<i>Hirundo rustica</i>	BARS	SR
Barred Owl	<i>Strix varia</i>	BADO	R
Bewick's Wren²	<i>Thryomanes bewickii</i>	BEWR	R
Black Vulture	<i>Coragyps atratus</i>	BLVU	R
Black-and-white Warbler	<i>Mniotilta varia</i>	BAWW	SR
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	BBCU	SR
Blue Grosbeak	<i>Passerina caerulea</i>	BLGR	SR
Blue Jay	<i>Cyanocitta cristata</i>	BLJA	R
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	BGGN	SR
Blue-winged Warbler²	<i>Vermivora cyanoptera</i>	BWWA	SR
Bobolink	<i>Dolichonyx oryzivorus</i>	BOBO	T
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	BRBL	WR
Broad-winged Hawk	<i>Buteo platypterus</i>	BWHA	SR
Brown Creeper	<i>Certhia americana</i>	BRCR	WR
Brown Thrasher	<i>Toxostoma rufum</i>	BRTH	R
Brown-headed Cowbird	<i>Molothrus ater</i>	BHCO	R

¹ Residency: M = Migrant; R = year around resident; SR = summer resident; T = transient; WR = winter resident; According to James and Neal (1986).

² Species of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

³ Species recorded only between point transects or other times outside of 5-minute survey periods.

Table 2 (continued). Bird species recorded during breeding bird surveys at Pea Ridge National Military Park, Arkansas, from 2008 through 2021. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System website (ITIS 2021).

Common Name	Species Name	AOU Code	Residency ¹
Canada Goose	<i>Branta canadensis</i>	CANG	R
Carolina Chickadee	<i>Poecile carolinensis</i>	CACH	R
Carolina Wren	<i>Thryothorus ludovicianus</i>	CARW	R
Cedar Waxwing	<i>Bombycilla cedrorum</i>	CEDW	WR
Chestnut-sided Warbler	<i>Setophaga pensylvanica</i>	CSWA	T
Chimney Swift	<i>Chaetura pelagica</i>	CHSW	SR
Chipping Sparrow	<i>Spizella passerina</i>	CHSP	SR
Chuck-will's-widow ³	<i>Antrostomus carolinensis</i>	CWWI	SR
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	CLSW	SR
Common Grackle	<i>Quiscalus quiscula</i>	COGR	R
Common Yellowthroat	<i>Geothlypis trichas</i>	COYE	SR
Dickcissel	<i>Spiza americana</i>	DICK	SR
Downy Woodpecker	<i>Dryobates pubescens</i>	DOWO	R
Eastern Bluebird	<i>Sialia sialis</i>	EABL	R
Eastern Kingbird	<i>Tyrannus tyrannus</i>	EAKI	SR
Eastern Meadowlark	<i>Sturnella magna</i>	EAME	R
Eastern Phoebe	<i>Sayornis phoebe</i>	EAPH	R
Eastern Towhee	<i>Pipilo erythrophthalmus</i>	EATO	R
Eastern Wood-pewee	<i>Contopus virens</i>	EAWP	SR
Eastern Whip-poor-will²	<i>Antrostomus vociferus</i>	EWPW	SR
European Starling	<i>Sturnus vulgaris</i>	EUST	R
Field Sparrow	<i>Spizella pusilla</i>	FISP	R
Fish Crow	<i>Corvus ossifragus</i>	FICR	SR
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	GRSP	SR
Gray Catbird	<i>Dumetella carolinensis</i>	GRCA	SR
Great Blue Heron	<i>Ardea herodias</i>	GBHE	R
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	GCFL	SR
Great Horned Owl	<i>Bubo virginianus</i>	GHOW	R
Hairy Woodpecker	<i>Leuconotopicus villosus</i>	HAWO	R
Henslow's Sparrow²	<i>Ammodramus henslowii</i>	HESP	T
Hermit Thrush	<i>Catharus guttatus</i>	HETH	WR
Hooded Warbler	<i>Setophaga citrina</i>	HOWA	SR
Horned Lark	<i>Eremophila alpestris</i>	HOLA	R
House Sparrow	<i>Passer domesticus</i>	HOSP	R
House Finch	<i>Haemorhous mexicanus</i>	HOFI	R
Indigo Bunting	<i>Passerina cyanea</i>	INBU	SR
Kentucky Warbler²	<i>Geothlypis formosa</i>	KEWA	SR
Killdeer	<i>Charadrius vociferus</i>	KILL	R

¹ Residency: M = Migrant; R = year around resident; SR = summer resident; T = transient; WR = winter resident; According to James and Neal (1986).

² Species of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

³ Species recorded only between point transects or other times outside of 5-minute survey periods.

Table 2 (continued). Bird species recorded during breeding bird surveys at Pea Ridge National Military Park, Arkansas, from 2008 through 2021. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System website (ITIS 2021).

Common Name	Species Name	AOU Code	Residency ¹
Lark Sparrow	<i>Chondestes grammacus</i>	LASP	SR
Louisiana Waterthrush	<i>Parkesia motacilla</i>	LOWA	SR
Mourning Dove	<i>Zenaida macroura</i>	MODO	R
Northern Bobwhite	<i>Colinus virginianus</i>	NOBO	R
Northern Cardinal	<i>Cardinalis cardinalis</i>	NOCA	R
Northern Flicker	<i>Colaptes auratus</i>	NOFL	R
Northern Mockingbird	<i>Mimus polyglottos</i>	NOMO	R
Northern Parula	<i>Setophaga americana</i>	NOPA	SR
Orchard Oriole	<i>Icterus spurius</i>	OROR	SR
Ovenbird	<i>Seiurus aurocapilla</i>	OVEN	SR
Pileated Woodpecker	<i>Dryocopus pileatus</i>	PIWO	R
Prairie Warbler²	<i>Setophaga discolor</i>	PRAW	SR
Purple Finch	<i>Haemorhous purpureus</i>	PUFI	WR
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	RBWO	R
Red-eyed Vireo	<i>Vireo olivaceus</i>	REVI	SR
Red-headed Woodpecker²	<i>Melanerpes erythrocephalus</i>	RHWO	R
Red-shouldered Hawk	<i>Buteo lineatus</i>	RSHA	R
Red-tailed Hawk	<i>Buteo jamaicensis</i>	RTHA	R
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	RWBL	R
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	RTHU	SR
Savannah Sparrow	<i>Passerculus sandwichensis</i>	SAVS	WR
Scarlet Tanager	<i>Piranga olivacea</i>	SCTA	SR
Scissor-tailed Flycatcher	<i>Tyrannus forficatus</i>	STFL	SR
Sharp-shinned Hawk	<i>Accipiter striatus</i>	SSHA	WR
Song Sparrow	<i>Melospiza melodia</i>	SOSP	WR
Sora	<i>Porzana carolina</i>	SORA	M
Summer Tanager	<i>Piranga rubra</i>	SUTA	SR
Swainson's Thrush	<i>Catharus ustulatus</i>	SWTH	T
Tree Swallow	<i>Tachycineta bicolor</i>	TRES	SR
Tufted Titmouse	<i>Baeolophus bicolor</i>	TUTI	R
Turkey Vulture	<i>Cathartes aura</i>	TUVU	R
Veery	<i>Catharus fuscescens</i>	VEER	T
Warbling Vireo	<i>Vireo gilvus</i>	WAVI	SR
White-breasted Nuthatch	<i>Sitta carolinensis</i>	WBNU	R
White-eyed Vireo	<i>Vireo griseus</i>	WEVI	SR
Wild Turkey	<i>Meleagris gallopavo</i>	WITU	R
Willow Flycatcher	<i>Empidonax traillii</i>	WIFL	SR
Wilson's Warbler	<i>Cardellina pusilla</i>	WIWA	T

¹ Residency: M = Migrant; R = year around resident; SR = summer resident; T = transient; WR = winter resident; According to James and Neal (1986).

² Species of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

³ Species recorded only between point transects or other times outside of 5-minute survey periods.

Table 2 (continued). Bird species recorded during breeding bird surveys at Pea Ridge National Military Park, Arkansas, from 2008 through 2021. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System website (ITIS 2021).

Common Name	Species Name	AOU Code	Residency ¹
Wood Thrush²	<i>Hylocichla mustelina</i>	WOTH	SR
Worm-eating Warbler²	<i>Helminthos vermivorum</i>	WEWA	SR
Yellow Warbler	<i>Setophaga petechia</i>	Yewa	SR
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	YBSA	WR
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	YBCU	SR
Yellow-breasted Chat	<i>Icteria virens</i>	YBCH	SR
Yellow-rumped Warbler	<i>Setophaga coronata</i>	YRWA	WR
Yellow-throated Vireo	<i>Vireo flavifrons</i>	YTVI	SR
Yellow-throated Warbler	<i>Setophaga dominica</i>	YTWA	SR

¹ Residency: M = Migrant; R = year around resident; SR = summer resident; T = transient; WR = winter resident; According to James and Neal (1986).

² Species of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

³ Species recorded only between point transects or other times outside of 5-minute survey periods.

Four breeding species in grassland and 11 in woodland habitats were observed during the survey period in numbers large enough to calculate annual abundances with some degree of confidence (Appendix B and Appendix D, respectively). Of these 15 species, only the Blue-gray Gnatcatcher (*Poliophtila caerulea*), Eastern Wood-pewee (*Contopus virens*), Red-eyed Vireo (*Vireo olivaceus*), and Tufted Titmouse (*Baeolophus bicolor*) showed significant directional trends in abundance (Figure 3b and Appendix F). These species had moderate to strongly increasing abundance trends in the woodland habitat. Except for these four species, all other species in both the grassland and woodland habitats had uncertain population trends over the 14 years since monitoring began. An uncertain trend means that no significant increases or decreases occurred, but it is not certain that trends were < 5% per year (see Appendix F).

Regionwide, the populations of Field Sparrow (*Spizella pusilla*) recorded in grassland habitat, Blue-gray Gnatcatcher in woodland habitat, and Indigo Bunting (*Passerina cyanea*) in both habitats are in decline (Figures 3a and 3b and Appendix G). The population of Red-bellied Woodpecker (*Melanerpes carolinus*) in woodland habitat is increasing regionwide. Dickcissel (*Spiza americana*) in grassland habitat; Eastern Wood-pewee, Great Crested Flycatcher (*Myiarchus crinitus*), Northern Parula (*Setophaga americana*), Red-eyed Vireo, Summer Tanager (*Piranga rubra*), and Yellow-throated Vireo

(*Vireo flavifrons*) in woodland habitat; and Northern Cardinal (*Cardinalis cardinalis*) in both habitats have stable populations. Regionwide, Tufted Titmouse in woodland habitat has an undetermined population trend.

Diversity, richness, and the evenness of individuals distributed across species in the breeding bird communities of both grassland and woodland habitats on Pea Ridge National Military Park were unchanged over the 14 monitoring years since 2008 (Figures 4a and 4b). For the grassland bird community, richness averaged 30 species annually. Average estimated annual species richness was 39 by the ACE estimator and 41 by the ICE estimator for this habitat. For the woodland bird community, richness averaged 35 species annually. Average estimated annual species richness was 46 by the ACE estimator and 47 by the ICE estimator for this habitat. These results should be interpreted with caution because inter-annual variability in the number of plots sampled may be influencing changes in these metrics. The deep dip in all three-diversity metrics for grassland birds in 2013, for example, is almost certainly the result of only 5 grassland plots being sampled by an inexperienced birder that year, as opposed to any actual reduction in bird species diversity. With such small sample sizes, even species richness estimators will underestimate true species richness.

Trend Estimates for Common Grassland Species

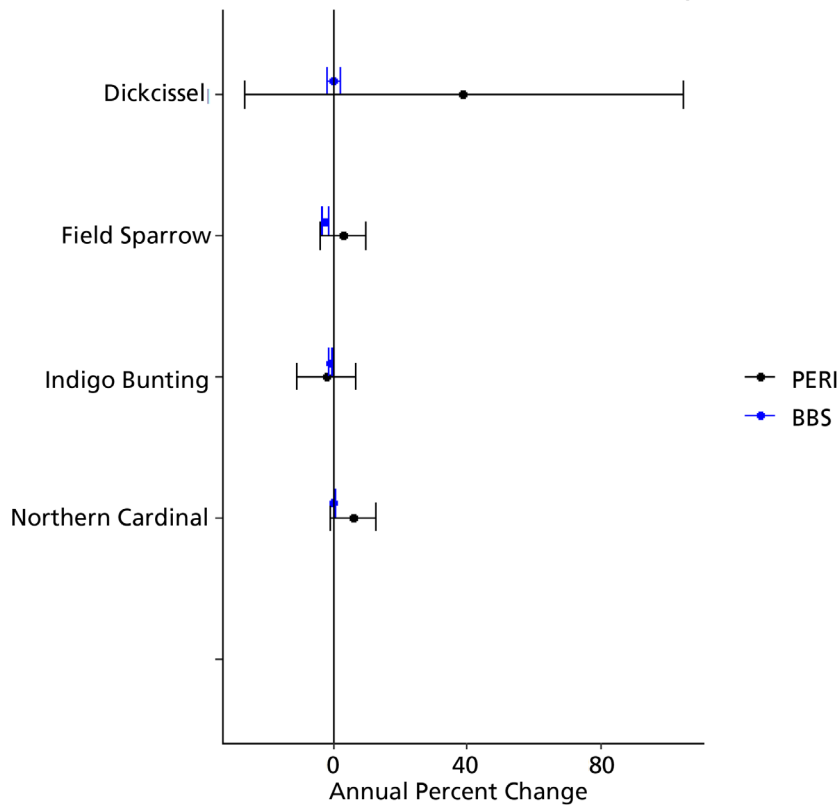


Figure 3a. Comparison of grassland bird population trends from Pea Ridge National Military Park, Arkansas, between 2008 and 2021 with those of the larger Central Hardwoods Bird Conservation Region (2008 through 2019). Error bars represent 95% confidence intervals.

Trend Estimates for Common Woodland Species

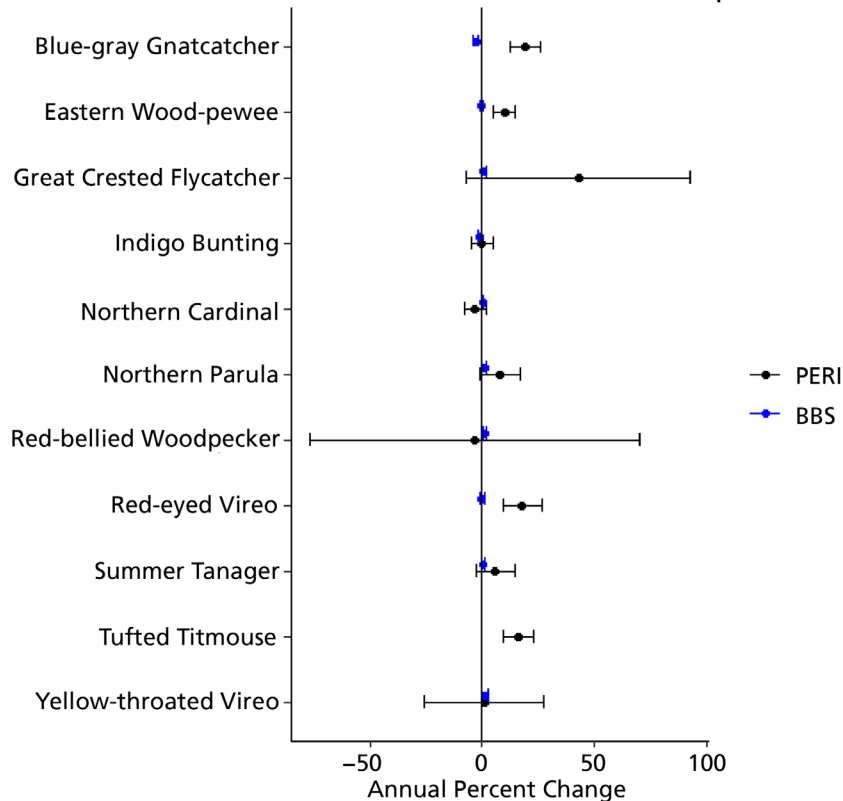


Figure 3b. Comparison of woodland bird population trends from Pea Ridge National Military Park, Arkansas, between 2008 and 2021 with those of the larger Central Hardwoods Bird Conservation Region (2008 through 2019). Error bars represent 95% confidence intervals. Regional trends were undetermined for Tufted Titmouse.

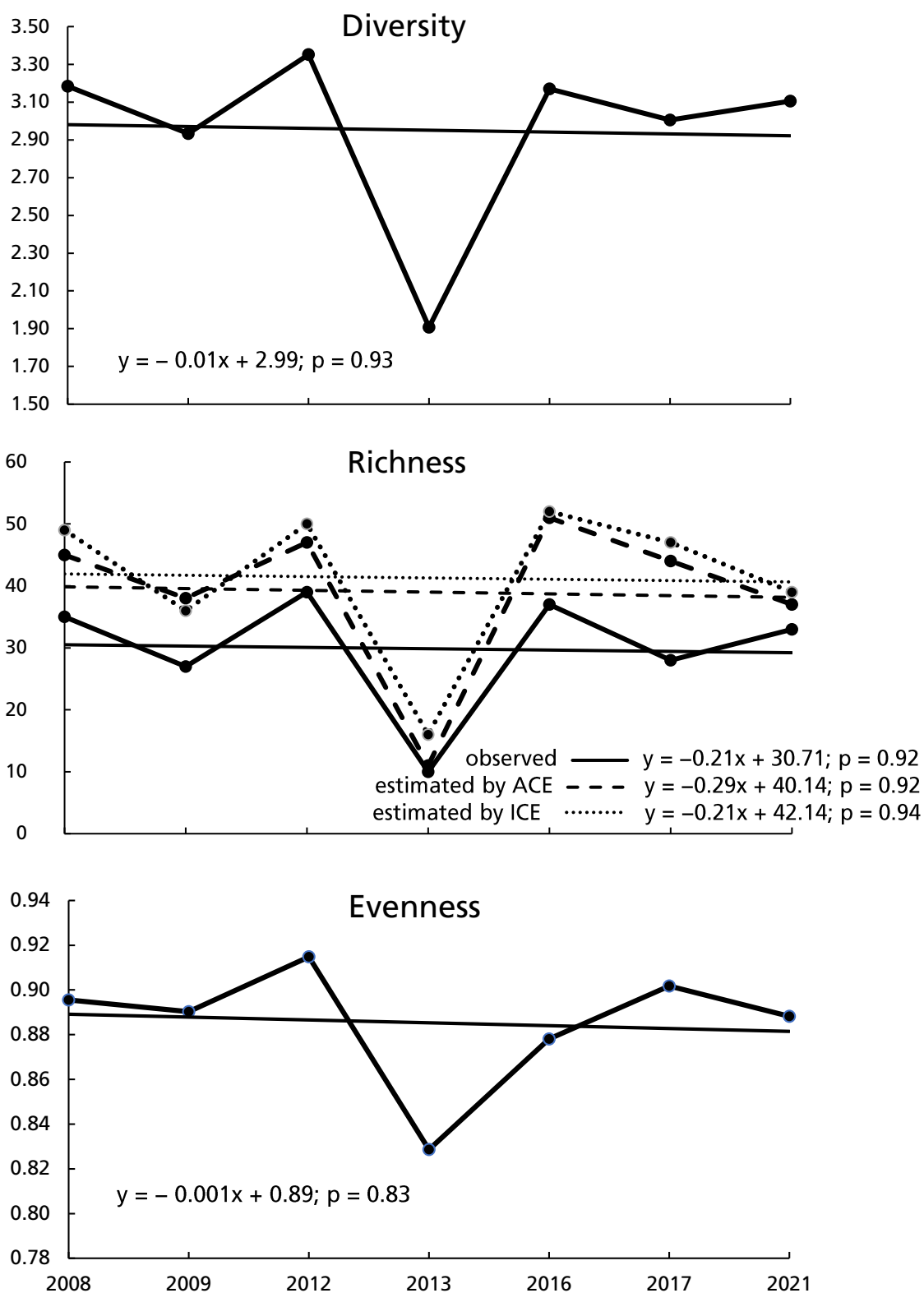


Figure 4a. Trends in grassland bird community diversity, richness, and species distribution evenness on Pea Ridge National Military Park, Arkansas, from 2008 through 2021.

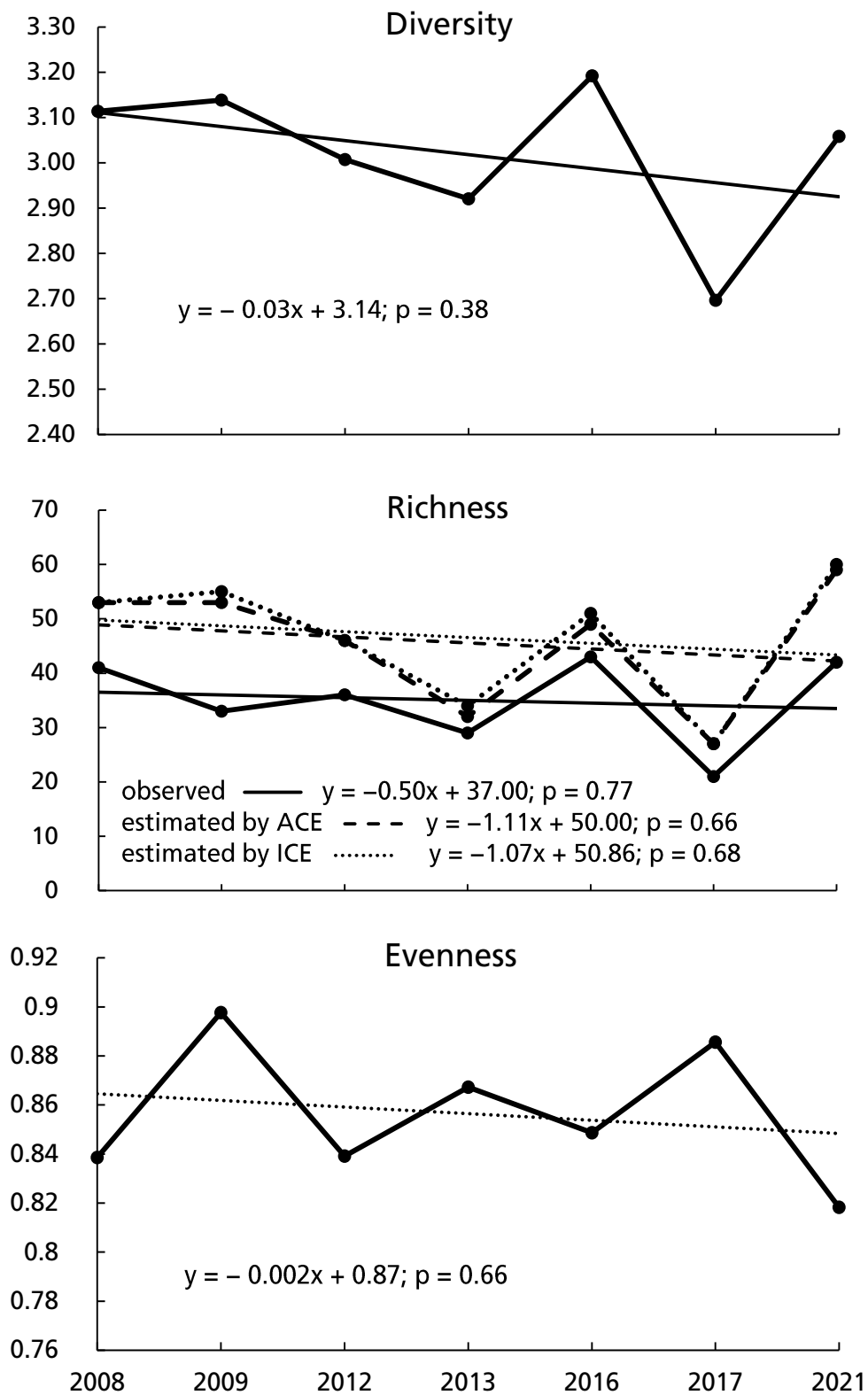


Figure 4b. Trends in woodland bird community diversity, richness, and species distribution evenness on Pea Ridge National Military Park, Arkansas, from 2008 through 2021.

Habitat Assessment

When sampled, habitats on the grassland plots at Pea Ridge National Military Park consisted primarily of the fescue/orchard grass (46–54%), old field/prairie type (18–32%), woodland (8–22%), and shrub (3–12%), with lesser amounts of other types present (Appendix H). Canopy cover averaged 8 to 18% on grassland plots, with cover provided primarily by hardwood trees, with some conifer trees present. Basal area of hardwood trees on grassland plots averaged between 1.63 and 2.88 m²/ha, and canopy height averaged 2.25 to 6.32 m. Tree species from 13 different families contributed to the canopy cover and basal area of grassland plots (Appendix J), with the largest trees occurring in the only non-hardwood family, the Cupressaceae (Eastern Redcedar, *Juniperus virginiana*). Trees from the Cupressaceae family are < 1 to 5% of the total canopy cover and have basal area of 0.10 to 0.30 m²/ha on plots sampled.

Habitats on woodland plots consisted primarily of the woodland (89–91%) and old field/prairie (3–4%) types, with lesser amounts of other types present (Appendix I). Canopy cover averaged 80 to 90% on woodland plots, with cover provided predominately by hardwood trees (78–80%). Basal area of hardwood trees on woodland plots averaged between 16.95 and 21.74 m²/ha, and canopy height averaged 16.14 to 22.02 m. Tree species from 21 different families contributed to the canopy cover and basal area (Appendix J) of woodland plots. However, the largest trees occurred in the Cannabaceae, Cornaceae, Cupressaceae, Fabaceae, Fagaceae, Juglandaceae, Nyssaceae, Rosaceae, and Sapindaceae families. Trees from the Cupressaceae family contributed 1 to 13% of the total canopy cover, had basal area of 0.49 to 2.77 m²/ha, and averaged between 1.19 and 2.89 m in height on plots sampled.

Across all grassland and woodland plots, the densest vegetation measures at the time of assessment (mid-May to mid-June) occurred in horizontal profile heights below 0.50 m (Appendices H and I). However, vegetation was measured in all height classes to 2.0 m. Average vertical structure diversity estimates across years ranged from 11 to 16% for grassland plots and 23 to 36% for woodland plots.

When sampled, grassland plots were primarily unvegetated (44–81%) at ground level, with grass litter (22–47%) common and bare soil (13–47%) exposed (Appendix H). Deciduous litter (1–9%), conifer litter (< 1–3%), woody debris (< 1–2%), and rock (< 1%) were also recorded on plots. Similarly, woodland plots were primarily unvegetated (72–88%) at ground level, with deciduous litter (49–65%) common and bare soil (10–23%) and rock (5–7%) exposed (Appendix I). Woody debris (6–13%), grass litter (3–5%), and conifer litter (< 1–7%) were also recorded on plots.

When sampled, foliar cover on grassland plots was dominated by cool-season grasses (19–53%) and forbs (12–26%), followed by woody shrubs and vines (4–13%), warm-season grasses (1–11%), tree seedlings (< 1–2%), and mosses and lichens (< 1%; Appendix H). Total foliar cover on grassland plots averaged between 44 and 83%. Foliar cover on woodland plots was dominated by cool-season grasses (3–16%), forbs (4–10%), and woody shrubs and vines (2–10%), followed by moss and lichens (< 1–5%), tree seedlings (1–7%), and warm-season grasses (< 1%; Appendix I). Total foliar coverage on woodland plots averaged 20 to 50%.

Discussion

The 93 species that are permanent or summer residents to the area (James and Neal 1986) help us characterize the breeding bird community and bird habitat at Pea Ridge National Military Park. The nine breeding species of concern for the Central Hardwoods Bird Conservation Region should be given additional consideration in the management of natural resources on the park: Bald Eagle (*Haliaeetus leucocephalus*), Bewick's Wren (*Thryomanes bewickii*), Blue-winged Warbler (*Vermivora cyanoptera*), Eastern Whip-poor-will (*Antrostomus vociferus*), Kentucky Warbler (*Geothlypis formosa*), Prairie Warbler (*Setophaga discolor*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Wood Thrush (*Hylocichla mustelina*), and Worm-eating Warbler (*Helminthos vermivorum*). However, all nine species were recorded on Pea Ridge National Military Park in low numbers, making it difficult to assess the influences of managing for their habitat requirements (Table 2, Appendix C and Appendix E).

If it is not feasible to directly manage habitat for these species of concern, then at least habitat should be managed in a way that does not conflict with their

habitat preferences (see the [Central Hardwoods Joint Venture web page](https://www.chjv.org/) at <https://www.chjv.org/> for individual species habitat requirements and management recommendations; CHJV 2020). For example, the complete removal of all riparian woodland habitat would be detrimental to the Kentucky Warbler and Wood Thrush. However, the clearing of eastern redcedar (*Juniperus virginiana*) stands and the restoration of an oak savannah landscape with occasional open glades would enhance habitat for grassland-shrub species like the Bewick's Wren, Blue-winged Warbler, and Prairie Warbler. Open grassland species like the Red-headed Woodpecker would also benefit from any management action that produces an open woodland/savannah habitat.

At the start of monitoring in 2008, woodlands dominated grasslands by a 3:1 margin at Pea Ridge National Military Park (Diamond et al. 2013). This is the result of forest densification, which has occurred throughout the Ozark Highlands in which the park is located. Currently the Ozark Highlands woodland to grassland mix is nearly 50:50, with woodland having a



A barred owl at Pea Ridge National Military Park, Arkansas. NPS

slightly greater presence (NPS 2012). Ongoing forest thinning and stand clearing operations within the park since 2008 have created a more balanced mix of woodland to grassland habitat.

The mix of woodlands and grasslands, along with other vegetation, provides a relatively large diversity of habitat types for birds. Of the breeding birds recorded, 44 are eastern forest species and eight are grassland species (Rosenberg et al. 2019). The remaining resident species are habitat generalists, wetland species, or edge species favored by the mix and positioning of habitats on the park and the creeks and ravines that run through it. The habitat diversity (structural composition) seen on the park is especially important for the species of regional concern, as their microhabitat requirements vary (Pashley and Barrow 1993). As stated above, Red-headed Woodpeckers prefer woodland/savannah habitat such as farmlands, open woodlands, orchards, and urban/suburban forest—forests that are not overly dense. Kentucky Warblers and Wood Thrush prefer moist deciduous bottomlands and ravines, and deciduous woodlands, but most other species of regional concern require thick shrubby or old field/grassland habitats (Stokes and Stokes 1996).

Habitat availability and quality affect bird population trends within a region. However, when suitable habitat of enough size to meet a bird's requirements is found locally, then population trends in that area may differ from that of the region. The opposite may be true as well. The uncertain population trends of all but four species on the park suggests their populations are changing little, if any. Comparing population trends on the park with regional trends for the Central Hardwoods Bird Conservation Region (Figure 3a and 3b) suggests that the bird community at Pea Ridge National Military Park is faring similarly to that of the region, with a few notable exceptions. Populations of Blue-gray Gnatcatcher (*Poliophtila caerulea*), Eastern Wood-pewee (*Contopus virens*), Red-eyed Vireo (*Vireo olivaceus*), and Tufted Titmouse (*Baeolophus bicolor*) in woodland habitat

are increasing on Pea Ridge National Military Park (Figure 3b; Appendix F). However, in the Central Hardwoods Bird Conservation Region as a whole, populations of Blue-gray Gnatcatcher are declining, and Eastern Wood-pewee and Red-eyed Vireo populations are stable, suggesting the 3:1 ratio of woodlands to grasslands have favored the woodland habitat requirement of these two species (Stokes and Stokes 1996). Tufted Titmouse population trends region-wide were undetermined. Conversely, Red-bellied Woodpeckers (*Melanerpes carolinus*) in woodland habitat are increasing regionwide while remaining stable on Pea Ridge National Military Park. Red-bellied Woodpeckers utilize open woodland (Stokes and Stokes 1996), and their populations will likely increase on the park as they have in the region because park management continues to reduce forest stand densities. Regionwide populations of Field Sparrow (*Spizella pusilla*) and Indigo Bunting (*Passerina cyanea*) are in decline (Figure 3a, 3b and Appendix G), but populations of these two species are stable on Pea Ridge National Military Park. For the rest of the abundant species on the park, their populations are stable regionwide and in the park.

Over the 14 years of bird monitoring on Pea Ridge National Military Park, the stable diversity, richness and evenness values of birds in both grassland and woodland habitats suggests that the ability of park habitat to meet most species' requirements has remained stable (Figures 4a and 4b). While changes in population sizes, especially of common and widely distributed species, may be utilized to assess changing habitat conditions, weather and climate also play a role in determining habitat and should always be considered. Therefore, continued monitoring of birds on Pea Ridge National Military Park as management and climatic conditions change is essential for park natural resource decision-making.

Literature Cited

- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press. 432 pp.
- Cairns Jr., J., P. V. McCormick and B. R. Niederlehner. 2004. A proposed framework for developing indicators of ecosystem health. *Hydrobiologia* 263:1–44.
- Central Hardwoods Joint Venture (CHJV). 2020. [CHJV bird habitat management recommendations](https://www.chjv.org/recommendations) <https://www.chjv.org/> (accessed 6 November 2020).
- Colwell, R. K. 2013. [EstimateS: Statistical estimation of species richness and shared species from samples. Version 9](http://purl.oclc.org/estimates). User's Guide and application published at <http://purl.oclc.org/estimates>.
- Diamond, D. D., L. F. Elliott, M. D. DeBacker, K. M. James, D. L. Pursell, and A. Struckhoff. 2013. Vegetation mapping and classification of Pea Ridge National Military Park. Natural Resource Report NPS/PERI/NRR—2013/649. National Park Service, Fort Collins, Colorado.
- Fancy, S. G. 1997. A new approach for analyzing bird densities from variable circular plot counts. *Pacific Science* 51:107–114.
- Fitzgerald, J. A., and D. N. Pashley. 2000. Partners in Flight bird conservation plan for the Ozarks/Ouachita (Physiographic Area 19). Cornell Lab of Ornithology, Ithaca, New York.
- Gregory R. D., J. Reif, L. Fornasari, I. J. Burfield, P. Chylarecki, A. Van Strien, P. Vorisek, F. D. R. Jiguet, and A. W. Gmelig Meyling. 2007. Population trends of widespread woodland birds in Europe. *Ibis* 149:78–97.
- Integrated Taxonomic Information System (ITIS). 2021. [ITIS: USGS plant name verification web site](http://www.itis.usda.gov/). <http://www.itis.usda.gov/> (accessed 15 October 2021).
- James, D. A., and J. C. Neal. 1986. Arkansas birds: their distribution and abundance. The University of Arkansas Press, Fayetteville.
- Karr, J. R. 1991. Biological integrity: a long-neglected aspect of water resource management. *Ecological Applications* 1:66–84.
- Karr, J. R., and D. R. Dudley. 1981. Ecological perspective on water quality goals. *Environmental Management* 5:55–68.
- Link, W. A., and J. R. Sauer. 1998. Estimating population change from count data: application to the North American breeding bird survey. *Ecological Applications* 8:258–266.
- Mallory, M. L., H. G. Gilchrist, B. M. Braune and A. J. Gaston. 2006. Marine birds as indicators of arctic marine ecosystem health: linking the northern ecosystem initiative to long-term studies. *Environmental Monitoring and Assessment* 113:31–48.
- Maurer, B. A. 1993. Biological diversity, ecological integrity, and neotropical migrants: New perspectives for wildlife managers. Pages 24–31 in D. M. Finch and P. W. Stangel, eds. Status and Management of Neotropical Migratory Birds. U.S. Forest Service General Technical Report RM-229.
- National Park Service (NPS). 2012. [NPScape GIS data store web site](http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm). Available at http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm (accessed 8 November 2012).
- North American Bird Conservation Initiative (NABCI). 2020. [North American bird conservation initiative](https://nabci-us.org/resources/bird-conservationregions-map/). Available at <https://nabci-us.org/resources/bird-conservationregions-map/> (accessed 25 June 2020).
- Pannekoek J., and A. J. Van Strien. 2005. TRIM 3 manual (Trends and Indices for Monitoring data). Statistics Netherlands, Voorburg, The Netherlands.

- Pashley, D. N., and W. C. Barrow. 1993. Effects of land use practices on neotropical migratory birds in bottomland hardwood forests. Pages 315–320 *in* D.M. Finch and P.W. Stangel, eds. Status and Management of Neotropical Migratory Birds. U.S. Forest Service General Technical Report RM-229.
- Peitz, D. G. 2009. Bird monitoring at Pea Ridge National Military Park, Arkansas 2008 status report. Natural Resource Technical Report NPS/HTLN/NRTR—2009/194. National Park Service, Fort Collins, Colorado.
- Peitz, D. G., G. A. Rowell, J. L. Haack, K. M. James, L. W. Morrison, and M. D. Debacker. 2008. Breeding bird monitoring protocol for the Heartland Network Inventory and Monitoring Program. Natural Resource Report NPS/HTLN/NRR-2008/044. National Park Service, Fort Collins, Colorado.
- Pielou, E. C. 1969. An introduction to mathematical ecology. John Wiley and Sons, New York, New York. 286 pp.
- Reese, G. C., K. R. Wilson, and C. H. Flather. 2014. Performance of species richness estimators across assemblage types and survey parameters. *Global Ecology and Biogeography*, 23:585–594.
- Rosenberg, K. V., A. M. Dokter, P. J. Blancher, J. R. Sauer, A. C. Smith, P. A. Smith, J. C. Stanton, A. Panjabi, L. Helft, M. Parr, and P. P. Marra. 2019. Decline of the North American avifauna. *Science* 10.1126/science.aaw1313 (2019).
- Sauer, J. R., W. A. Link, and J. E. Hines. 2020. [The North American breeding bird survey, analysis results 1966 - 2019](#). U.S. Geological Survey data release. Available at <https://doi.org/10.5066/P96A7675>.
- Shannon, C. E. 1949. The mathematical theory of communication. University of Illinois Press, Urbana, Illinois. 177 pp.
- Stokes, D. W., and L. Q. Stokes. 1996. Stokes field guide to birds: eastern region. Little, Brown and Company, New York, New York.
- U.S. Fish and Wildlife Service (USFWS). 2008. [Birds of conservation concern 2008](#). United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp. Online version available at <https://www.fws.gov/program/migratory-birds>.
- Van Strien, A. J., J. Pannekoek, and D. W. Gibbons. 2001. Indexing European bird population trends using results of national monitoring schemes: a trial of a new method. *Bird Study* 48:200–213.
- Walther, B. A., and J. L. Moore. 2005. The concepts of bias, precision and accuracy, and their use in testing the performance of species richness estimators, with a literature review of estimator performance. *Ecography* 28:815–829.
- Wood, J. K., N. Nur, C. A. Howell, and G. R. Geupel. 2006. Overview of Cosumnes riparian bird study and recommendations for monitoring and management. A Report to the California Bay-Delta Authority Ecosystem Restoration Program. Petaluma, California.

Appendix A. Plots Sampled

Table A1. Plots sampled on Pea Ridge National Military Park, Arkansas, between 2008 and 2021 and gross habitat type. "Yes" indicates plot was sampled in that year; "No" indicates it was not.

Plot	2008	2009	2010	2012	2013	2016	2017	2021	Plot Type
1	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland-Shrubland
2	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Woodland
3	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
4	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
5	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
6*	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
7	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Woodland
8*	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
9	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
10*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Woodland
11	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
12	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
13	Yes	No	No	Yes	Yes	Yes	No	Yes	Woodland
14	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland-Shrubland
15	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Woodland
16	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Woodland
17*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Woodland
18	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
19	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
20	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
21	Yes	Yes	No	No	No	Yes	Yes	Yes	Grassland-Shrubland
22*	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
23*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Woodland
24*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Woodland
25	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
26*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Woodland
27	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
28	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Woodland
29	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
30	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland-Shrubland
31	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland-Shrubland
32	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
33	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
34	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
35	Yes	No	Yes	Yes	No	Yes	No	Yes	Woodland
36	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
37	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
38	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland

* Plots that were included in analysis of individual bird species trends (also in bold).

Table A1 (continued). Plots sampled on Pea Ridge National Military Park, Arkansas, between 2008 and 2021 and gross habitat type. “Yes” indicates plot was sampled in that year; “No” indicates it was not.

Plot	2008	2009	2010	2012	2013	2016	2017	2021	Plot Type
39	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
40*	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Grassland-Shrubland
41	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland-Shrubland
42*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Woodland
43	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
44*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Woodland
45	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
46*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Woodland
47	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
48	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Woodland
49	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland
50	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland
51	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
52	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
53	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
54	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Grassland
55	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
56	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
57	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
58	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
59	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland
60*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
61	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
62	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Woodland
63	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Grassland
64*	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Grassland
65	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
66	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Woodland
67	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
68	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Woodland
69	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland-Shrubland
70*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Woodland
71	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
72	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
73	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Grassland
74	Yes	Yes	No	Yes	No	Yes	No	Yes	Grassland
75	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
76	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
77	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
78	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland

* Plots that were included in analysis of individual bird species trends (also in bold).

Table A1 (continued). Plots sampled on Pea Ridge National Military Park, Arkansas, between 2008 and 2021 and gross habitat type. “Yes” indicates plot was sampled in that year; “No” indicates it was not.

Plot	2008	2009	2010	2012	2013	2016	2017	2021	Plot Type
79*	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Grassland
80*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Woodland
81*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
82*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Grassland
83*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
84	Yes	Yes	No	Yes	No	Yes	No	Yes	Grassland
85	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Grassland
86	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland-Shrubland
87*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Woodland
88	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Woodland
89*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Woodland
90*	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Grassland
91	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland
92	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Grassland-Shrubland
93*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
94	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Woodland
95*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
96	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Woodland
97*	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
98	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland
99	Yes	Yes	No	Yes	No	Yes	No	Yes	Woodland

* Plots that were included in analysis of individual bird species trends (also in bold).

Appendix B. Proportion of Grassland Plots Occupied and Abundance (Corrected for Undetected Individuals)

Table B1. Annual proportion of grassland plots occupied by each breeding bird species and estimated abundance (determined using Distance software) of each species at Pea Ridge National Military Park, Arkansas, during the 2008 to 2021 spring bird surveys (n = number of plots sampled). Note that the proportion of plots occupied includes flyovers, whereas estimated abundance using Distance does not. “–” denotes when annual abundance value could not be calculated because the species was present, but distance measures from observers could not be determined.

Common Name	Proportion of Plots Occupied (Abundance)							
	2008 n = 26	2009 n = 26	2010 n = 7	2012 n = 25	2013 n = 5	2016 n = 26	2017 n = 19	2021 n = 26
Dickcissel	0.00 (0)	0.15 (30)	0.00 (0)	0.24 (127)	0.80 (629)	0.35 (171)	0.21 (52)	0.35 (106)
Field Sparrow	0.46 (109)	0.31 (50)	0.00 (0)	0.16 (32)	0.60 (109)	0.31 (43)	0.47 (65)	0.73 (100)
Indigo Bunting	0.31 (622)	0.58 (956)	0.14 (1243)	0.44 (951)	0.40 (497)	0.35 (595)	0.32 (414)	0.19 (777)
Northern Cardinal	0.35 (189)	0.46 (89)	0.29 (–)	0.24 (119)	0.40 (174)	0.50 (202)	0.53 (174)	0.54 (254)

Appendix C. Proportion of Grassland Plots Occupied and Abundance (Not Corrected for Undetected Individuals)

Table C1. Annual proportion of grassland plots occupied by each breeding bird species and estimated abundance (determined using birds within 200-m of plot center) of each species at Pea Ridge National Military Park, Arkansas, during the 2008 to 2021 spring bird surveys (n = number of plots sampled). Note that the proportion of plots occupied includes flyovers, whereas estimated abundance does not. “–” denotes when annual abundance value could not be calculated because the species was present, but distance measures from observers could not be determined or the species was outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)							
	2008 n = 26	2009 n = 26	2010 n = 7	2012 n = 25	2013 n = 5	2016 n = 26	2017 n = 19	2021 n = 26
Acadian Flycatcher	0.04 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.05 (2)	0.00 (0)
American Crow	0.31 (1)	0.50 (7)	0.57 (–)	0.04 (3)	0.80 (0)	0.00 (0)	0.53 (15)	0.62 (5)
American Goldfinch	0.08 (5)	0.00 (0)	0.00 (0)	0.00 (0)	0.20 (13)	0.15 (1)	0.05 (2)	0.00 (0)
American Redstart	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.04 (2)
American Robin	0.08 (2)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.04 (–)
American Woodcock	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Bald Eagle*	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (–)
Baltimore Oriole	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.08 (1)	0.00 (0)	0.00 (0)
Barn Swallow	0.12 (–)	0.08 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (–)	0.11 (14)	0.15 (–)
Barred Owl	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)
Black and White Warbler	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.04 (1)
Black Vulture	0.00 (0)	0.00 (0)	0.14 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Blue-gray Gnatcatcher	0.15 (5)	0.12 (1)	0.00 (0)	0.04 (1)	0.00 (0)	0.04 (2)	0.16 (5)	0.23 (16)
Blue Grosbeak	0.00 (0)	0.04 (–)	0.00 (0)	0.08 (4)	0.00 (0)	0.15 (5)	0.00 (0)	0.00 (0)
Blue Jay	0.12 (–)	0.23 (5)	0.14 (–)	0.00 (0)	0.00 (0)	0.08 (1)	0.00 (0)	0.12 (6)
Blue-winged Warbler	0.08 (2)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.12 (4)	0.00 (0)	0.04 (1)
Brown-headed Cowbird	0.12 (4)	0.08 (4)	0.00 (0)	0.16 (9)	0.00 (0)	0.35 (7)	0.00 (0)	0.08 (2)
Brown Thrasher	0.08 (4)	0.00 (0)	0.00 (0)	0.00 (0)	0.20 (6)	0.04 (1)	0.16 (5)	0.08 (4)
Canada Goose	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.08 (–)
Carolina Chickadee	0.04 (1)	0.00 (0)	0.00 (0)	0.04 (3)	0.00 (0)	0.00 (0)	0.05 (2)	0.12 (5)
Carolina Wren	0.15 (5)	0.00 (0)	0.00 (0)	0.12 (3)	0.00 (0)	0.12 (5)	0.05 (2)	0.00 (0)
Chimney Swift	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (–)	0.00 (0)	0.00 (0)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

Table C1 (continued). Annual proportion of grassland plots occupied by each breeding bird species and estimated abundance (determined using birds within 200-m of plot center) of each species at Pea Ridge National Military Park, Arkansas, during the 2008 to 2021 spring bird surveys (n = number of plots sampled). Note that the proportion of plots occupied includes flyovers, whereas estimated abundance does not. “–” denotes when annual abundance value could not be calculated because the species was present, but distance measures from observers could not be determined or the species was outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)							
	2008 n = 26	2009 n = 26	2010 n = 7	2012 n = 25	2013 n = 5	2016 n = 26	2017 n = 19	2021 n = 26
Chipping Sparrow	0.04 (1)	0.12 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)
Cliff Swallow	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.05 (–)	0.00 (0)
Common Grackle	0.00 (0)	0.15 (17)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Common Yellowthroat	0.12 (5)	0.08 (2)	0.00 (0)	0.08 (3)	0.00 (0)	0.31 (15)	0.05 (2)	0.15 (5)
Eastern Bluebird	0.08 (5)	0.00 (0)	0.00 (0)	0.12 (10)	0.00 (0)	0.00 (0)	0.05 (–)	0.04 (2)
Eastern Kingbird	0.04 (2)	0.04 (–)	0.14 (–)	0.28 (14)	0.00 (0)	0.04 (–)	0.05 (2)	0.08 (2)
Eastern Meadowlark	0.38 (16)	0.35 (11)	0.14 (–)	0.16 (5)	0.40 (51)	0.27 (14)	0.05 (2)	0.58 (15)
Eastern Phoebe	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.15 (5)
Eastern Towhee	0.42 (12)	0.19 (–)	0.00 (0)	0.16 (6)	0.00 (0)	0.27 (7)	0.26 (7)	0.12 (2)
Eastern Whip-poor-will*	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Eastern Wood-pewee	0.12 (1)	0.04 (–)	0.00 (0)	0.04 (1)	0.00 (0)	0.15 (5)	0.16 (5)	0.19 (1)
European Starling	0.00 (0)	0.08 (9)	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.19 (12)
Grasshopper Sparrow	0.23 (9)	0.08 (1)	0.00 (0)	0.12 (4)	0.00 (0)	0.27 (12)	0.00 (0)	0.23 (7)
Gray Catbird	0.04 (1)	0.00 (0)	0.00 (0)	0.08 (3)	0.20 (6)	0.04 (1)	0.00 (0)	0.08 (2)
Great Blue Heron	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.04 (–)
Great Crested Flycatcher	0.04 (1)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Great Horned Owl	0.00 (0)	0.00 (0)	0.14 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Horned Lark	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
House Sparrow	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Kentucky Warbler*	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Killdeer	0.00 (0)	0.04 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Lark Sparrow	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Louisiana Waterthrush	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Mourning Dove	0.04 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.12 (2)	0.11 (3)	0.04 (1)
Northern Bobwhite	0.04 (1)	0.27 (–)	0.00 (0)	0.16 (9)	0.20 (13)	0.15 (4)	0.11 (8)	0.00 (0)
Northern Flicker	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

Table C1 (continued). Annual proportion of grassland plots occupied by each breeding bird species and estimated abundance (determined using birds within 200-m of plot center) of each species at Pea Ridge National Military Park, Arkansas, during the 2008 to 2021 spring bird surveys (n = number of plots sampled). Note that the proportion of plots occupied includes flyovers, whereas estimated abundance does not. “–” denotes when annual abundance value could not be calculated because the species was present, but distance measures from observers could not be determined or the species was outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)							
	2008 n = 26	2009 n = 26	2010 n = 7	2012 n = 25	2013 n = 5	2016 n = 26	2017 n = 19	2021 n = 26
Northern Mockingbird	0.00 (0)	0.00 (0)	0.00 (0)	0.08 (3)	0.00 (0)	0.12 (5)	0.00 (0)	0.00 (0)
Northern Parula	0.15 (5)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.19 (7)	0.05 (2)	0.08 (2)
Orchard Oriole	0.00 (0)	0.00 (0)	0.00 (0)	0.08 (3)	0.00 (0)	0.00 (0)	0.05 (2)	0.00 (0)
Prairie Warbler*	0.08 (2)	0.00 (0)	0.00 (0)	0.16 (6)	0.00 (0)	0.04 (2)	0.05 (2)	0.00 (0)
Red-bellied Woodpecker	0.04 (–)	0.08 (2)	0.14 (–)	0.04 (–)	0.00 (0)	0.08 (1)	0.00 (0)	0.27 (9)
Red-eyed Vireo	0.00 (0)	0.04 (–)	0.00 (0)	0.20 (6)	0.00 (0)	0.04 (1)	0.11 (3)	0.08 (2)
Red-shouldered Hawk	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.20 (–)	0.00 (0)	0.00 (0)	0.00 (0)
Red-tailed Hawk	0.04 (1)	0.23 (5)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.05 (2)	0.08 (–)
Red-winged Blackbird	0.08 (6)	0.15 (5)	0.00 (0)	0.04 (10)	0.00 (0)	0.08 (4)	0.00 (0)	0.08 (9)
Ruby-throated Hummingbird	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (–)	0.00 (0)	0.00 (0)
Scissor-tailed Flycatcher	0.00 (0)	0.08 (2)	0.00 (0)	0.04 (1)	0.20 (13)	0.08 (1)	0.05 (2)	0.00 (0)
Summer Tanager	0.08 (2)	0.08 (2)	0.00 (0)	0.12 (3)	0.00 (0)	0.15 (2)	0.16 (5)	0.04 (2)
Tree Swallow	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (–)
Tufted Titmouse	0.23 (7)	0.12 (2)	0.00 (0)	0.08 (4)	0.40 (–)	0.12 (4)	0.26 (7)	0.65 (17)
Turkey Vulture	0.00 (0)	0.12 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.05 (–)	0.12 (–)
Warbling Vireo	0.00 (0)	0.04 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
White-breasted Nuthatch	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
White-eyed Vireo	0.08 (2)	0.00 (0)	0.00 (0)	0.08 (3)	0.00 (0)	0.08 (2)	0.00 (0)	0.00 (0)
Willow Flycatcher	0.00 (0)	0.00 (0)	0.00 (0)	0.20 (6)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Wood Thrush*	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Yellow-billed Cuckoo	0.00 (0)	0.00 (0)	0.00 (0)	0.12 (3)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Yellow-breasted Chat	0.19 (6)	0.04 (–)	0.00 (0)	0.12 (4)	0.20 (–)	0.08 (2)	0.05 (2)	0.19 (6)
Yellow-throated Vireo	0.15 (5)	0.04 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

Appendix D. Proportion of Woodland Plots Occupied and Abundance (Corrected for Undetected Individuals)

Table D1. Annual proportion of woodland plots occupied by each breeding bird species and estimated abundance (determined using Distance software) of each species at Pea Ridge National Military Park, Arkansas, during the 2008 to 2021 spring bird surveys (n = number of plots sampled). Note that the proportion of plots occupied includes flyovers, whereas estimated abundance using Distance does not.

Common Name	Proportion of Plots Occupied (Abundance)							
	2008 n = 73	2009 n = 71	2010 n = 29	2012 n = 73	2013 n = 19	2016 n = 73	2017 n = 21	2021 n = 73
Blue-gray Gnatcatcher	0.22 (913)	0.30 (693)	0.03 (841)	0.40 (1589)	0.26 (885)	0.34 (1456)	0.29 (961)	0.52 (2028)
Eastern Wood-pewee	0.36 (196)	0.20 (31)	0.00 (0)	0.40 (205)	0.47 (250)	0.23 (149)	0.62 (326)	0.51 (303)
Great Crested Flycatcher	0.01 (19)	0.07 (79)	0.00 (0)	0.26 (427)	0.05 (70)	0.14 (240)	0.00 (0)	0.33 (532)
Indigo Bunting	0.29 (919)	0.45 (525)	0.03 (447)	0.25 (620)	0.42 (1128)	0.29 (773)	0.67 (1191)	0.26 (710)
Northern Cardinal	0.30 (352)	0.66 (275)	0.55 (424)	0.30 (318)	0.63 (670)	0.41 (443)	0.29 (243)	0.38 (372)
Northern Parula	0.27 (293)	0.08 (27)	0.00 (0)	0.25 (233)	0.42 (540)	0.22 (237)	0.10 (89)	0.26 (281)
Red-bellied Woodpecker	0.22 (169)	0.35 (149)	0.24 (211)	0.15 (117)	0.11 (89)	0.25 (227)	0.19 (161)	0.19 (174)
Red-eyed Vireo	0.11 (157)	0.24 (202)	0.03 (344)	0.29 (439)	0.42 (651)	0.40 (636)	0.43 (589)	0.33 (489)
Summer Tanager	0.37 (434)	0.10 (153)	0.00 (0)	0.48 (555)	0.74 (1052)	0.29 (311)	0.33 (290)	0.27 (274)
Tufted Titmouse	0.27 (243)	0.23 (48)	0.03 (203)	0.38 (394)	0.89 (1152)	0.47 (448)	0.19 (154)	0.58 (567)
Yellow-throated Vireo	0.44 (648)	0.01 (36)	0.00 (0)	0.15 (221)	0.21 (258)	0.10 (128)	0.00 (0)	0.21 (285)

Appendix E. Proportion of Woodland Plots Occupied and Abundance (Not Corrected for Undetected Individuals)

Table E1. Annual proportion of woodland plots occupied by each breeding bird species and estimated abundance (determined using birds within 200 m of plot center) of each species at Pea Ridge National Military Park, Arkansas, during the 2008 to 2021 spring bird surveys (n = number of plots sampled). Note that the proportion of plots occupied includes flyovers, whereas estimated abundance does not. “–” denotes when annual abundance value could not be calculated because the species was present, but distance measures from observers could not be determined or the species was outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)							
	2008 n = 73	2009 n = 71	2010 n = 29	2012 n = 73	2013 n = 19	2016 n = 73	2017 n = 21	2021 n = 73
Acadian Flycatcher	0.23 (–)	0.07 (6)	0.00 (0)	0.00 (0)	0.21 (27)	0.22 (26)	0.38 (39)	0.00 (0)
American Crow	0.05 (1)	0.39 (7)	0.38 (–)	0.10 (7)	0.42 (6)	0.14 (7)	0.67 (69)	0.22 (7)
American Goldfinch	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (–)	0.00 (0)	0.03 (6)
American Kestrel	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (1)	0.00 (0)	0.00 (0)
American Redstart	0.05 (9)	0.06 (1)	0.00 (0)	0.05 (6)	0.00 (0)	0.07 (7)	0.05 (5)	0.21 (28)
American Robin	0.00 (0)	0.01 (1)	0.00 (0)	0.01 (1)	0.00 (0)	0.03 (3)	0.00 (0)	0.01 (1)
Baltimore Oriole	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.05 (6)	0.00 (0)	0.00 (0)
Barn Swallow	0.00 (0)	0.01 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Barred Owl	0.00 (0)	0.01 (–)	0.00 (0)	0.03 (1)	0.00 (0)	0.03 (1)	0.00 (0)	0.01 (1)
Bewick's Wren*	0.04 (4)	0.01 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Black and White Warbler	0.11 (11)	0.01 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.08 (8)	0.05 (5)	0.01 (1)
Black-billed Cuckoo	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (4)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Black Vulture	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (–)
Blue Jay	0.08 (6)	0.30 (4)	0.17 (4)	0.14 (14)	0.16 (16)	0.05 (1)	0.10 (10)	0.11 (7)
Blue-winged Warbler*	0.00 (0)	0.04 (1)	0.03 (4)	0.10 (10)	0.00 (0)	0.01 (1)	0.00 (0)	0.00 (0)
Broad-winged Hawk	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (–)
Brown-headed Cowbird	0.04 (4)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (6)	0.05 (5)	0.04 (14)
Brown Thrasher	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (1)	0.00 (0)	0.00 (0)
Carolina Chickadee	0.01 (1)	0.14 (1)	0.03 (–)	0.07 (9)	0.21 (27)	0.07 (7)	0.24 (25)	0.15 (16)
Carolina Wren	0.19 (24)	0.06 (–)	0.00 (0)	0.05 (6)	0.42 (43)	0.14 (16)	0.43 (44)	0.00 (0)
Chimney Swift	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (–)
Chipping Sparrow	0.01 (1)	0.01 (1)	0.00 (0)	0.00 (0)	0.05 (5)	0.03 (4)	0.00 (0)	0.01 (1)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

Table E1 (continued). Annual proportion of woodland plots occupied by each breeding bird species and estimated abundance (determined using birds within 200 m of plot center) of each species at Pea Ridge National Military Park, Arkansas, during the 2008 to 2021 spring bird surveys (n = number of plots sampled). Note that the proportion of plots occupied includes flyovers, whereas estimated abundance does not. “–” denotes when annual abundance value could not be calculated because the species was present, but distance measures from observers could not be determined or the species was outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)							
	2008 n = 73	2009 n = 71	2010 n = 29	2012 n = 73	2013 n = 19	2016 n = 73	2017 n = 21	2021 n = 73
Common Yellowthroat	0.00 (0)	0.03 (1)	0.00 (0)	0.01 (1)	0.00 (0)	0.04 (4)	0.00 (0)	0.03 (4)
Dickcissel	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.05 (11)	0.01 (1)	0.00 (0)	0.00 (0)
Downy Woodpecker	0.00 (0)	0.04 (3)	0.07 (–)	0.01 (1)	0.21 (27)	0.03 (3)	0.00 (0)	0.00 (0)
Eastern Bluebird	0.00 (0)	0.00 (0)	0.03 (4)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Eastern Kingbird	0.00 (0)	0.00 (0)	0.03 (7)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Eastern Meadowlark	0.00 (0)	0.01 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (–)
Eastern Phoebe	0.03 (3)	0.07 (4)	0.07 (7)	0.00 (0)	0.00 (0)	0.01 (1)	0.00 (0)	0.05 (5)
Eastern Towhee	0.12 (14)	0.11 (1)	0.00 (0)	0.11 (10)	0.11 (11)	0.05 (6)	0.00 (0)	0.01 (1)
Eastern Whip-poor-will*	0.01 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (1)
Field Sparrow	0.07 (6)	0.01 (–)	0.00 (0)	0.01 (1)	0.11 (11)	0.04 (4)	0.05 (5)	0.12 (13)
Fish Crow	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (–)	0.05 (11)	0.00 (0)	0.00 (0)	0.00 (0)
Grasshopper Sparrow	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.03 (4)
Gray Catbird	0.01 (1)	0.00 (0)	0.00 (0)	0.03 (3)	0.05 (5)	0.00 (0)	0.00 (0)	0.01 (1)
Great Horned Owl	0.00 (0)	0.03 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Hairy Woodpecker	0.01 (1)	0.10 (3)	0.00 (0)	0.01 (1)	0.05 (5)	0.03 (3)	0.00 (0)	0.01 (1)
Hooded Warbler	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.04 (4)
House Finch	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (1)
Kentucky Warbler*	0.05 (6)	0.01 (–)	0.00 (0)	0.07 (7)	0.11 (11)	0.08 (9)	0.00 (0)	0.03 (3)
Louisiana Waterthrush	0.01 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (3)	0.00 (0)	0.00 (0)
Mourning Dove	0.00 (0)	0.01 (1)	0.07 (–)	0.01 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (1)
Northern Bobwhite	0.00 (0)	0.01 (–)	0.00 (0)	0.05 (–)	0.00 (0)	0.01 (–)	0.00 (0)	0.00 (0)
Northern Flicker	0.00 (0)	0.00 (0)	0.07 (–)	0.00 (0)	0.05 (5)	0.00 (0)	0.00 (0)	0.00 (0)
Northern Mockingbird	0.01 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.03 (3)
Ovenbird	0.01 (1)	0.03 (–)	0.00 (0)	0.01 (1)	0.00 (0)	0.04 (4)	0.00 (0)	0.04 (4)
Pileated Woodpecker	0.12 (9)	0.07 (4)	0.00 (0)	0.01 (–)	0.00 (0)	0.07 (6)	0.05 (5)	0.16 (15)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

Table E1 (continued). Annual proportion of woodland plots occupied by each breeding bird species and estimated abundance (determined using birds within 200 m of plot center) of each species at Pea Ridge National Military Park, Arkansas, during the 2008 to 2021 spring bird surveys (n = number of plots sampled). Note that the proportion of plots occupied includes flyovers, whereas estimated abundance does not. “–” denotes when annual abundance value could not be calculated because the species was present, but distance measures from observers could not be determined or the species was outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)							
	2008 n = 73	2009 n = 71	2010 n = 29	2012 n = 73	2013 n = 19	2016 n = 73	2017 n = 21	2021 n = 73
Prairie Warbler*	0.01 (1)	0.00 (0)	0.00 (0)	0.01 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Red-headed Woodpecker*	0.00 (0)	0.01 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Red-shouldered Hawk	0.00 (0)	0.00 (0)	0.00 (0)	0.01 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Red-tailed Hawk	0.03 (–)	0.00 (0)	0.00 (0)	0.03 (1)	0.05 (–)	0.01 (–)	0.00 (0)	0.01 (–)
Ruby-throated Hummingbird	0.01 (–)	0.01 (1)	0.00 (0)	0.01 (–)	0.00 (0)	0.04 (–)	0.00 (0)	0.00 (0)
Scarlet Tanager	0.05 (6)	0.00 (0)	0.03 (5)	0.00 (0)	0.00 (0)	0.00 (0)	0.05 (5)	0.00 (0)
Turkey Vulture	0.03 (1)	0.01 (–)	0.07 (–)	0.00 (0)	0.00 (0)	0.03 (–)	0.00 (0)	0.01 (–)
Warbling Vireo	0.00 (0)	0.01	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
White-breasted Nuthatch	0.10 (11)	0.08 (4)	0.07 (7)	0.23 (26)	0.21 (21)	0.11 (13)	0.05 (5)	0.16 (17)
White-eyed Vireo	0.04 (4)	0.04 (1)	0.00 (0)	0.03 (3)	0.00 (0)	0.07 (7)	0.00 (0)	0.01 (1)
Wild Turkey	0.00 (0)	0.01 (–)	0.00 (0)	0.01 (–)	0.00 (0)	0.01 (1)	0.00 (0)	0.00 (0)
Wood Thrush*	0.05 (10)	0.01 (–)	0.00 (0)	0.00 (0)	0.16 (11)	0.03 (3)	0.00 (0)	0.01 (1)
Worm-eating Warbler*	0.07 (1)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Yellow-breasted Chat	0.03 (3)	0.01 (–)	0.00 (0)	0.04 (6)	0.00 (0)	0.01 (1)	0.00 (0)	0.04 (6)
Yellow-billed Cuckoo	0.03 (3)	0.01 (–)	0.07 (–)	0.10 (9)	0.42 (44)	0.00 (0)	0.00 (0)	0.00 (0)
Yellow-throated Warbler	0.00 (0)	0.07 (–)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
Yellow Warbler	0.03 (3)	0.01 (1)	0.00 (0)	0.03 (3)	0.00 (0)	0.03 (3)	0.00 (0)	0.04 (4)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008; also in bold).

Appendix F. Pea Ridge National Military Park Trends

Table F1. Trends, annual change in abundance (individuals), of breeding birds recorded on Pea Ridge National Military Park, Arkansas, from 2008 through 2021.

Habitat	Bird Common Name	Trend ^A	SE of Slope	Trend Classification ^B
Grassland	Dickcissel	1.39	0.34	Uncertain
	Field Sparrow	1.03	0.04	Uncertain
	Indigo Bunting	0.98	0.05	Uncertain
	Northern Cardinal	1.06	0.04	Uncertain
Woodland	Blue-gray Gnatcatcher	1.19	0.04	Strong Increase
	Eastern Wood-pewee	1.10	0.03	Moderate increase
	Great Crested Flycatcher	1.43	0.26	Uncertain
	Indigo Bunting	1.00	0.03	Uncertain
	Northern Cardinal	0.97	0.03	Uncertain
	Northern Parula	1.08	0.05	Uncertain
	Red-bellied Woodpecker	0.97	0.04	Uncertain
	Red-eyed Vireo	1.18	0.05	Strong Increase
	Summer Tanager	1.06	0.05	Uncertain
	Tufted Titmouse	1.16	0.04	Strong Increase
	Yellow-throated Vireo	1.01	0.14	Uncertain

^A Trends were determined using the statistical software package 'rtrim' built under R version 3.6.3.

^B Trend classification types depending on statistical significance and magnitude (Pannekoek and Van Strien 2005; Van Strien et al. 2001) and following Gregory et al. (2007). The multiplicative overall slope estimate in TRIM was converted into one of the following categories depending on the overall slope as well as its 95% confidence interval (= slope $\pm$ 1.96 times the standard error of the slope): Strong increase—increase significantly more than 5% per year. Criterion: lower limit of confidence interval > 1.05. Moderate increase—significant increase, but not significantly more than 5% per year. Criterion: 1.00 < lower limit of confidence interval < 1.05. Stable—no significant increase or decline, and it is certain that trends are less than 5% per year. Criterion: confidence interval encloses 1.00 but lower limit > 0.95 and upper limit < 1.05. Uncertain—no significant increase or decline, but not certain if trends are less than 5% per year. Criterion: confidence interval encloses 1.00 but lower limit < 0.95 or upper limit > 1.05. Moderate decline—significant decline, but not significantly more than 5% per year. Criterion: 0.95 < upper limit of confidence interval < 1.00. Steep decline—decline significantly more than 5% per year. Criterion: upper limit of confidence interval < 0.95.

Appendix G. Regional Trends

Table G1. Central Hardwoods regional trends in breeding birds recorded on Pea Ridge National Military Park, Arkansas, for years 2008 through 2019. Regional trend data was obtained from the national Breeding Bird Surveys (BBS) Program (Sauer et al. 2020). Trend is defined as an interval-specific geometric mean of proportional changes in population size (Link and Sauer 1998), expressed as a percentage. “–” denotes when regional trend values were not available.

Common Name	Annual Percent Change in Population Size	95% Confidence Interval	
		Lower	Upper
Acadian Flycatcher	2.39	1.34	3.56
American Crow	–0.66	–1.30	–0.01
American Goldfinch	–2.28	–3.43	–1.17
American Kestrel	1.68	–0.26	3.74
American Redstart	–	–	–
American Robin	–0.44	–1.12	0.23
American Woodcock	–0.60	–4.91	4.09
Bald Eagle^A	13.07	4.06	23.08
Baltimore Oriole	–1.88	–3.77	0.04
Barn Swallow	–2.87	–3.82	–1.94
Barred Owl	1.67	–0.93	4.39
Bewick’s Wren^A	–9.53	–14.90	–4.19
Black Vulture	5.11	0.26	9.81
Black-and-white Warbler	–3.95	–6.42	–1.55
Black-billed Cuckoo	–4.21	–12.04	2.62
Blue Grosbeak	0.46	–0.62	1.55
Blue Jay	–0.13	–0.91	0.65
Blue-gray Gnatcatcher	–2.86	–4.02	–1.70
Blue-winged Warbler^A	–4.14	–7.14	–1.02
Broad-winged Hawk	0.23	–1.98	2.50
Brown Thrasher	–0.47	–1.45	0.51
Brown-headed Cowbird	–1.80	–2.80	–0.81
Canada Goose	10.54	3.63	17.74
Carolina Chickadee	–0.47	–1.72	0.72
Carolina Wren	3.27	2.13	4.37
Chimney Swift	–2.66	–4.03	–1.21
Chipping Sparrow	–0.31	–1.14	0.53
Chuck-will’s-widow ^B	–2.64	–5.28	–0.14
Cliff Swallow	10.79	4.82	16.93
Common Grackle	–4.95	–6.25	–3.69
Common Yellowthroat	–0.74	–1.47	0.02
Dickcissel	0.03	–1.83	1.96
Downy Woodpecker	–	–	–
Eastern Bluebird	–0.90	–2.16	0.40

^A Species considered of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 2008; also in bold).

^B Species recorded between point transects or other times outside of 5-minute survey periods.

Table G1 (continued). Central Hardwoods regional trends in breeding birds recorded on Pea Ridge National Military Park, Arkansas, for years 2008 through 2019. Regional trend data was obtained from the national Breeding Bird Surveys (BBS) Program (Sauer et al. 2020). Trend is defined as an interval-specific geometric mean of proportional changes in population size (Link and Sauer 1998), expressed as a percentage. “–” denotes when regional trend values were not available.

Common Name	Annual Percent Change in Population Size	95% Confidence Interval	
		Lower	Upper
Eastern Kingbird	–1.53	–2.60	–0.47
Eastern Meadowlark	–2.46	–3.31	–1.60
Eastern Phoebe	–1.05	–2.19	0.08
Eastern Towhee	–0.20	–1.12	0.74
Eastern Wood-pewee	–0.38	–1.19	0.44
Eastern Whip-poor-will^A	–2.13	–5.58	1.27
European Starling	–2.37	–3.63	–1.17
Field Sparrow	–2.48	–3.33	–1.62
Fish Crow	6.06	–0.84	13.09
Grasshopper Sparrow	–9.98	–12.43	–7.23
Gray Catbird	–1.62	–2.94	–0.30
Great Blue Heron	–0.22	–2.37	1.93
Great Crested Flycatcher	0.65	–0.43	1.72
Great Horned Owl	–2.15	–5.58	1.46
Hairy Woodpecker	0.62	–1.00	2.38
Hooded Warbler	1.84	–0.50	4.26
Horned Lark	–5.36	–8.89	–2.21
House Sparrow	–4.60	–6.00	–3.22
House Finch	2.49	–1.14	5.91
Indigo Bunting	–0.92	–1.39	–0.45
Kentucky Warbler^A	0.38	–1.05	1.80
Killdeer	–0.68	–1.96	0.64
Lark Sparrow	3.00	–1.79	9.22
Louisiana Waterthrush	0.82	–1.16	2.86
Mourning Dove	–0.02	–0.75	0.71
Northern Bobwhite	–5.55	–6.79	–4.32
Northern Cardinal	0.26	–0.19	0.72
Northern Flicker	–	–	–
Northern Mockingbird	–0.41	–1.27	0.48
Northern Parula	0.89	–0.39	2.22
Orchard Oriole	–1.84	–3.06	–0.67
Ovenbird	–0.58	–2.38	1.29
Pileated Woodpecker	0.21	–1.18	1.60
Prairie Warbler^A	–0.10	–1.72	1.61
Red-bellied Woodpecker	1.31	0.44	2.19
Red-eyed Vireo	0.07	–0.75	0.89

^A Species considered of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 2008; also in bold).

^B Species recorded between point transects or other times outside of 5-minute survey periods.

Table G1 (continued). Central Hardwoods regional trends in breeding birds recorded on Pea Ridge National Military Park, Arkansas, for years 2008 through 2019. Regional trend data was obtained from the national Breeding Bird Surveys (BBS) Program (Sauer et al. 2020). Trend is defined as an interval-specific geometric mean of proportional changes in population size (Link and Sauer 1998), expressed as a percentage. “–” denotes when regional trend values were not available.

Common Name	Annual Percent Change in Population Size	95% Confidence Interval	
		Lower	Upper
Red-headed Woodpecker^A	4.65	2.70	6.76
Red-shouldered Hawk	5.44	2.99	7.98
Red-tailed Hawk	1.91	0.33	3.59
Red-winged Blackbird	–2.27	–3.12	–1.43
Ruby-throated Hummingbird	–0.65	–2.25	1.00
Scarlet Tanager	–0.44	–1.97	1.09
Scissor-tailed Flycatcher	1.82	–2.17	5.64
Summer Tanager	0.59	–0.35	1.54
Tree Swallow	1.64	–2.03	5.53
Tufted Titmouse	–	–	–
Turkey Vulture	4.20	2.12	6.28
Warbling Vireo	–1.17	–2.83	0.53
White-breasted Nuthatch	–1.38	–2.99	0.21
White-eyed Vireo	0.97	–0.01	1.96
Wild Turkey	–2.28	–5.77	1.45
Willow Flycatcher	–	–	–
Wood Thrush^A	1.82	0.72	2.95
Worm-eating Warbler^A	–2.62	–5.36	0.06
Yellow Warbler	–2.37	–4.99	0.02
Yellow-billed Cuckoo	1.04	–0.53	2.62
Yellow-breasted Chat	–0.14	–0.95	0.68
Yellow-throated Vireo	1.05	–0.44	2.52
Yellow-throated Warbler	–0.50	–2.39	1.36

^A Species considered of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 2008; also in bold).

^B Species recorded between point transects or other times outside of 5-minute survey periods.

Appendix H. Habitat Parameters in Grassland Areas

Tables H1 through H3 show the averages for habitat parameters in three different sized plots in the grassland areas at Pea Ridge National Military Park, Arkansas, from 2008 through 2021 (n = number of plots sampled).

Table H1. Average ($\pm$ standard deviation) percent cover of each habitat type in 50-m plots in the grassland areas at Pea Ridge National Military Park, Arkansas, during the bird breeding seasons from 2008 to 2021. Total percent coverages across habitat types may not sum to 100% as values are averaged over mid-point values of cover classes (i.e., class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

Habitat Parameter	2008 n = 26	2012 n = 25	2016 n = 24	2021 n = 26
Fescue/Orchard Grass (%)	47.52 ($\pm$ 46.41)	54.10 ($\pm$ 46.64)	54.48 ($\pm$ 44.45)	46.20 ($\pm$ 45.18)
Old Field/Prairie (%)	31.92 ($\pm$ 38.80)	18.20 ($\pm$ 35.03)	20.42 ($\pm$ 36.87)	25.57 ($\pm$ 40.10)
Pasture Road (%)	0.12 ($\pm$ 0.59)	0.62 ($\pm$ 3.00)	0.38 ($\pm$ 1.01)	0.22 ($\pm$ 0.80)
Paved Road (%)	0.25 ($\pm$ 0.82)	0.72 ($\pm$ 3.03)	1.42 ($\pm$ 4.23)	0.15 ($\pm$ 0.59)
Pond (%)	0.12 ($\pm$ 0.59)	0.00	0.00	0.00
Shrub (%)	2.94 ($\pm$ 8.14)	7.50 ($\pm$ 21.54)	2.81 ($\pm$ 8.51)	12.06 ($\pm$ 25.93)
Woodland (%)	8.29 ($\pm$ 15.58)	18.90 ($\pm$ 32.17)	22.13 ($\pm$ 30.65)	13.13 ($\pm$ 19.53)

Table H2. Average ($\pm$ standard deviation) canopy cover, canopy height, basal area, percent cover of vegetation at various horizontal height increments to 2.0 m, and vertical structure diversity in 5-m subplots in the grassland areas at Pea Ridge National Military Park, Arkansas, during the bird breeding seasons from 2008 to 2021. For percent cover data, total percent coverages may not sum to 100% as values are averaged over mid-point values of cover classes (i.e., class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

Habitat Parameter	Subcategory	2008 n = 26	2012 n = 25	2016 n = 24	2021 n = 26
Canopy Cover	Hardwood (%)	5.85 ($\pm$ 11.16)	13.09 ($\pm$ 25.74)	7.25 ($\pm$ 15.51)	12.79 ($\pm$ 23.27)
	Conifer (%)	3.38 ($\pm$ 14.08)	4.93 ($\pm$ 20.05)	1.06 ($\pm$ 5.20)	0.33 ($\pm$ 1.70)
	Total cover (%)	9.27 ($\pm$ 18.17)	18.11 ($\pm$ 31.02)	8.09 ($\pm$ 18.36)	13.11 ($\pm$ 23.87)
Canopy Height	Hardwood (m)	2.25 ($\pm$ 4.32)	4.20 ($\pm$ 7.32)	3.28 ($\pm$ 6.22)	6.32 ($\pm$ 9.18)
	Conifer (m)	0.00	0.84 ($\pm$ 2.48)	0.44 ($\pm$ 2.14)	0.33 ($\pm$ 1.46)
Basal Area	Hardwood (m ² /ha)	1.63 ($\pm$ 3.16)	2.20 ($\pm$ 4.10)	2.29 ($\pm$ 4.16)	2.88 ($\pm$ 6.92)
	Conifer (m ² /ha)	0.29 ($\pm$ 1.08)	0.30 ($\pm$ 1.10)	0.10 ($\pm$ 0.51)	0.10 ($\pm$ 0.49)
	Total (m ² /ha)	1.92 ($\pm$ 3.56)	2.50 ($\pm$ 4.08)	2.40 ($\pm$ 4.33)	2.98 ($\pm$ 7.00)
Horizontal Vegetation Profile—measured at 15 m north of plot center (percent cover at different height increments)	0.00–0.25 m (%)	93.85 ($\pm$ 9.83)	93.60 ($\pm$ 19.50)	96.46 ($\pm$ 3.53)	91.30 ($\pm$ 11.46)
	0.25–0.50 m (%)	73.42 ($\pm$ 32.56)	89.20 ($\pm$ 20.36)	91.35 ($\pm$ 8.66)	68.39 ($\pm$ 34.93)
	0.50–0.75 m (%)	15.98 ($\pm$ 28.33)	50.32 ($\pm$ 37.62)	49.96 ($\pm$ 40.93)	44.44 ($\pm$ 41.30)
	0.75–1.00 m (%)	8.35 ($\pm$ 20.17)	32.46 ($\pm$ 30.74)	27.50 ($\pm$ 38.16)	21.57 ($\pm$ 35.15)
	1.00–1.25 m (%)	5.19 ($\pm$ 16.90)	22.46 ($\pm$ 27.53)	13.00 ($\pm$ 26.47)	16.63 ($\pm$ 32.86)
	1.25–1.50 m (%)	4.69 ($\pm$ 14.12)	12.70 ($\pm$ 24.39)	4.19 ($\pm$ 19.88)	8.96 ($\pm$ 23.33)
	1.50–1.75 m (%)	3.98 ($\pm$ 16.79)	12.20 ($\pm$ 25.56)	4.15 ($\pm$ 19.89)	11.59 ($\pm$ 28.42)
	1.75–2.00 m (%)	3.88 ($\pm$ 16.80)	15.80 ($\pm$ 30.39)	4.29 ($\pm$ 19.86)	10.65 ($\pm$ 27.95)
Vertical Structure Diversity (%)	n/a	11.22 ($\pm$ 6.65)	14.62 ($\pm$ 13.65)	15.89 ($\pm$ 13.01)	14.08 ($\pm$ 12.32)

Table H3. Average percent ($\pm$ standard deviation) soil substrate cover and plant guild cover in 1.78-m sample plots in the grassland areas at Pea Ridge National Military Park, Arkansas, during the bird breeding seasons from 2008 to 2021. Total percent coverages may not necessarily sum to 100% as values are averaged over mid-point values of cover classes (i.e., class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

Habitat Parameter	2008 n=26	2012 n=25	2016 n=24	2021 n=26
Deciduous Litter (%)	1.44 ($\pm$ 4.04)	1.40 ($\pm$ 3.10)	5.52 ($\pm$ 14.52)	9.27 ($\pm$ 19.69)
Conifer Litter (%)	2.65 ($\pm$ 12.23)	0.16 ($\pm$ 0.61)	0.04 ($\pm$ 0.14)	0.02 ($\pm$ 0.10)
Grass Litter (%)	35.92 ($\pm$ 30.46)	29.80 ($\pm$ 17.79)	22.31 ($\pm$ 18.38)	47.25 ($\pm$ 28.38)
Bare Soil (%)	47.31 ($\pm$ 27.45)	14.06 ($\pm$ 14.08)	13.23 ($\pm$ 15.33)	19.04 ($\pm$ 19.24)
Rock (%)	0.12 ($\pm$ 0.59)	0.02 ($\pm$ 0.10)	0.27 ($\pm$ 0.63)	0.13 ($\pm$ 0.59)
Woody Debris (%)	2.00 ($\pm$ 7.32)	0.86 ($\pm$ 3.06)	0.71 ($\pm$ 1.22)	0.98 ($\pm$ 3.02)
Unvegetated (%)	76.92 ($\pm$ 13.18)	43.90 ($\pm$ 17.38)	80.63 ($\pm$ 21.66)	63.77 ($\pm$ 27.82)
Warm-season Grass (%)	3.71 ($\pm$ 5.71)	0.76 ($\pm$ 3.03)	10.67 ($\pm$ 20.36)	11.46 ($\pm$ 17.92)
Cool-season Grass (%)	18.81 ($\pm$ 16.54)	20.80 ($\pm$ 15.38)	53.42 ($\pm$ 32.06)	53.02 ($\pm$ 25.19)
Forb (%)	15.02 ($\pm$ 15.49)	19.28 ($\pm$ 12.46)	12.13 ($\pm$ 12.82)	26.04 ($\pm$ 23.89)
Moss and Lichen (%)	0.50 ($\pm$ 0.77)	0.00	0.29 ($\pm$ 0.62)	0.04 ($\pm$ 0.14)
Woody Shrub and Vine (%)	3.90 ($\pm$ 10.33)	6.68 ($\pm$ 14.60)	12.54 ($\pm$ 21.99)	9.67 ($\pm$ 17.41)
Tree Seedling (%)	0.02 ($\pm$ 0.10)	0.50 ($\pm$ 0.97)	2.42 ($\pm$ 8.08)	0.87 ($\pm$ 3.00)
Total Foliar (%)	44.42 ($\pm$ 21.73)	56.40 ($\pm$ 15.93)	78.98 ($\pm$ 21.11)	82.98 ($\pm$ 16.23)

Appendix I. Habitat Parameters in Woodland Areas

Tables I1 through I3 show the averages for habitat parameters in three different sized plots in the woodland areas at Pea Ridge National Military Park, Arkansas, from 2008 through 2021 (n = number of plots sampled).

Table I1. Average ($\pm$ standard deviation) percent cover of each habitat type in 50-m plots in the woodland areas at Pea Ridge National Military Park, Arkansas, during the bird breeding seasons from 2008 to 2021. Total percent coverages across habitat types may not sum to 100% as values are averaged over mid-point values of cover classes (i.e., class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

Habitat Parameter	2008 n=73	2012 n=73	2016 n=73	2021 n=72
Drainage/Stream (%)	0.29 (± 1.81)	4.15 (± 13.67)	0.01 (± 0.06)	1.06 (± 3.10)
Old Field/Prairie (%)	2.83 (± 9.90)	4.49 (± 13.97)	3.74 (± 13.33)	2.72 (± 11.35)
Pasture Road (%)	0.41 (± 1.89)	0.34 (± 1.84)	0.22 (± 0.76)	0.26 (± 1.80)
Paved Road (%)	0.33 (± 1.84)	0.29 (± 1.81)	0.71 (± 3.02)	0.68 (± 3.03)
Shrub (%)	1.99 (± 8.90)	0.00	0.00	1.04 (± 6.21)
Woodland (%)	89.32 (± 8.14)	88.66 (± 18.39)	91.47 (± 16.80)	90.87 (± 15.08)

Table I2. Average ($\pm$ standard deviation) canopy cover, canopy height, basal area, percent cover of vegetation at various horizontal height increments to 2.0 m, and vertical structure diversity in 5-m subplots in the woodland areas at Pea Ridge National Military Park, Arkansas, during the bird breeding seasons from 2008 to 2021. For percent cover data, total percent coverages may not sum to 100% as values are averaged over mid-point values of cover classes (i.e., class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

Habitat Parameter	Subcategory	2008 n=73	2012 n=73	2016 n=73	2021 n=72
Canopy Cover	Hardwood (%)	78.40 (± 30.15)	79.39 (± 26.82)	79.84 (± 22.24)	79.15 (± 22.01)
	Conifer (%)	12.61 (± 26.76)	10.93 (± 23.76)	8.88 (± 21.75)	1.07 (± 4.35)
	Total cover (%)	90.09 (± 16.70)	88.72 (± 18.84)	83.75 (± 17.83)	80.18 (± 21.42)
Canopy Height	Hardwood (m)	17.95 (± 7.53)	16.14 (± 8.27)	20.05 (± 6.41)	22.02 (± 5.41)
	Conifer (m)	2.16 (± 4.33)	1.96 (± 4.46)	2.89 (± 5.58)	1.19 (± 3.93)
Basal Area	Hardwood (m ² /ha)	16.95 (± 9.66)	17.50 (± 9.90)	17.40 (± 10.76)	21.74 (± 9.91)
	Conifer (m ² /ha)	2.77 (± 6.52)	2.57 (± 5.03)	2.47 (± 5.61)	0.49 (± 1.95)
	Total (m ² /ha)	19.73 (± 8.42)	20.07 (± 9.00)	19.86 (± 11.79)	22.22 (± 9.81)
Horizontal Vegetation Profile—measured at 15 m north of plot center (percent cover at different height increments)	0.00–0.25 m (%)	70.58 (± 32.80)	79.23 (± 26.93)	81.22 (± 28.55)	76.33 (± 31.41)
	0.25–0.50 m (%)	51.44 (± 41.17)	55.87 (± 37.63)	56.60 (± 39.26)	50.08 (± 39.83)
	0.50–0.75 m (%)	22.58 (± 35.08)	29.61 (± 34.78)	21.93 (± 32.86)	35.43 (± 37.18)
	0.75–1.00 m (%)	17.42 (± 32.48)	22.44 (± 30.41)	14.46 (± 28.55)	25.72 (± 35.80)
	1.00–1.25 m (%)	17.77 (± 31.04)	20.86 (± 31.97)	11.67 (± 26.73)	22.13 (± 34.78)
	1.25–1.50 m (%)	20.92 (± 33.77)	22.51 (± 34.46)	9.19 (± 23.97)	21.08 (± 32.43)
	1.50–1.75 m (%)	28.79 (± 39.10)	24.07 (± 35.28)	9.67 (± 23.06)	17.57 (± 30.71)
	1.75–2.00 m (%)	26.11 (± 36.48)	22.63 (± 34.21)	12.29 (± 26.54)	17.39 (± 29.51)
Vertical Structure Diversity (%)	n/a	30.19 (± 14.43)	35.56 (± 18.58)	35.78 (± 12.78)	23.48 (± 11.60)

Table I3. Average percent ($\pm$ standard deviation) soil substrate cover and plant guild cover in 1.78-m sample plots in the woodland areas at Pea Ridge National Military Park, Arkansas, during the bird breeding seasons from 2008 to 2021. Total percent coverages may not necessarily sum to 100% as values are averaged over mid-point values of cover classes (i.e., class 1 = 0.5%, class 2 = 3.0%, class 3 = 15.0%, class 4 = 37.5%, class 5 = 62.5%, class 6 = 85.0%, and class 7 = 97.5%).

Habitat Parameter	2008 n=73	2012 n=73	2016 n=73	2021 n=72
Deciduous Litter (%)	55.78 ($\pm$ 34.26)	45.67 ($\pm$ 31.45)	64.50 ($\pm$ 32.72)	49.21 ($\pm$ 37.94)
Conifer Litter (%)	6.54 ($\pm$ 18.79)	2.10 ($\pm$ 6.90)	1.83 ($\pm$ 6.55)	0.13 ($\pm$ 0.51)
Grass Litter (%)	2.78 ($\pm$ 8.60)	2.86 ($\pm$ 6.37)	3.93 ($\pm$ 9.10)	4.63 ($\pm$ 15.74)
Bare Soil (%)	15.64 ($\pm$ 22.48)	16.71 ($\pm$ 19.17)	10.46 ($\pm$ 18.18)	23.46 ($\pm$ 26.89)
Rock (%)	6.91 ($\pm$ 13.13)	5.43 ($\pm$ 12.89)	6.71 ($\pm$ 14.22)	4.93 ($\pm$ 10.83)
Woody Debris (%)	6.02 ($\pm$ 7.41)	8.95 ($\pm$ 14.79)	12.91 ($\pm$ 17.43)	8.50 ($\pm$ 9.96)
Unvegetated (%)	87.12 ($\pm$ 14.52)	72.29 ($\pm$ 19.06)	86.30 ($\pm$ 23.32)	87.74 ($\pm$ 15.59)
Warm-season Grass (%)	0.79 ($\pm$ 2.56)	0.00	0.33 ($\pm$ 1.84)	0.66 ($\pm$ 2.56)
Cool-season Grass (%)	2.82 ($\pm$ 5.73)	4.72 ($\pm$ 9.79)	16.18 ($\pm$ 23.58)	12.25 ($\pm$ 18.50)
Forb (%)	4.25 ($\pm$ 6.09)	9.84 ($\pm$ 13.60)	10.42 ($\pm$ 12.42)	9.01 ($\pm$ 11.56)
Moss and Lichen (%)	5.11 ($\pm$ 7.56)	0.73 ($\pm$ 2.53)	3.31 ($\pm$ 6.22)	0.97 ($\pm$ 3.01)
Woody Shrub and Vine (%)	4.51 ($\pm$ 6.38)	1.77 ($\pm$ 7.98)	9.65 ($\pm$ 15.66)	9.72 ($\pm$ 17.39)
Tree Seedling (%)	1.82 ($\pm$ 3.41)	1.40 ($\pm$ 2.99)	7.31 ($\pm$ 10.90)	3.03 ($\pm$ 4.99)
Total Foliar (%)	20.07 ($\pm$ 15.55)	25.88 ($\pm$ 20.93)	50.23 ($\pm$ 31.86)	39.72 ($\pm$ 27.62)

Appendix J. Tree Density by Size Class and Family

Tables J1 and J2 show 2008 to 2021 tree density at Pea Ridge National Military Park by size class and family in the grassland and woodland areas, respectively (n = number of plots sampled).

Table J1. Stems per hectare for trees found in the grassland areas at Pea Ridge National Military Park, Arkansas, by size class, during the 2008 to 2021 bird breeding seasons. Tree stems per hectare are reported by family.

Stem Size Class	Family	2008 n=26	2012 n=25	2016 n=24	2021 n=26
< 1.0 cm	Anacardiaceae	0	5	0	0
	Cornaceae	0	5	0	0
	Cupressaceae	0	0	0	5
	Fagaceae	0	5	0	0
	Lauraceae	20	5	5	44
	Rosaceae	5	0	37	5
	Snag	10	15	106	34
1.1–2.85 cm	Anacardiaceae	5	5	0	0
	Cannabaceae	0	10	0	10
	Cornaceae	0	0	11	0
	Cupressaceae	0	10	5	0
	Ebenaceae	0	36	0	0
	Juglandaceae	0	0	0	0
	Lauraceae	34	56	16	98
	Moraceae	0	0	0	5
	Nyssaceae	0	5	0	0
	Oleaceae	0	0	0	10
	Ulmaceae	0	0	0	0
	Snag	10	5	37	78
2.6–8.0 cm	Anacardiaceae	0	0	0	0
	Cannabaceae	0	15	0	20
	Cornaceae	0	0	0	5
	Ebenaceae	0	15	0	0
	Fagaceae	0	5	11	5
	Juglandaceae	0	5	0	10
	Lauraceae	24	138	37	20
	Moraceae	0	0	0	15
	Oleaceae	0	0	0	10
	Rosaceae	0	0	11	5
	Ulmaceae	0	0	0	5
	Snag	15	20	42	20

Table J1 (continued). Stems per hectare for trees found in the grassland areas at Pea Ridge National Military Park, Arkansas, by size class, during the 2008 to 2021 bird breeding seasons. Tree stems per hectare are reported by family.

Stem Size Class	Family	2008 n=26	2012 n=25	2016 n=24	2021 n=26
8.1–15.0 cm	Cannabaceae	0	5	0	5
	Cupressaceae	5	0	0	0
	Ebenaceae	0	10	0	0
	Fagaceae	0	5	5	0
	Juglandaceae	0	5	0	5
	Lauraceae	29	36	5	0
	Moraceae	0	0	0	5
	Oleaceae	0	0	0	5
	Rosaceae	0	0	0	5
	Snag	20	5	0	10
15.1–23.0 cm	Cupressaceae	5	15	0	0
	Cannabaceae	0	0	0	5
	Ebenaceae	0	0	5	5
	Fagaceae	0	5	0	0
	Lauraceae	10	25	5	5
	Snag	0	0	0	10
23.1–38.0 cm	Cupressaceae	5	0	0	0
	Fagaceae	0	5	0	10
	Lauraceae	0	0	5	0
	Snag	0	0	0	5
> 38.0 cm	Cupressaceae	0	5	0	0
	Snag	0	5	0	0

Table J2. Stems per hectare for trees found in the woodland areas at Pea Ridge National Military Park, Arkansas, by size class, during the 2008 to 2021 bird breeding seasons. Tree stems per hectare are reported by family.

Stem Size Class	Family	2008 n=73	2012 n=73	2016 n=73	2021 n=72
< 1.0 cm	Anacardiaceae	2	3	0	0
	Annonaceae	2	0	10	9
	Cannabaceae	5	0	0	0
	Cornaceae	2	7	0	0
	Cupressaceae	0	7	2	4
	Ebenaceae	0	2	3	0
	Fabaceae	0	2	10	9
	Fagaceae	2	38	0	25
	Lauraceae	42	40	26	14
	Moraceae	0	2	0	0
	Nyssaceae	0	2	0	0
	Oleaceae	0	2	0	2
	Rhamnaceae	0	17	7	22
	Rosaceae	19	0	0	0
	Sapindaceae	0	2	2	0
	Ulmaceae	2	5	3	5
	Snag	24	34	23	5
1.1–2.5 cm	Aceraceae	0	0	0	4
	Adoxaceae	2	0	0	0
	Anacardiaceae	14	3	0	0
	Annonaceae	12	9	5	2
	Cannabaceae	0	3	2	4
	Cornaceae	0	12	2	0
	Cupressaceae	3	12	7	2
	Ebenaceae	0	12	3	9
	Fabaceae	0	3	3	12
	Fagaceae	10	49	0	7
	Juglandaceae	2	3	0	2
	Lauraceae	96	127	28	18
	Moraceae	0	2	0	0
	Oleaceae	0	12	5	0
	Rhamnaceae	0	17	0	9
	Rosaceae	10	0	0	0
	Sapindaceae	7	3	2	0
	Simaroubaceae	0	0	2	4
	Ulmaceae	7	7	3	12
	Snag	78	56	28	19

Table J2 (continued). Stems per hectare for trees found in the woodland areas at Pea Ridge National Military Park, Arkansas, by size class, during the 2008 to 2021 bird breeding seasons. Tree stems per hectare are reported by family.

Stem Size Class	Family	2008 n=73	2012 n=73	2016 n=73	2021 n=72
2.6–8.0 cm	Aceraceae	0	0	0	7
	Adoxaceae	2	3	2	0
	Anacardiaceae	0	0	2	0
	Annonaceae	2	16	0	2
	Betulaceae	5	0	0	0
	Cannabaceae	8	9	12	4
	Cornaceae	92	68	44	27
	Cupressaceae	40	30	30	11
	Ebenaceae	0	23	16	18
	Fabaceae	0	9	51	9
	Fagaceae	54	56	0	19
	Juglandaceae	54	30	47	34
	Lauraceae	28	19	27	7
	Nyssaceae	0	5	7	0
	Oleaceae	7	0	5	2
	Rhamnaceae	0	7	0	0
	Rosaceae	10	0	3	0
	Sapindaceae	10	5	10	0
	Ulmaceae	54	24	33	28
	Snag	197	94	49	34
8.1–15.0 cm	Aceraceae	0	0	0	5
	Betulaceae	3	0	0	0
	Cannabaceae	5	5	5	0
	Cornaceae	38	38	31	25
	Cupressaceae	49	52	16	5
	Ebenaceae	3	7	2	2
	Fabaceae	10	10	75	4
	Fagaceae	65	38	0	42
	Juglandaceae	37	37	44	34
	Lauraceae	5	5	10	2
	Magnoliaceae	3	0	0	0
	Moraceae	3	5	2	2
	Nyssaceae	0	2	2	2
	Oleaceae	0	3	2	4
	Rhamnaceae	0	2	0	0
	Rosaceae	0	2	3	0
	Sapindaceae	2	12	7	0
	Ulmaceae	10	19	5	19
	Snag	70	45	44	28

Table J2 (continued). Stems per hectare for trees found in the woodland areas at Pea Ridge National Military Park, Arkansas, by size class, during the 2008 to 2021 bird breeding seasons. Tree stems per hectare are reported by family.

Stem Size Class	Family	2008 n=73	2012 n=73	2016 n=73	2021 n=72
15.1–23.0 cm	Cannabaceae	0	2	0	0
	Cornaceae	3	3	2	2
	Cupressaceae	26	14	19	4
	Ebenaceae	3	2	0	7
	Fabaceae	0	3	35	0
	Fagaceae	37	51	0	30
	Juglandaceae	16	14	35	19
	Lauraceae	0	0	3	2
	Magnoliaceae	2	0	0	0
	Moraceae	0	9	2	2
	Nyssaceae	0	0	2	4
	Oleaceae	3	2	2	0
	Sapindaceae	2	2	3	0
	Ulmaceae	3	2	3	11
	Snag	10	16	17	9
23.1–38.0 cm	Cupressaceae	26	23	7	0
	Fabaceae	0	0	68	0
	Fagaceae	31	38	0	44
	Juglandaceae	9	7	23	11
	Nyssaceae	0	0	5	4
	Oleaceae	12	3	3	4
	Rosaceae	2	0	2	0
	Ulmaceae	0	0	2	2
	Snag	10	10	14	2
>38.0 cm	Cannabaceae	2	0	0	0
	Cornaceae	0	0	0	2
	Cupressaceae	5	5	3	0
	Fabaceae	0	0	30	0
	Fagaceae	65	51	0	37
	Juglandaceae	2	2	2	0
	Nyssaceae	0	2	0	0
	Rosaceae	0	2	3	2
	Sapindaceae	2	0	0	0
	Snag	3	3	7	2

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1201 Oak Ridge Drive, Suite 150
Fort Collins, Colorado 80525