



Bird Community Monitoring at Wilson's Creek National Battlefield, Missouri

Status Report 2008–2020

Natural Resource Report NPS/HTLN/NRR—2021/2320



ON THE COVER
Cannon at Wilson's Creek National Battlefield
Photography by NPS, Heartland Inventory and Monitoring Network

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October 2021

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Peitz, D. G., and N. S. Reibold. 2021. Bird community monitoring at Wilson's Creek National Battlefield, Missouri: Status report 2008–2020. Natural Resource Report NPS/HTLN/NRR—2021/2320. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/nrr-2287875>.

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Executive Summary

Breeding bird surveys were initiated on Wilson's Creek National Monument, Missouri, in 2008 to assess temporal changes in the species composition and abundance of birds on the park and to 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 38 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-min sampling period were recorded.

In the 13 years since initiating our breeding bird survey, birds were surveyed on as many of the 38 variable circular plots as possible each year, resulting in 444 cumulative plot visits. Surveys have yielded records for 119 different species of birds. Ninety-eight of the species recorded are classified as permanent or summer residents to the area, 18 are classified as transients in the area, and 3 as winter residents to the area. Eight breeding species recorded are considered species of conservation concern for the Central Hardwoods Bird Conservation Region, the bird conservation region in which Wilson's Creek National Battlefield is located. Of the 98 breeding species recorded, 12 species in grassland habitat and 15 in woodland habitat occurred in numbers large enough to calculate annual abundances with some degree of confidence. Trends in abundance were classified as uncertain for most species, which means that no significant increases or decreases occurred but it is not certain that trends were <5% per year. The Indigo Bunting (*Passerina cyanea*) population in grassland habitat was stable. The Eastern Towhee (*Pipilo erythrophthalmus*) and Eastern Wood-pewee (*Contopus virens*) populations in woodland habitat were in moderate decline.

Comparing population trends on the park with regional trends for the Central Hardwoods Bird Conservation Region suggests that the bird community at Wilson's Creek National Battlefield is faring similarly to 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 decline in species richness could reflect habitat management practices, but it 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 Wilson's Creek National Battlefield as management and weather and climatic conditions change is essential for park management.

Acknowledgments

We would like to thank the staff of Wilson’s Creek National Battlefield, Missouri, for allowing us access to the park during our breeding bird surveys. We would also like to thank our volunteers who assisted with bird surveys on the park: Ann Liles, Kendell R. Loyd, April McDonough, Audrey M. Menninga, Rachelle M. Pollock, Dean R. Rising, Myra Scroggs, Bradly S. Thornton, Dorthy J. Thurman, Caleb L. Thyer, and Jeff M. Williams.

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.

Wilson's Creek National Battlefield, Missouri, is located in the western edge of the Ozark Highland section of the Central Hardwoods Bird Conservation Region (Figure 1). This section, commonly referred to as oak savanna, historically consisted of the transition zone between the northern and western tallgrass prairie and southern and eastern pine-hardwood forest. The Central Hardwoods Bird Conservation Region is one of 67 regions identified in the North American Bird Conservation Initiative (NABCI). Started in 1999, 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).

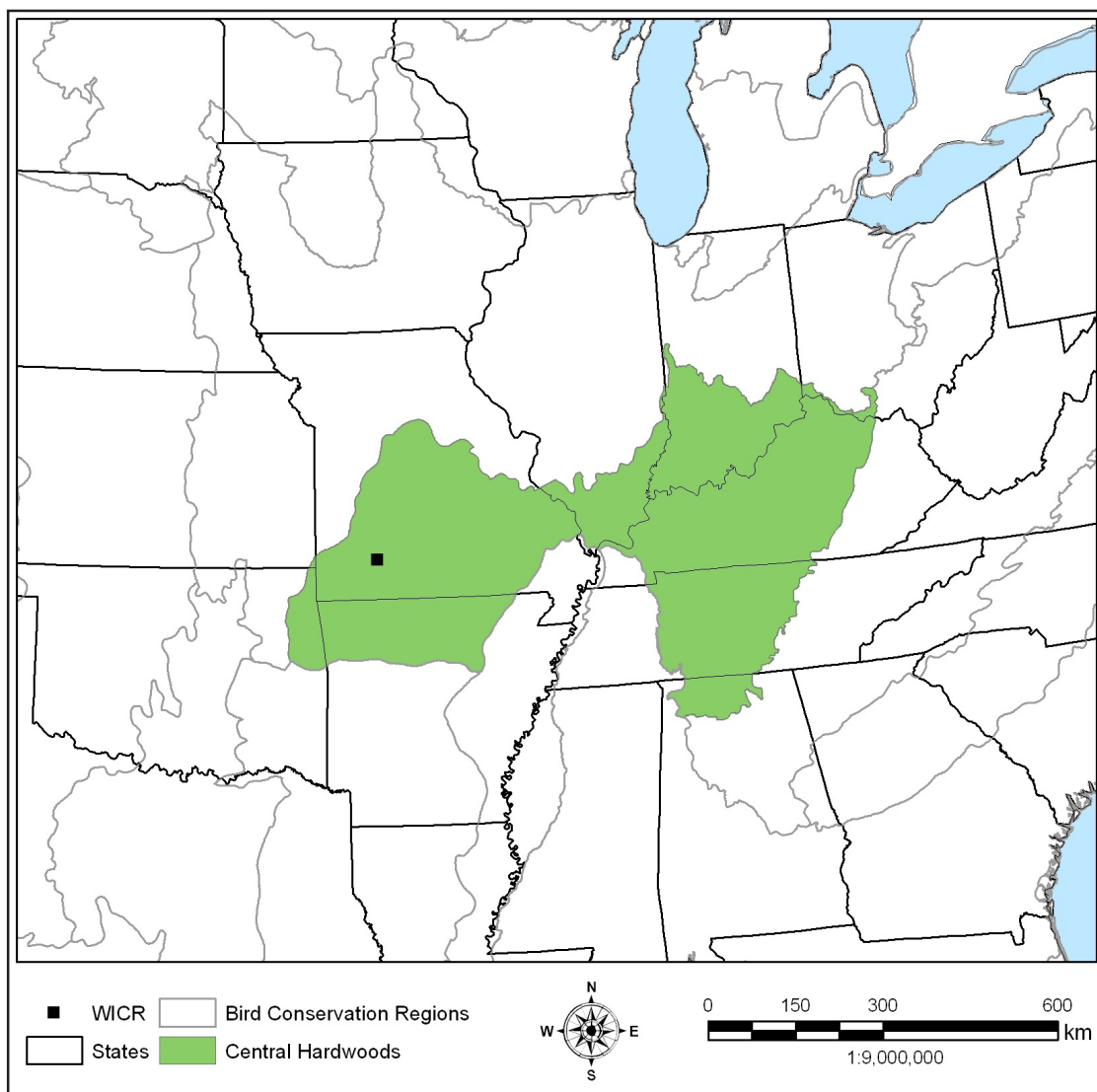


Figure 1. Location of Wilson's Creek National Battlefield within the Central Hardwoods Bird Conservation Region.

Topography of the area in and around Wilson's Creek National Battlefield is less dissected than other portions of the Ozark Highlands but more dissected than areas of the Osage Plains further north and west (Fitzgerald and Pashley 2000). This landscape contains a rich mix of forested plant communities and grasslands. Approximately 115 species of breeding birds can be found in the habitat of the area (Robbins and Easterla 1992). Widespread habitat loss to agriculture, as well as urban and industrial development, threaten the integrity of the area for birds.

Data collected during the U.S. Geological Survey's annual North American Breeding Bird Surveys (BBS) between 2005 and 2015 indicate that a number of potential breeding species occurring at Wilson's Creek National Battlefield show evidence of population decline (Sauer et al. 2017). In fact, 26% of the recorded species have populations reported to be in decline, with species such as the Barn Swallow (*Hirundo rustica*), Belted Kingfisher (*Megasceryle alcyon*), Bewick's Wren (*Thryomanes bewickii*), Carolina Wren (*Thryothorus ludovicianus*), Cedar

Waxwing (*Bombycilla cedrorum*), Chimney Swift (*Chaetura pelagica*), Eastern Bluebird (*Sialia sialis*), Grasshopper Sparrow (*Ammodramus savannarum*), House Sparrow (*Passer domesticus*), and Northern Bobwhite (*Colinus virginianus*) declining at alarming rates.

We use long-term trends in the composition and abundance of bird populations as indicators of ecosystem integrity at Wilson's Creek National Battlefield. Ecosystem integrity is defined as the system's capability to support and maintain a balanced, integrated, and 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). Because birds serve as good indicators of changes in ecosystems (Cairns et al. 2004; Mallory et al. 2006; Wood et al. 2006), bird monitoring can help us evaluate the effectiveness of management actions to restore and maintain the cultural landscape at Wilson's Creek National Battlefield.



Cedar Waxwing (*Bombycilla cedrorum*) is a year-round resident at Wilson's Creek National Battlefield and is declining at alarming rates in the region.

Objectives

There are two primary objectives for monitoring breeding birds at Wilson's Creek National Battlefield:

- Identify significant temporal changes in the species composition and abundance of bird communities that occur on Wilson's Creek National Battlefield 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 13 years of monitoring (2008–2020).

Methods

Site Selection

Permanent monitoring locations or plots were selected by overlaying a systematic grid of 400 x 400-m cells (originating from a random start point). 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 38 permanent plots: 19 are located in woodland habitat, two in shrubland habitat (subsequently grouped with woodland plots for analysis), and 17 are in grassland/open habitat (Figure 2). Monitoring occurred on the majority of the 38 sites in each year (Table 1; Appendix A). When plots were not sampled during a year it was due to flooding during an inclement weather event.

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.

Habitat assessment crews worked independent of the birder in 2016 and 2020, and monitoring plots were located using a GNSS unit but not marked with pin flags. In years when habitat assessments were not conducted (2009–2011, 2013–2015, and 2017–2019), monitoring plots were located using a GNSS unit and plots 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-min 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 and not the individual bird. During analysis, each individual in a cluster or flock was treated as a separate observation.

Table 1. Number of plots sampled and sampling dates for breeding bird surveys conducted at Wilson’s Creek National Battlefield by year. Also listed are the observers who conducted the surveys and whether or not habitat data were collected during the survey year. See Appendices B through 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 20–May 22	36	D.G. Peitz*	Yes
2009	May 27–June 4	38	D.R. Rising	No
2010	May 10–June 7	33	D.J. Thurman, M.J. Scroggs, and A. McDonough	No
2011	May 19–June 8	38	D.J. Thurman, M.J. Scroggs, A.S. Liles, and D.R. Rising	No
2012	May 25–June 1	35	D.G. Peitz*	Yes
2013	May 31–June 5	33	D.J. Thurman, M.J. Scroggs, A.S. Liles, and D.R. Rising	No
2014	May 2–May 7	35	D.J. Thurman, M.J. Scroggs, A.S. Liles, and D.R. Rising	No
2015	June 11–June 22	21	A.M. Menninga, R.M. Pollock, C.L. Thyer, and J.M. Williams	No
2016	May 9–May 11	37	D.G. Peitz*	Yes
2017	June 2–June 6	38	D.J. Thurman, M.J. Scroggs, A.S. Liles, and D.R. Rising	No
2018	May 18–June 5	37	B.S. Thornton	No
2019	May 29–May 31	27	K.R. Loyd	No
2020	May 8–May 15	36	D.G. Peitz*	Yes

*Heartland I&M Network staff.

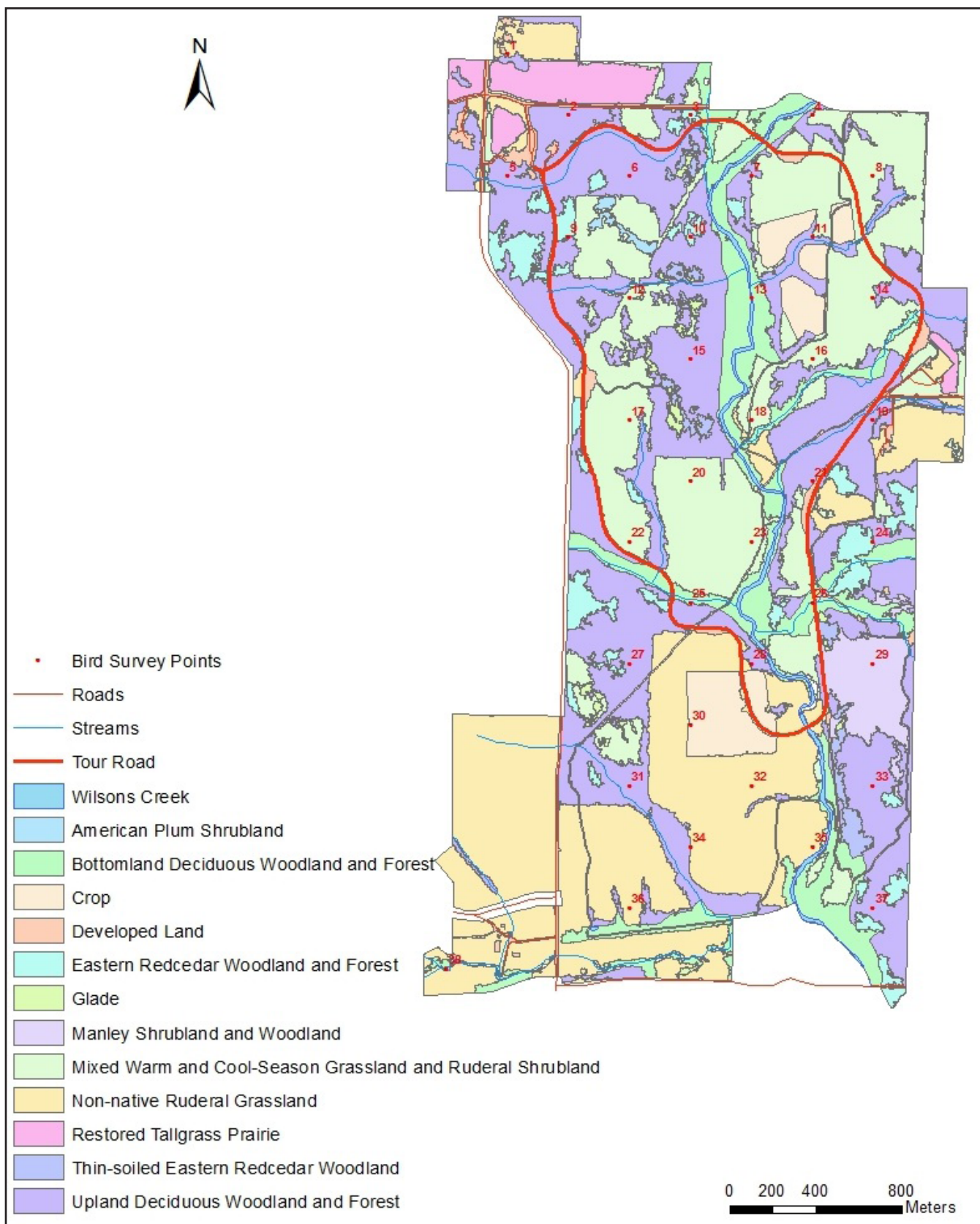


Figure 2. Bird plot locations on Wilson's Creek National Battlefield. Vegetation mapping and classification provided by Diamond et al. (2013).



Habitats at Wilson's Creek National Battlefield include prairie grasslands, woodlands, and streams. NPS

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.

Variable circular plot counts were conducted in 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-min 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 2020. During years when habitat assessments were made, 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 set up a 5-m radius subplot and completed all habitat measures for this 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 (lawn, 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 m above ground surface using a 0.15-cm-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 m 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 in 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 from analysis of breeding birds within Wilson's Creek National Battlefield. Proportion of plots occupied by each bird species was calculated (total number of plots occupied by a species/number of plots surveyed) by habitat type and reported in Appendix B through E. For species with greater than 60 observations recorded, Distance software (Distance 6.0 Release 2) was used to determine park-wide abundance of each species (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 nine species: American Crow (*Corvus brachyrhynchos*), Brown-headed Cowbird (*Molothrus ater*), Common Yellowthroat (*Geothlypis trichas*), Eastern Meadowlark (*Sturnella magna*), Eastern Towhee (*Pipilo erythrophthalmus*), Indigo Bunting (*Passerina cyanea*), Northern Cardinal (*Cardinalis cardinalis*), Red-bellied Woodpecker (*Melanerpes carolinus*), and Tufted Titmouse (*Baeolophus bicolor*). The Half-normal + Cosine function was chosen for three species: Dickcissel (*Spiza americana*), Field Sparrow (*Spizella pusilla*), and

Yellow-breasted Chat (*Icteria virens*). Abundances for these species are reported in Appendix B. In woodland habitat the Hazard-rate + Simple polynomial function was chosen for 11 species: American Crow (*Corvus brachyrhynchos*), Blue-gray Gnatcatcher (*Poliophtila caerulea*), Eastern Towhee (*Pipilo erythrophthalmus*), Eastern Wood-pewee (*Contopus virens*), Field Sparrow (*Spizella pusilla*), Indigo Bunting (*Passerina cyanea*), Northern Cardinal (*Cardinalis cardinalis*), Northern Parula (*Setophaga americana*), Red-billed Woodpecker (*Melanerpes carolinus*), Red-eyed Vireo (*Vireo olivaceus*), and Yellow-billed Cuckoo (*Coccyzus americanus*). The Uniform + Cosine function was chosen for four species: Brown-headed Cowbird (*Molothrus ater*), Carolina Wren (*Thryothorus ludovicianus*), Tufted Titmouse (*Baeolophus bicolor*), and Yellow-breasted Chat (*Icteria virens*). 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 and sampled in the cohort of 35 plots monitored in most years), trends were calculated by regressing abundance against survey years in the statistical software TRIM Version 3.54 (Pannekoek and Van Strien 2005) and reported in Appendix F. TRIM is a program developed for the analysis of count data obtained from the monitoring of wildlife populations. 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 taken into account with this software. In flood years when data were not collected from a plot, abundance values were extrapolated from years when data were collected.

For this report, we additionally obtained regional breeding bird trends for the Central Hardwoods Bird Conservation Region during the period from 2005 through 2015 from the Breeding Bird Survey (BBS)

website of the USGS Patuxent Wildlife Research Center (Appendix G; Sauer et al. 2017). It is possible to determine trends for many bird species and many regions of interest for periods ranging from 1966 to 2015 by using the [interactive calculator available at https://www.mbr-pwrc.usgs.gov/bbs/trend/tf15.html](https://www.mbr-pwrc.usgs.gov/bbs/trend/tf15.html). However, we chose the last 11-year period of available data to maximize the accuracy of regional trend results without going too far beyond the sampling period at Wilson's Creek National Battlefield. We compared regional trends with those calculated using TRIM for park habitats. Regional trends with a confidence interval that straddled zero were classified as uncertain for comparison with results from Wilson's Creek National Battlefield. 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



Henslow's Sparrow (*Ammodramus henslowii*) is a species of regional concern in the Central Hardwoods Bird Conservation Region and a summer resident at Wilson's Creek National Battlefield. Photo by Jeremy Stringfield.

annually. Species distribution evenness values were calculated using Pielou (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. However, different species richness estimators will produce varying estimates 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 (Appendix H and I). Averages ($\pm$ std dev) for horizontal vegetation cover between 0–0.25, 0.25–0.5, 0.5–0.75, 0.75–1.0, 1.0–1.25, 1.25–1.5, 1.5–1.75, and 1.75–2.0 m were calculated. Average ($\pm$ std dev) annual vertical structure diversity was estimated 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 (Appendix H and I). Foliar cover by guild—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).

Results

Bird Surveys

Between 2008 and 2020, 21 to 38 plots on Wilson's Creek National Battlefield were surveyed annually for breeding birds (Table 1). During this 13-year period, there were 444 plot surveys and 119 different bird species were recorded, 98 of which are species with the potential to breed within the park (Table 2; Robbins and Easterla 1992). Four breeding species were only observed outside 5-min survey periods: Baltimore Oriole (*Icterus galbula*), Northern Harrier (*Circus cyaneus*), Rose-breasted Grosbeak

(*Pheucticus ludovicianus*), and Willow Flycatcher (*Empidonax traillii*). Eight of the breeding species recorded are considered species of regional concern for the Central Hardwoods Bird Conservation Region (UFWFS 2008): Bell's Vireo (*Vireo bellii*), Bewick's Wren (*Thryomanes bewickii*), Blue-winged Warbler (*Vermivora cyanoptera*), Henslow's Sparrow (*Ammodramus henslowii*), Kentucky Warbler (*Geothlypis formosa*), Prairie Warbler (*Setophaga discolor*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), and Wood Thrush (*Hylocichla mustelina*).

Table 2. Bird species recorded during breeding bird surveys at Wilson's Creek National Battlefield from 2008 through 2020. 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 web site (ITIS 2020).

Common Name	Species Name	AOU Code	Residency ^A
Acadian Flycatcher	<i>Empidonax virescens</i>	ACFL	SR
American Coot	<i>Fulica americana</i>	AMCO	SR
American Crow	<i>Corvus brachyrhynchos</i>	AMCR	R
American Goldfinch	<i>Spinus tristis</i>	AMGO	R
American Redstart	<i>Setophaga ruticilla</i>	AMRE	SR
American Robin	<i>Turdus migratorius</i>	AMRO	R
Baltimore Oriole ^C	<i>Icterus galbula</i>	BAOR	SR
Bank Swallow	<i>Riparia riparia</i>	BANS	SR
Barn Swallow	<i>Hirundo rustica</i>	BARS	SR
Barred Owl	<i>Strix varia</i>	BDOW	R
Bell's Vireo^B	<i>Vireo bellii</i>	BEVI	SR
Belted Kingfisher	<i>Megasceryle alcyon</i>	BEKI	R
Bewick's Wren^B	<i>Thryomanes bewickii</i>	BEWR	R
Black and White Warbler	<i>Mniotilta varia</i>	BAWW	SR
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	BBCU	SR
Black-throated Green Warbler ^C	<i>Setophaga virens</i>	BTNW	T
Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	BGGN	SR
Blue Grosbeak	<i>Passerina caerulea</i>	BLGR	SR
Blue Jay	<i>Cyanocitta cristata</i>	BLJA	R
Blue-winged Warbler^B	<i>Vermivora cyanoptera</i>	BWWA	SR
Broad-winged Hawk	<i>Buteo platypterus</i>	BWHA	SR
Brown-headed Cowbird	<i>Molothrus ater</i>	BHCO	R
Brown Thrasher	<i>Toxostoma rufum</i>	BRTH	SR
Canada Goose	<i>Branta canadensis</i>	CAGO	R
Carolina Chickadee	<i>Poecile carolinensis</i>	CACH	R

^A Residency: R = year around resident; SR = summer resident; T = transient; WR = winter resident; according to Robbins and Easterla (1992).

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

^C Species only recorded between point transects or other times outside of 5-min survey periods.

Table 2 (continued). Bird species recorded during breeding bird surveys at Wilson's Creek National Battlefield from 2008 through 2020. 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 web site (ITIS 2020).

Common Name	Species Name	AOU Code	Residency ^A
Carolina Wren	<i>Thryothorus ludovicianus</i>	CARW	R
Cedar Waxwing	<i>Bombycilla cedrorum</i>	CEDW	R
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
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	CLSW	SR
Common Grackle	<i>Quiscalus quiscula</i>	COGR	R
Common Yellowthroat	<i>Geothlypis trichas</i>	COYE	SR
Cooper's Hawk	<i>Accipiter cooperii</i>	COHA	SR
Dickcissel	<i>Spiza americana</i>	DICK	SR
Downy Woodpecker	<i>Picoides 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
European Starling	<i>Sturnus vulgaris</i>	EUST	R
Field Sparrow	<i>Spizella pusilla</i>	FISP	R
Fish Crow	<i>Corvus ossifragus</i>	FICR	R
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
Green Heron	<i>Butorides virescens</i>	GRHE	SR
Hairy Woodpecker	<i>Picoides villosus</i>	HAWO	R
Henslow's Sparrow^B	<i>Ammodramus henslowii</i>	HESP	SR
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 Wren	<i>Troglodytes aedon</i>	HOWR	SR
Indigo Bunting	<i>Passerina cyanea</i>	INBU	SR
Kentucky Warbler^B	<i>Geothlypis formosa</i>	KEWA	SR
Killdeer	<i>Charadrius vociferus</i>	KILL	R
Lark Sparrow	<i>Chondestes grammacus</i>	LASP	SR
Least Flycatcher	<i>Empidonax minimus</i>	LEFL	T
Lincoln's Sparrow ^C	<i>Melospiza lincolni</i>	LISP	T
Little Blue Heron	<i>Egretta caerulea</i>	LBHE	T

^A Residency: R = year around resident; SR = summer resident; T = transient; WR = winter resident; according to Robbins and Easterla (1992).

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

^C Species only recorded between point transects or other times outside of 5-min survey periods.

Table 2 (continued). Bird species recorded during breeding bird surveys at Wilson's Creek National Battlefield from 2008 through 2020. 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 web site (ITIS 2020).

Common Name	Species Name	AOU Code	Residency ^A
Louisiana Waterthrush	<i>Parkesia motacilla</i>	LOWA	SR
Mourning Dove	<i>Zenaida macroura</i>	MODO	R
Nashville Warbler	<i>Leiothlypis ruficapilla</i>	NAWA	T
Northern Bobwhite	<i>Colinus virginianus</i>	NOBO	R
Northern Cardinal	<i>Cardinalis cardinalis</i>	NOCA	R
Northern Flicker	<i>Colaptes auratus</i>	YSFL	R
Northern Harrier ^C	<i>Circus cyaneus</i>	NOHA	SR
Northern Mockingbird	<i>Minus polyglottos</i>	NOMO	R
Northern Parula	<i>Setophaga americana</i>	NOPA	SR
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	NRWS	SR
Northern Waterthrush	<i>Parkesia noveboracensis</i>	NOWA	T
Orchard Oriole	<i>Icterus spurius</i>	OROR	SR
Olive-sided Flycatcher	<i>Contopus cooperi</i>	OSFL	T
Ovenbird	<i>Seiurus aurocapilla</i>	OVEN	SR
Palm Warbler	<i>Setophaga palmarum</i>	PAWA	T
Philadelphia Vireo	<i>Vireo philadelphicus</i>	PHVI	T
Pileated Woodpecker	<i>Dryocopus pileatus</i>	PIWO	R
Prairie Warbler^B	<i>Setophaga discolor</i>	PRAW	SR
Prothonotary Warbler	<i>Protonotaria citrea</i>	PROW	SR
Red-bellied Woodpecker	<i>Melanerpes carolinus</i>	RBWO	R
Red-eyed Vireo	<i>Vireo olivaceus</i>	REVI	SR
Red-headed Woodpecker^B	<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
Rose-breasted Grosbeak ^C	<i>Pheucticus ludovicianus</i>	RBGR	SR
Ruby-crowned Kinglet	<i>Regulus calendula</i>	RCKI	T
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
Song Sparrow	<i>Melospiza melodia</i>	SOSP	R
Summer Tanager	<i>Piranga rubra</i>	SUTA	SR
Swainson's Hawk	<i>Buteo swainsoni</i>	SWHA	T
Swainson's Thrush	<i>Catharus ustulatus</i>	SWTH	T
Tennessee Warbler	<i>Leiothlypis peregrina</i>	TEWA	T
Tree Swallow	<i>Tachycineta bicolor</i>	TRES	SR
Tufted Titmouse	<i>Baeolophus bicolor</i>	ETTI	R

^A Residency: R = year around resident; SR = summer resident; T = transient; WR = winter resident; according to Robbins and Easterla (1992).

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

^C Species only recorded between point transects or other times outside of 5-min survey periods.

Table 2 (continued). Bird species recorded during breeding bird surveys at Wilson's Creek National Battlefield from 2008 through 2020. 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 web site (ITIS 2020).

Common Name	Species Name	AOU Code	Residency ^A
Turkey Vulture	<i>Cathartes aura</i>	TUVU	R
Vesper Sparrow	<i>Pooecetes gramineus</i>	VESP	T
Warbling Vireo	<i>Vireo gilvus</i>	WAVI	SR
White-breasted Nuthatch	<i>Sitta carolinensis</i>	WBNH	R
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	WCSP	WR
White-eyed Vireo	<i>Vireo griseus</i>	WEVI	SR
White-throated Sparrow	<i>Zonotrichia albicollis</i>	WTSP	WR
Wild Turkey	<i>Meleagris gallopavo</i>	WITU	R
Willow Flycatcher ^C	<i>Empidonax traillii</i>	WIFL	SR
Wilson's Warbler	<i>Cardellina pusilla</i>	WIWA	T
Wood Thrush^B	<i>Hylocichla mustelina</i>	WOTH	SR
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	YBSA	T
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	T
Yellow-throated Vireo	<i>Vireo flavifrons</i>	YTVI	SR
Yellow-throated Warbler	<i>Setophaga dominica</i>	YTWA	SR
Yellow Warbler	<i>Setophaga petechia</i>	YWAR	SR

^A Residency: R = year around resident; SR = summer resident; T = transient; WR = winter resident; according to Robbins and Easterla (1992).

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

^C Species only recorded between point transects or other times outside of 5-min survey periods.

Twelve breeding species in grassland and 15 in woodland habitats were observed during the survey period in large enough numbers to calculate annual abundances with some degree of confidence (Appendix B and Appendix D, respectively). Of these 27 species, Indigo Bunting (*Passerina cyanea*) abundance in grassland habitat was stable (Figure 3a and Appendix F), and only the Eastern Towhee (*Pipilo erythrophthalmus*) and Eastern Wood-pewee (*Contopus virens*) showed significant directional trends in abundance (Figure 3b and Appendix F). Abundance trends for both species in the woodland habitat showed that they were declining moderately over time. With a single exception, all other species in both the grassland and woodland habitats had uncertain population trends over the 13 monitoring years. 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). A trend could not be determined for the American crow (*Corvus brachyrhynchos*) in woodland habitat.

Region-wide, the populations of Eastern Meadow-lark (*Sturnella magna*) recorded in grassland habitat; Carolina Wren (*Thryothorus ludovicianus*) in woodland habitat; and Brown-headed Cowbird (*Molothrus ater*), Eastern Towhee, Field Sparrow (*Spizella pusilla*), and Indigo Bunting in both habitats are in decline (Figure 3a, 3b and Appendix G). Population trends of Northern Parula (*Setophaga americana*) in woodland habitat, and Red-bellied Woodpecker (*Melanerpes carolinus*) and Tufted Titmouse (*Baeolophus bicolor*) in grassland and woodland habitats are increasing region-wide. Common Yellowthroat (*Passerina cyanea*) and Dickcissel (*Spiza americana*) in grassland habitat; Blue-gray Gnatcatcher (*Poliophtila caerulea*), Eastern Wood-pewee, Red-eyed Vireo (*Vireo olivaceus*), and Yellow-billed Cuckoo (*Coccyzus americanus*) in woodland habitat; and American Crow), Northern Cardinal (*Cardinalis cardinalis*), and Yellow-breasted Chat (*Icteria virens*) in both habitats have stable populations.

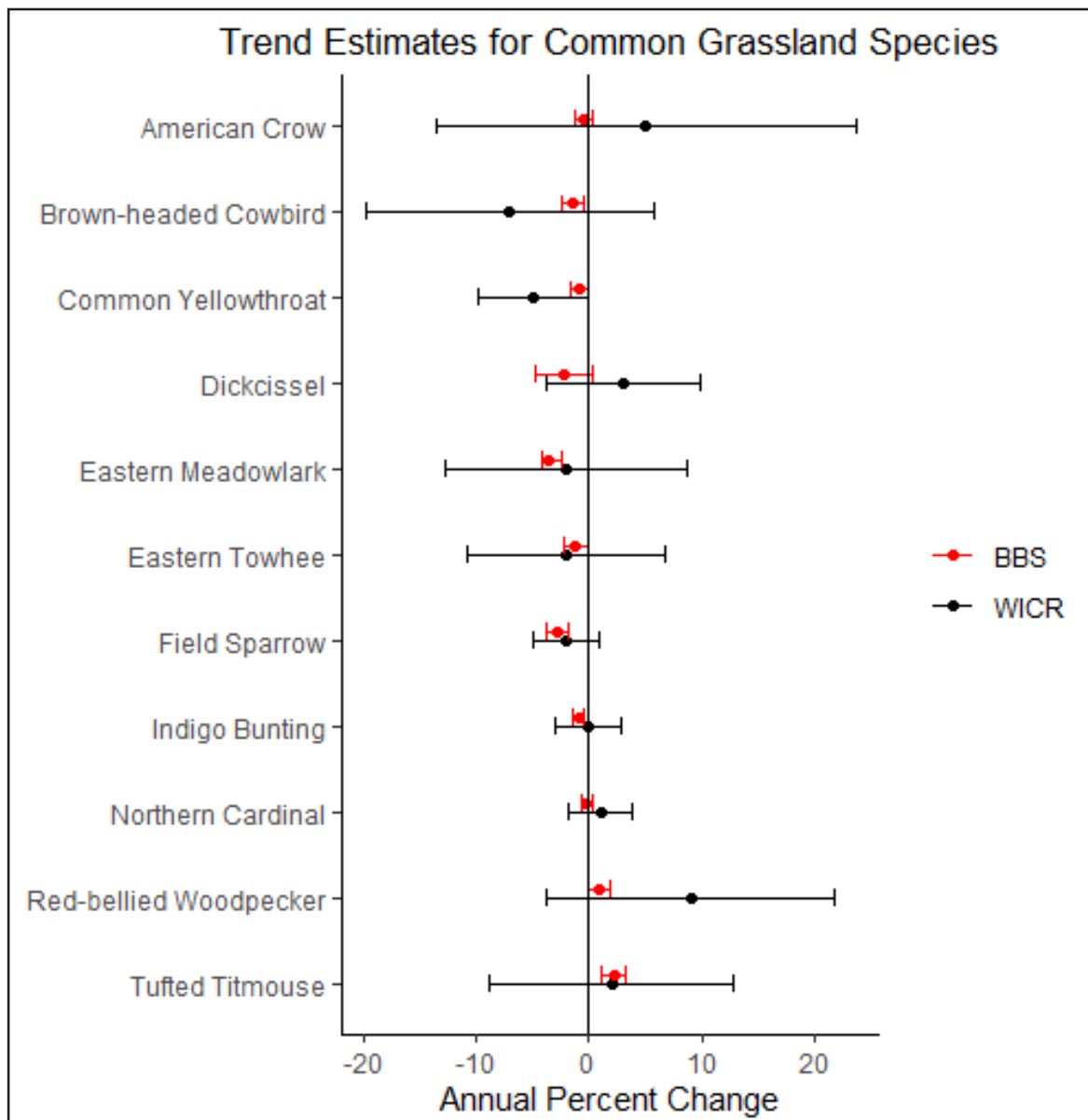


Figure 3a. Comparison of grassland bird population trends from Wilson's Creek National Battlefield (2008 through 2020) with trends in the larger Central Hardwoods Bird Conservation Region (2005 through 2015). Error bars represent 95% confidence intervals. Yellow-breasted Chat is not shown because of unreliably wide confidence intervals.

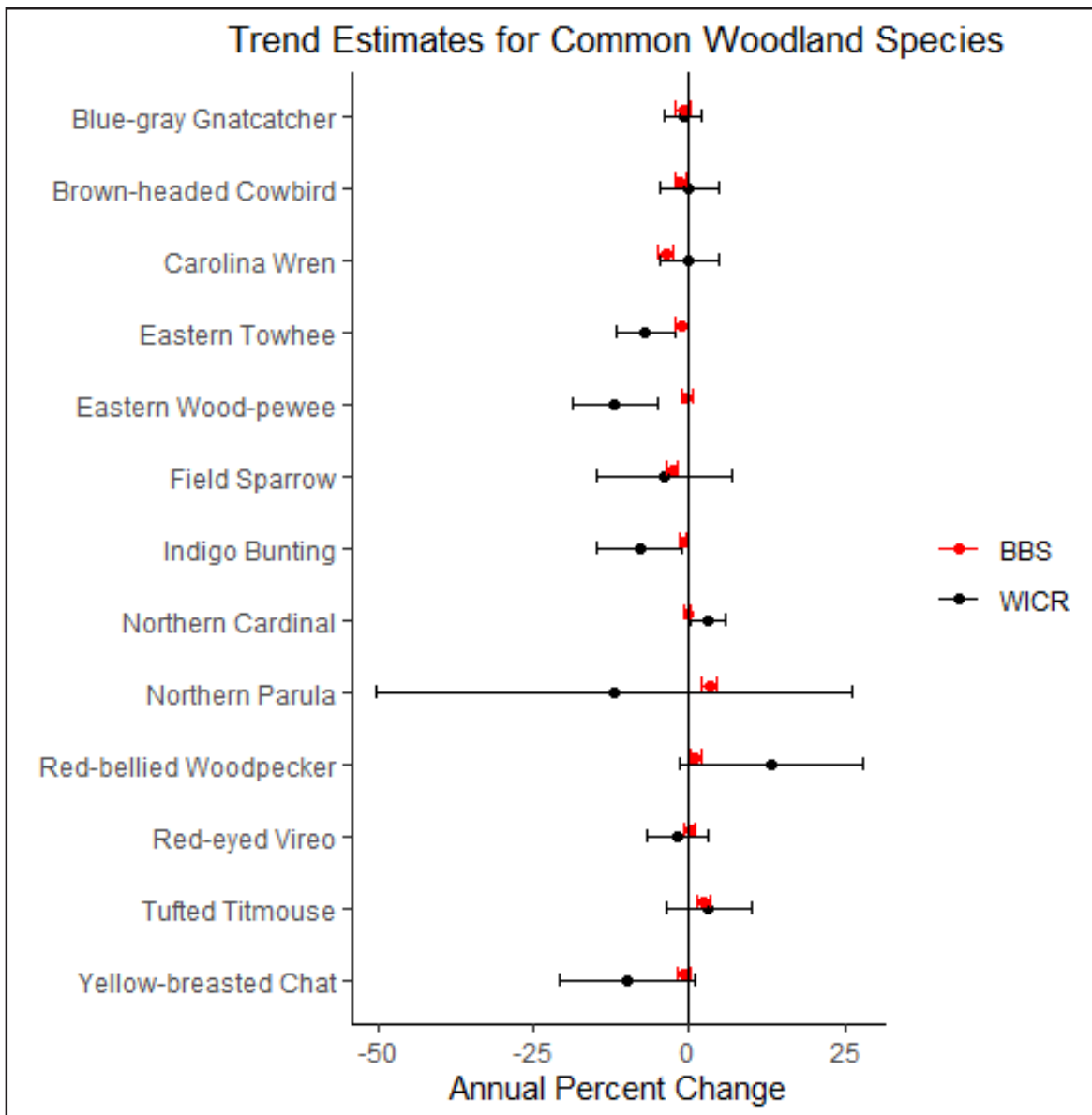


Figure 3b. Comparison of woodland bird population trends from Wilson’s Creek National Battlefield (2008 through 2020) with trends in the larger Central Hardwoods Bird Conservation Region (2005 through 2015). Error bars represent 95% confidence intervals. Yellow-billed Cuckoo is not shown because of unreliaibly wide confidence intervals.

Diversity, richness, and the evenness of individuals distributed across species in the breeding bird communities of both grassland and woodland habitats on Wilson’s Creek National Battlefield were unchanged over the 13 monitoring years since 2008 (Figure 4a and 4b). Grassland bird community richness averaged 42 species annually. Average estimated annual species richness was 55 by the ACE estimator

and 62 by the ICE estimator for this habitat. Woodland bird community richness averaged 37 species annually. Average estimated annual species richness was 48 by the ACE estimator and 53 by the ICE estimator for this habitat. These results should be interpreted with caution as inter-annual variability in the number of plots sampled may be influencing changes in these metrics.

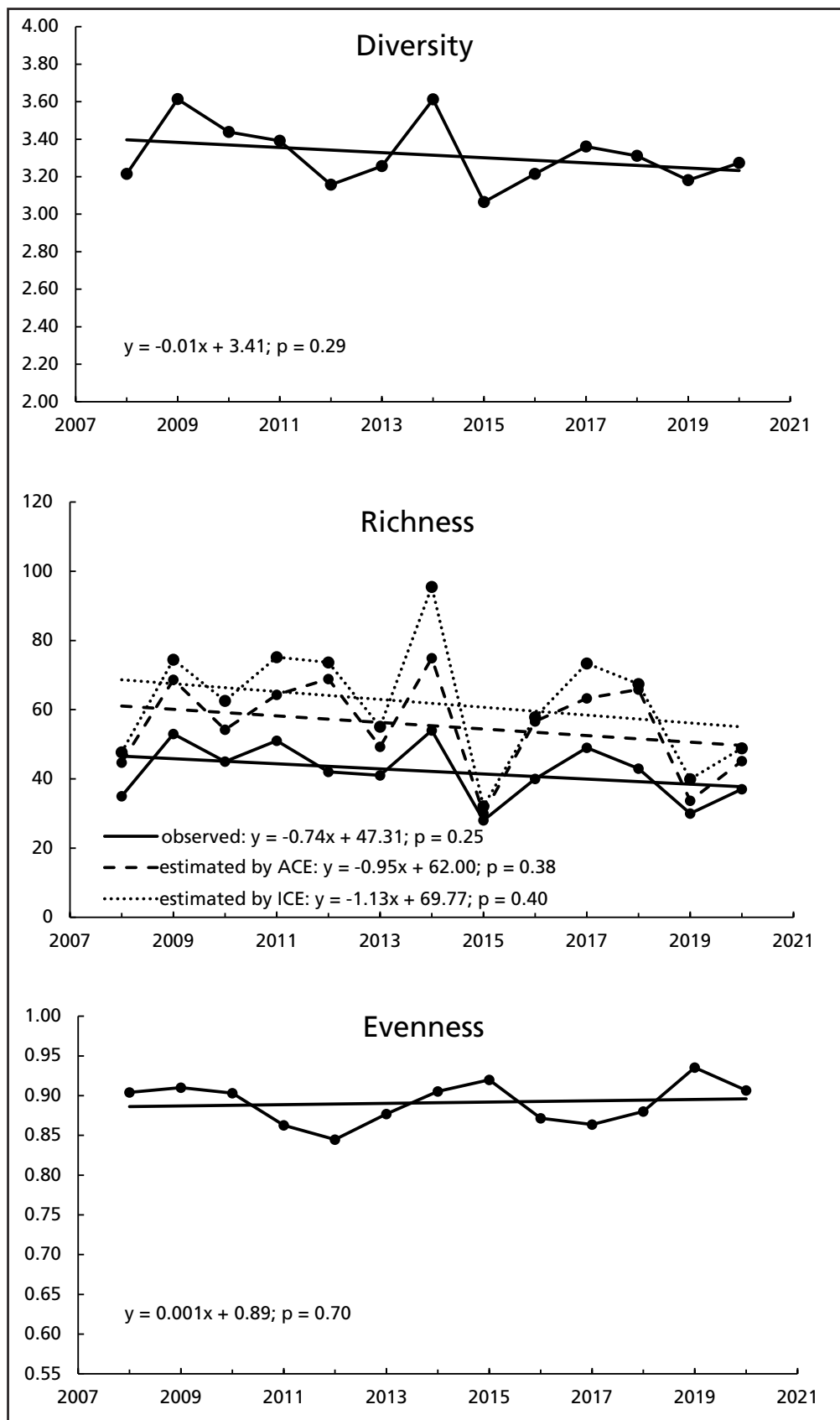


Figure 4a. Trends in grassland bird community diversity, richness, and species distribution evenness on Wilson's Creek National Battlefield (2008 through 2020).

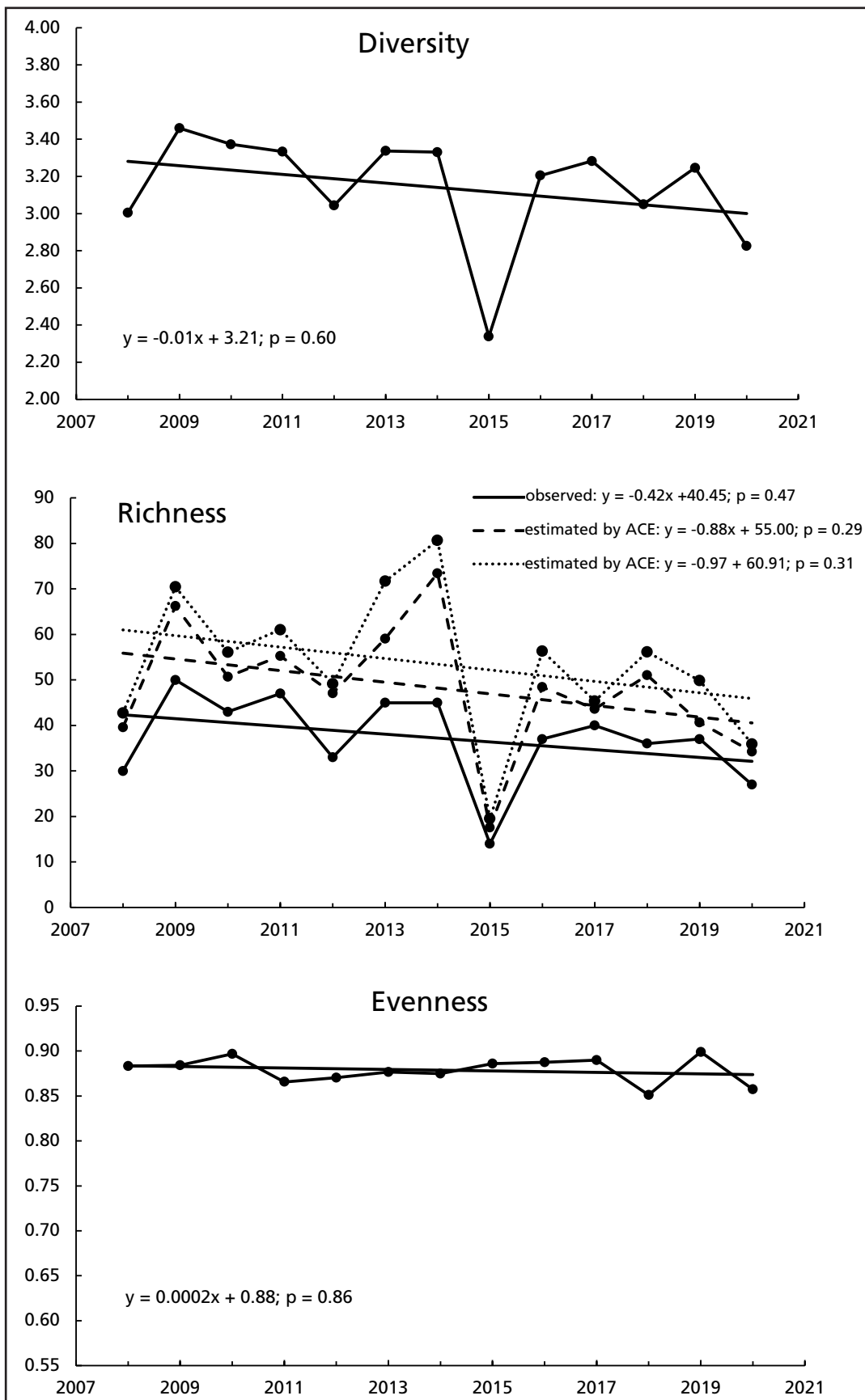


Figure 4b. Trends in woodland bird community diversity, richness, and species distribution evenness on Wilson's Creek National Battlefield (2008 through 2020).

Habitat Assessment

When sampled, habitats on the grassland plots at Wilson's Creek National Battlefield consisted primarily of the old field/prairie type (66–83%), woodland (6–14%), and shrub (1–9%), with lesser amounts of other types present (Appendix H). Canopy cover averaged 10 to 16% on grassland plots, with cover provided entirely by hardwood trees. Basal area of hardwood trees on grassland plots averaged between 1.25 and 2.50 m²/ha, and canopy height averaged 0.87 to 3.98 m. Hardwood tree species from 10 different families contributed to the canopy cover and basal area of grassland plots (Appendix J), with the largest trees occurring in the Moraceae family.

Habitats on woodland plots consisted primarily of the woodland (24–82%) and old field/prairie (6–12%) types, with lesser amounts of other types present (Appendix I). Canopy cover averaged 75 to 89% on woodland plots, with cover provided predominately by hardwood trees (70–83%). Basal area of hardwood trees on woodland plots averaged between 14.74 and 21.25 m²/ha, and canopy height averaged 14.03 to 19.40 m. Hardwood tree species from 16 different families contributed to the canopy cover and basal area (Appendix J) of woodland plots. However, most of the largest trees occurred in the Cannabaceae, Cupressaceae, Fabaceae, Fagaceae, Juglandaceae, Moraceae, and Ulmaceae families. Interestingly, trees from the Juniperaceae family were not recorded on 5-m subplots, however they contributed 4 to 16% of the total canopy cover, 1.25 to 1.75 m²/ha of the total basal area and averaged between 2.59 and 2.90 m in height on plots sampled.

Across all grassland plots, the densest vegetation measures at the time of assessment (mid-May to mid-June) occurred in horizontal profile heights

below 0.50 m (Appendix H). However, vegetation was measured in all height classes to 2.0 m. Across all woodland plots, the densest vegetation measures occurred in horizontal profile heights below 1.0 m (Appendix I). Similar to grassland plots, woodland vegetation was measured in all height classes to 2.0 m. Average vertical structure diversity estimates across years ranged between 14 and 18% for grassland plots, and 36 to 50% for woodland plots.

When sampled, grassland plots were primarily unvegetated (48–87%) at ground level, with grass litter (22–76%) common, and bare soil (1–45%) exposed (Appendix H). Deciduous litter (<1–6%), conifer litter (<1%), woody debris (<1–3%), and rock (0–6%) were also recorded on grassland plots. Similarly, woodland plots were primarily unvegetated (64–96%) at ground level, with deciduous litter (34–49%) common, and bare soil (7–30%) exposed (Appendix I). Woody debris (7–13%), grass litter (6–12%), rock (2–5%), and conifer litter (<1–2%) were also recorded on woodland plots.

When sampled, foliar cover on grassland plots was dominated by cool-season grasses (23–49%) and forbs (15–22%), followed by woody shrubs and vines (8–17%), warm-season grasses (2–16%), tree seedlings (<1%), and mosses and lichens (<1%; Appendix H). Total foliar cover on grassland plots averaged between 56 and 87%. Foliar cover on woodland plots was dominated by woody shrubs and vines (16–40%), cool-season grasses (9–18%), and forbs (9–15%), followed by moss and lichens (1–5%), tree seedlings (1–3%), and warm-season grasses (<1–2%; Appendix I). Total foliar coverage on woodland plots averaged 55 to 68%.

Discussion

The 98 species that are permanent or summer residents to the area (Robbins and Easterla 1992) have value in characterizing the breeding bird community of Wilson's Creek National Battlefield and the habitat on which they rely. The eight 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: Bell's Vireo (*Vireo bellii*), Bewick's Wren (*Thryomanes bewickii*), Blue-winged Warbler (*Vermivora cyanoptera*), Henslow's Sparrow (*Ammodramus henslowii*), Kentucky Warbler (*Geothlypis formosa*), Prairie Warbler (*Setophaga discolor*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), and Wood Thrush (*Hylocichla mustelina*). However, all eight species were recorded on Wilson's Creek National Battlefield in low numbers making it difficult to assess the influences of managing for their habitat requirements (Table 2 and Appendices C and E). If it is not feasible to manage habitat for these species directly, then at least habitat should be managed in a way that does not conflict with their habitat preferences ([see the Central Hardwoods Joint Venture website at https://www.chjv.org](https://www.chjv.org) for individual species habitat requirements and management recommendations). For example, the complete removal of all riparian woodland habitat would be detrimental to the Kentucky Warbler and Wood Thrush. The clearing of Eastern Redcedar (*Juniperus virginiana*) stands from the park, and the restoration of an oak savannah landscape with occasional open glades would enhance habitat for both grassland-shrub species like the Bell's Vireo, Bewick's Wren, Blue-winged Warbler, and Prairie Warbler and open grassland species like the Henslow's Sparrow. Red-headed Woodpecker would benefit from any management action that produces an open woodland/savannah habitat.

Grasslands dominate the bird habitat at Wilson's Creek National Battlefield by only a slight margin over woodlands (Diamond et al. 2013). This is very similar to what occurs within the Ozark Highlands in which the park is located, where the mix is nearly 50:50, with woodland having a slightly greater presence (NPS 2012). For the park, the rich mix of woodland and grassland habitat types, along with other habitat types present, positively influenced the number of bird species observed. Of the breeding

birds recorded, 42 are eastern forest species and nine are grassland species (Rosenberg et al. 2019). The remaining resident species are habitat generalist, wetland, or edge species favored by the mix and positioning of habitats on the park and the creeks 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 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 trend of most 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 (Figures 3a and 3b) suggests that the bird community at Wilson's Creek National Battlefield is faring similarly to that of the region, with a few notable exceptions. For example, the Eastern Wood-pewee (*Contopus virens*) population in woodland habitat is declining moderately on Wilson's Creek National Battlefield (Figure 3b and Appendix F). However, in the Central Hardwoods Bird Conservation Region as a whole, Eastern Wood-pewee populations are stable, suggesting current management actions on the park are not satisfying their requirements for open woodlands (Stokes and Stokes 1996). Conversely, the Indigo Bunting (*Passerina cyanea*) population has a stable trend on Wilson's Creek National Battlefield (Figure 3b and Appendix F), whereas it is declining in the Central Hardwoods Bird Conservation Region as a whole. Indigo Buntings utilize brush and low trees near open areas (Stokes and Stokes 1996), a habitat type that is common on the park. Like the Indigo Bunting, region-wide the populations of Eastern Meadowlark (*Sturnella magna*), Carolina Wren

(*Thryothorus ludovicianus*), Brown-headed Cowbird (*Molothrus ater*), and Field Sparrow (*Spizella pusilla*) are in decline (Figures 3a and 3b and Appendix G) while they are uncertain on the park. However, populations of three species are increasing region-wide while they are uncertain on the park: Northern Parula (*Setophaga americana*), Red-bellied Woodpecker (*Melanerpes carolinus*) and Tufted Titmouse (*Baeolophus bicolor*). Populations are stable region-wide for the rest of the abundant species on Wilson's Creek National Battlefield except for Eastern Towhee (*Pipilo erythrophthalmus*), which is declining on the park and region-wide.

Over the 13 years of bird monitoring on Wilson's Creek National Battlefield, the stable diversity, richness and evenness values in both grassland and

woodland habitats suggests that the ability of park habitat to meet the requirements of most species 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 Wilson's Creek National Battlefield as management and weather and climatic conditions change is essential for park natural resource decision-making.

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Appendix A. Plots Sampled

Table A1. Plots sampled on Wilson's Creek National Battlefield between 2008 and 2020 and gross habitat type. "Yes" indicates plot was sampled; "No" indicates it was not.

Plot	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Plot Type
WICR1*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR2*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
WICR3*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
WICR4*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR5*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
WICR6*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
WICR7*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
WICR8*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR9*	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
WICR10*	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Woodland
WICR11*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
WICR12*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Shrub
WICR13	No	Yes	No	Yes	No	No	No	No	No	Yes	No	No	No	Woodland
WICR14*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Grassland
WICR15*	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Woodland
WICR16*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Grassland
WICR17*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR18*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR19*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
WICR20*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR21*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
WICR22*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR23*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR24*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Woodland
WICR25*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
WICR26*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland

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

Table A1 (continued). Plots sampled on Wilson’s Creek National Battlefield between 2008 and 2020 and gross habitat type. “Yes” indicates plot was sampled; “No” indicates it was not.

Plot	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Plot Type
WICR27*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Woodland
WICR28*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grassland
WICR29	Yes	Yes	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Shrub
WICR30*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Grassland
WICR31*	Yes	Yes	No	Yes	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
WICR32*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Grassland
WICR33*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
WICR34*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Grassland
WICR35*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Grassland
WICR36*	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	Yes	No	Yes	Grassland
WICR37*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Woodland
WICR38	No	Yes	No	No	Yes	No	No	No	Yes	Yes	Yes	Yes	No	Grassland

* Plots 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; shown in parentheses) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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=16	2009 n=17	2010 n=16	2011 n=17	2012 n=17	2013 n=15	2014 n=16	2015 n=11	2016 n=17	2017 n=17	2018 n=17	2019 n=12	2020 n=16
American Crow	0.13 (5)	0.29 (15)	0.50 (47)	0.59 (59)	0.18 (10)	0.40 (45)	0.38 (21)	0.46 (46)	0.29 (5)	0.53 (59)	0.35 (25)	0.33 (20)	0.31 (21)
Brown-headed Cowbird	0.31 (175)	0.35 (137)	0.31 (204)	0.35 (220)	0.35 (192)	0.33 (187)	0.44 (233)	0.36 (170)	0.41 (192)	0.06 (27)	0.41 (165)	0.25 (156)	0.19 (58)
Common Yellowthroat	0.31 (114)	0.29 (129)	0.31 (137)	0.53 (279)	0.59 (300)	0.40 (194)	0.31 (114)	0 (0)	0.41 (150)	0.47 (214)	0.24 (86)	0.25 (122)	0.25 (91)
Dickcissel	0.31 (145)	0.35 (106)	0.63 (273)	0.29 (106)	0.71 (439)	0.53 (274)	0.13 (80)	0.64 (257)	0.29 (151)	0.53 (212)	0.47 (302)	0.33 (129)	0.50 (257)
Eastern Meadowlark	0.13 (22)	0.41 (126)	0.25 (56)	0.24 (53)	0.18 (42)	0.13 (36)	0.56 (112)	0.09 (33)	0.12 (21)	0.41 (126)	0.35 (74)	0 (0)	0.13 (22)
Eastern Towhee	0.13 (40)	0.41 (132)	0.56 (241)	0.35 (113)	0.18 (57)	0.33 (214)	0.38 (141)	0.27 (88)	0.12 (57)	0.24 (94)	0.24 (76)	0.25 (80)	0.25 (80)
Field Sparrow	0.38 (77)	0.76 (186)	0.69 (186)	0.65 (227)	0.71 (155)	0.90 (234)	0.56 (121)	0.50 (143)	0.47 (93)	0.71 (165)	0.71 (155)	0.67 (132)	0.50 (99)
Indigo Bunting	0.75 (394)	0.71 (441)	0.50 (320)	0.76 (394)	0.41 (232)	0.53 (237)	0.44 (197)	0.36 (215)	0.82 (487)	0.59 (301)	0.82 (510)	0.67 (329)	0.50 (296)
Northern Cardinal	0.25 (72)	0.53 (152)	0.56 (198)	0.65 (220)	0.53 (186)	0.73 (326)	0.56 (252)	0.36 (131)	0.82 (271)	0.65 (271)	0.47 (220)	0.58 (168)	0.31 (108)
Red-bellied Woodpecker	0.13 (12)	0.12 (6)	0.31 (36)	0.18 (17)	0.35 (34)	0.47 (64)	0.25 (24)	0.27 (26)	0.18 (17)	0.41 (51)	0.47 (73)	0.33 (32)	0.19 (18)
Tufted Titmouse	0.13 (25)	0.29 (72)	0.56 (140)	0.41 (108)	0.29 (60)	0.87 (244)	0.56 (166)	0.09 (19)	0.35 (96)	0.59 (192)	0.41 (84)	0 (0)	0.44 (89)
Yellow-breasted Chat	0.25 (57)	0.53 (161)	0 (0)	0.47 (197)	0.35 (143)	0.33 (101)	0.13 (57)	0 (0)	0.06 (18)	0.24 (125)	0.24 (107)	0.17 (51)	0.31 (95)

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; shown in parentheses) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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 outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)												
	2008 n=16	2009 n=17	2010 n=16	2011 n=17	2012 n=17	2013 n=15	2014 n=16	2015 n=11	2016 n=17	2017 n=17	2018 n=17	2019 n=12	2020 n=16
Acadian Flycatcher	0 (0)	0.18 (5)	0.19 (6)	0.12 (5)	0 (0)	0.13 (4)	0.06 (2)	0 (0)	0 (0)	0.18 (5)	0 (0)	0.17 (5)	0 (0)
American Coot	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (–)
American Goldfinch	0.06 (–)	0.24 (5)	0.31 (4)	0.12 (2)	0.06 (–)	0.27 (4)	0.25 (20)	0.36 (29)	0 (0) 0.29	0.29 (17)	0.24 (7)	0.25 (10)	0.19 (15)
American Redstart	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
American Robin	0 (0)	0.18 (5)	0.06 (4)	0.06 (2)	0 (0)	0.07 (2)	0.06 (6)	0.18 (3)	0 (0)	0.18 (5)	0 (0)	0 (0)	0.06 (2)
Bank Swallow	0.06 (–)	0 (0)	0.13 (4)	0.06 (2)	0.06 (–)	0 (0)	0.13 (15)	0 (0)	0.06 (–)	0 (0)	0 (0)	0 (0)	0 (0)
Barn Swallow	0 (0)	0 (0)	0.06 (2)	0.06 (3)	0 (0)	0 (0)	0 (0)	0.18 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Barred Owl	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0.06 (–)	0 (0)	0 (0)	0 (0)	0 (0)
Bell's Vireo*	0 (0)	0.06 (2)	0.13 (4)	0.06 (2)	0.06 (2)	0 (0)	0.06 (–)	0 (0)	0 (0)	0 (0)	0.18 (7)	0 (0)	0 (0)
Belted Kingfisher	0 (0)	0 (0)	0 (0)	0.06 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)
Bewick's Wren*	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)
Black and White Warbler	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Blue-gray Gnatcatcher	0.13 (4)	0.18 (5)	0.31 (13)	0.29 (10)	0.12 (4)	0.27 (12)	0.25 (9)	0.18 (8)	0.12 (7)	0.24 (9)	0.47 (16)	0.08 (5)	0.19 (6)
Blue Grosbeak	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.08 (2)	0 (0)
Blue Jay	0.13 (4)	0.18 (7)	0.19 (9)	0.35 (10)	0.06 (–)	0.1 (6)	0.25 (7)	0.2 (5)	0.18 (9)	0.24 (7)	0.41 (21)	0.42 (20)	0.13 (2)
Blue-winged Warbler*	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Broad-winged Hawk	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)
Brown Thrasher	0.13 (2)	0.06 (2)	0.13 (7)	0 (0)	0 (0)	0 (0)	0.06 (6)	0 (0)	0.12 (3)	0.06 (2)	0 (0)	0 (0)	0 (0)
Canada Goose	0.06 (–)	0.06 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Carolina Chickadee	0.19 (5)	0.06 (2)	0.06 (7)	0.06 (3)	0.18 (7)	0.27 (8)	0.13 (4)	0.18 (8)	0.18 (5)	0.06 (2)	0.06 (3)	0 (0)	0 (0)
Carolina Wren	0.13 (4)	0.47 (14)	0.31 (7)	0.12 (3)	0.18 (5)	0.53 (20)	0.44 (15)	0 (0)	0.18 (5)	0.47 (16)	0.12 (3)	0 (0)	0.19 (4)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 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; shown in parentheses) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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 outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)												
	2008 n=16	2009 n=17	2010 n=16	2011 n=17	2012 n=17	2013 n=15	2014 n=16	2015 n=11	2016 n=17	2017 n=17	2018 n=17	2019 n=12	2020 n=16
Cedar Waxwing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (10)	0 (0)	0 (0)	0 (0)
Chimney Swift	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.07 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Chipping Sparrow	0 (0)	0.12 (3)	0 (0)	0.12 (5)	0 (0)	0.07 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)
Cliff Swallow	0 (0)	0.06 (–)	0 (0)	0 (0)	0 (0)	0.13 (4)	0.13 (22)	0.18 (40)	0 (0)	0.12 (–)	0.12 (–)	0.08 (–)	0 (0)
Common Grackle	0.06 (–)	0 (0)	0.06 (2)	0.06 (–)	0.06 (2)	0 (0)	0.06 (–)	0.27 (13)	0 (0)	0.12 (2)	0 (0)	0 (0)	0 (0)
Downy Woodpecker	0 (0)	0.06 (2)	0 (0)	0.06 (2)	0.06 (2)	0.13 (4)	0.13 (2)	0 (0)	0 (0)	0.06 (2)	0 (0)	0.17 (5)	0.06 (2)
Eastern Bluebird	0 (0)	0.18 (7)	0.06 (2)	0.24 (10)	0.06 (2)	0.13 (10)	0.09 (–)	0.09 (3)	0 (0)	0.06 (3)	0.18 (5)	0.08 (10)	0.06 (4)
Eastern Kingbird	0 (0)	0.06 (2)	0 (0)	0 (0)	0.06 (2)	0 (0)	0.06 (15)	0 (0)	0.12 (9)	0 (0)	0.12 (2)	0 (0)	0 (0)
Eastern Phoebe	0.06 (2)	0.18 (7)	0.06 (2)	0.12 (5)	0.06 (2)	0 (0)	0 (0)	0 (0)	0.06 (2)	0.06 (2)	0.12 (3)	0.08 (3)	0.06 (2)
Eastern Wood-pewee	0 (0)	0.29 (9)	0.13 (2)	0.24 (7)	0.06 (2)	0.13 (4)	0.06 (2)	0.18 (5)	0.06 (2)	0.12 (3)	0 (0)	0.25 (7)	0.13 (6)
European Starling	0 (0)	0.06 (–)	0 (0)	0.06 (2)	0.06 (5)	0.07 (2)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Fish Crow	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.12 (12)	0 (0)	0.08 (–)	0 (0)
Grasshopper Sparrow	0 (0)	0.06 (2)	0.13 (4)	0.06 (3)	0.18 (5)	0.07 (2)	0.13 (4)	0 (0)	0.12 (5)	0.06 (2)	0 (0)	0 (0)	0.13 (4)
Gray Catbird	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0.06 (2)	0 (0)	0 (0)
Great Blue Heron	0.06 (–)	0.06 (2)	0 (0)	0 (0)	0.18 (–)	0 (0)	0.19 (–)	0 (0)	0.06 (–)	0.06 (–)	0.06 (–)	0 (0)	0 (0)
Great Crested Flycatcher	0.25 (4)	0.18 (5)	0.13 (4)	0.24 (7)	0 (0)	0.33 (10)	0.31 (9)	0 (0)	0.12 (2)	0.24 (7)	0.12 (3)	0 (0)	0.12 (6)
Green Heron	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)
Hairy Woodpecker	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0.08 (2)	0 (0)
Henslow's Sparrow*	0 (0)	0 (0)	0.06 (4)	0.06 (2)	0 (0)	0 (0)	0.13 (6)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Hooded Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.12 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Horned Lark	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)
House Sparrow	0 (0)	0.06 (2)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
House Wren	0 (0)	0.12 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0.12 (3)	0.12 (3)	0.06 (2)	0 (0)	0 (0)
Kentucky Warbler*	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.19 (6)	0 (0)	0 (0)	0.06 (2)	0.06 (2)	0 (0)	0 (0)
Killdeer	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0.09 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 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; shown in parentheses) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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 outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)												
	2008 n=16	2009 n=17	2010 n=16	2011 n=17	2012 n=17	2013 n=15	2014 n=16	2015 n=11	2016 n=17	2017 n=17	2018 n=17	2019 n=12	2020 n=16
Lark Sparrow	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Louisiana Waterthrush	0 (0)	0.12 (5)	0 (0)	0.06 (2)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)
Mourning Dove	0 (0)	0.12 (2)	0.06 (–)	0.06 (2)	0 (0)	0.27 (12)	0 (0)	0.27 (5)	0 (0)	0.12 (3)	0.18 (3)	0 (0)	0 (0)
Northern Bobwhite	0.13 (5)	0.29 (10)	0.06 (2)	0.12 (3)	0.24 (3)	0 (0)	0 (0)	0.18 (11)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)
Northern Flicker	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Northern Mockingbird	0.31 (9)	0.06 (2)	0 (0)	0.12 (3)	0.06 (–)	0.07 (4)	0.19 (6)	0.27 (8)	0.35 (10)	0.18 (5)	0 (0)	0.08 (2)	0 (0)
Northern Parula	0.06 (2)	0.18 (5)	0.19 (6)	0.12 (5)	0.18 (5)	0.13 (4)	0.25 (9)	0 (0)	0.24 (7)	0.06 (2)	0.12 (4)	0.25 (10)	0.13 (4)
Northern Rough-winged Swallow	0 (0)	0 (0)	0.06 (–)	0.06 (2)	0.06 (–)	0 (0)	0.06 (–)	0 (0)	0 (0)	0.12 (3)	0.06 (–)	0 (0)	0.06 (–)
Orchard Oriole	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Ovenbird	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Pileated Woodpecker	0 (0)	0.06 (–)	0.13 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)
Prairie Warbler*	0.06 (2)	0 (0)	0 (0)	0 (0)	0.06 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)
Prothonotary Warbler	0 (0)	0.12 (3)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)
Red-eyed Vireo	0 (0)	0.29 (12)	0.13 (4)	0.18 (5)	0.06 (2)	0.07 (2)	0.25 (9)	0 (0)	0.06 (2)	0.06 (2)	0.06 (2)	0.08 (0)	0.13 (4)
Red-shouldered Hawk	0 (0)	0 (0)	0.06 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.08 (–)	0.06 (–)
Red-tailed Hawk	0.06 (4)	0.12 (3)	0 (0)	0.06 (–)	0.18 (2)	0.07 (2)	0 (0)	0.09 (3)	0 (0)	0 (0)	0.06 (2)	0.08 (–)	0.06 (–)
Red-winged Blackbird	0 (0)	0 (0)	0 (0)	0.12 (2)	0.06 (2)	0 (0)	0.06 (4)	0.09 (8)	0.06 (2)	0.12 (3)	0 (0)	0 (0)	0 (0)
Ruby-throated Hummingbird	0 (0)	0.06 (2)	0 (0)	0.06 (2)	0 (0)	0.07 (2)	0.06 (2)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)
Scarlet Tanager	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Scissor-tailed Flycatcher	0 (0)	0 (0)	0.06 (–)	0 (0)	0 (0)	0.1 (4)	0 (0)	0 (0)	0.06 (2)	0.06 (3)	0 (0)	0 (0)	0.06 (–)
Song Sparrow	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Summer Tanager	0 (0)	0.12 (3)	0 (0)	0 (0)	0 (0)	0.07 (4)	0.13 (4)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)
Tree Swallow	0 (0)	0.06 (–)	0 (0)	0.06 (–)	0.06 (–)	0 (0)	0.06 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Turkey Vulture	0.06 (–)	0.12 (–)	0.13 (–)	0.06 (2)	0 (0)	0.07 (2)	0 (0)	0.36 (13)	0.06 (–)	0.06 (–)	0.12 (–)	0.25 (2)	0.19 (–)
Warbling Vireo	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.13 (4)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 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; shown in parentheses) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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 outside of 200 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)												
	2008 n=16	2009 n=17	2010 n=16	2011 n=17	2012 n=17	2013 n=15	2014 n=16	2015 n=11	2016 n=17	2017 n=17	2018 n=17	2019 n=12	2020 n=16
White-breasted Nuthatch	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0.06 (–)	0 (0)	0 (0)	0 (0)
White-eyed Vireo	0.06 (2)	0.06 (2)	0.19 (6)	0.24 (7)	0.06 (2)	0.07 (4)	0.06 (2)	0 (0)	0.06 (2)	0.12 (3)	0.06 (2)	0.25 (7)	0.06 (2)
Wild Turkey	0.13 (2)	0.06 (2)	0.13 (4)	0 (0)	0.12(16)	0.13 (4)	0.19 (7)	0 (0)	0.18 (14)	0.18 (7)	0.06 (–)	0 (0)	0 (0)
Wood Thrush*	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)
Yellow-billed Cuckoo	0 (0)	0.12 (7)	0.31 (7)	0.12 (5)	0.41 (21)	0.27 (8)	0.06 (–)	0 (0)	0 (0)	0.12 (3)	0.41 (10)	0.42 (15)	0.25 (4)
Yellow-throated Vireo	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0.06 (2)	0 (0)	0 (0)
Yellow-throated Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 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; shown in parentheses) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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=20	2009 n=21	2010 n=17	2011 n=21	2012 n=18	2013 n=18	2014 n=19	2015 n=10	2016 n=20	2017 n=21	2018 n=20	2019 n=15	2020 n=20
American Crow	0.15 (—)	0.29 (81)	0.65 (113)	0.38 (30)	0.17 (12)	0.22 (47)	0.37 (56)	0.50 (107)	0.15 (21)	0.48 (112)	0.25 (43)	0.47 (85)	0.05 (—)
Blue-gray Gnatcatcher	0.50 (749)	0.29 (370)	0.65 (1066)	0.52 (986)	0.50 (647)	0.78 (1366)	0.63 (1226)	0 (0)	0.20 (259)	0.52 (1049)	0.75 (1229)	0.27 (345)	0.25 (341)
Brown-headed Cowbird	0.15 (106)	0.29 (255)	0.47 (315)	0.24 (255)	0 (0)	0.17 (111)	0.32 (176)	0 (0)	0.05 (33)	0.19 (159)	0.15 (67)	0.13 (89)	0.05 (35)
Carolina Wren	0.30 (167)	0.67 (427)	0.29 (186)	0.19 (100)	0.22 (117)	0.56 (352)	0.47 (278)	0 (0)	0.25 (132)	0.57 (402)	0.35 (185)	0.27 (141)	0.35 (222)
Eastern Towhee	0.35 (122)	0.52 (189)	0.29 (136)	0.67 (267)	0.28 (110)	0.44 (257)	0.58 (261)	0.20 (66)	0.15 (50)	0.38 (126)	0.40 (149)	0.20 (66)	0.20 (69)
Eastern Wood-pewee	0.25 (134)	0.38 (242)	0.35 (180)	0.29 (170)	0.22 (141)	0.39 (198)	0.11 (54)	0.30 (204)	0.05 (25)	0.33 (170)	0.10 (51)	0.07 (34)	0.15 (80)
Field Sparrow	0.10 (41)	0.48 (275)	0.35 (181)	0.71 (312)	0.22 (107)	0.50 (257)	0.42 (182)	0.20 (77)	0.20 (96)	0.38 (275)	0.40 (173)	0.20 (77)	0.15 (61)
Indigo Bunting	0.60 (822)	0.48 (470)	0.53 (580)	0.62 (587)	0.28 (456)	0.61 (730)	0.58 (605)	0 (0)	0.40 (575)	0.43 (470)	0.45 (411)	0.73 (767)	0.10 (86)
Northern Cardinal	0.40 (288)	0.67 (474)	0.71 (468)	0.90 (710)	0.56 (414)	0.83 (663)	0.79 (628)	0.50 (398)	0.70 (423)	0.81 (734)	0.75 (547)	0.67 (497)	0.70 (550)
Northern Parula	0.15 (92)	0.24 (138)	0.24 (205)	0.52 (359)	0.28 (161)	0.28 (226)	0.26 (214)	0 (0)	0.55 (348)	0.14 (111)	0.20 (145)	0.07 (39)	0 (0)
Red-bellied Woodpecker	0.05 (23)	0.24 (104)	0.41 (154)	0.14 (42)	0.11 (49)	0.72 (340)	0.37 (138)	0.10 (44)	0.20 (109)	0.52 (271)	0.40 (197)	0.33 (146)	0.20 (92)
Red-eyed Vireo	0.20 (130)	0.52 (352)	0.29 (181)	0.33 (235)	0.17 (103)	0.22 (171)	0.11 (130)	0.10 (62)	0.30 (105)	0.24 (147)	0.20 (154)	0.27 (164)	0.20 (130)
Tufted Titmouse	0.15 (78)	0.48 (283)	0.53 (291)	0.33 (212)	0.50 (275)	0.56 (357)	0.63 (495)	0.40 (247)	0.35 (173)	0.71 (519)	0.50 (247)	0.07 (33)	0.60 (313)
Yellow-billed Cuckoo	0 (0)	0.10 (34)	0.18 (62)	0.33 (118)	0.56 (157)	0.44 (177)	0 (0)	0 (0)	0.05 (10)	0.19 (67)	0.50 (247)	0.60 (259)	0.10 (19)
Yellow-breasted Chat	0.15 (43)	0.48 (154)	0.12 (32)	0.29 (128)	0.28 (90)	0.44 (135)	0.37 (128)	0 (0)	0.05 (13)	0.24 (77)	0.15 (54)	0.13 (36)	0.05 (14)

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 50-m of plot center) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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 outside of 50 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)												
	2008 n=20	2009 n=21	2010 n=17	2011 n=21	2012 n=18	2013 n=18	2014 n=19	2015 n=10	2016 n=20	2017 n=21	2018 n=20	2019 n=15	2020 n=20
Acadian Flycatcher	0 (0)	0.14 (4)	0.12 (4)	0.14 (6)	0 (0)	0.17 (7)	0.05 (2)	0 (0)	0 (0)	0.10 (3)	0.05 (1)	0 (0)	0 (0)
American Goldfinch	0 (0)	0.24 (4)	0.24 (5)	0.10 (7)	0.06 (—)	0.22 (5)	0.32 (17)	0 (0)	0 (0)	0.14 (6)	0.10 (3)	0.13 (10)	0.10 (4)
American Redstart	0 (0)	0 (0)	0 (0)	0.10 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (1)	0 (0)	0 (0)	0 (0)	0.05 (1)
American Robin	0 (0)	0.05 (1)	0 (0)	0.05 (1)	0 (0)	0.11 (3)	0.05 (2)	0 (0)	0.05 (1)	0.10 (4)	0.05 (1)	0 (0)	0 (0)
Barn Swallow	0 (0)	0.05 (—)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Barred Owl	0 (0)	0 (0)	0.06 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (1)	0 (0)	0 (0)
Bell's Vireo*	0 (0)	0.05 (1)	0 (0)	0.05 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Black and White Warbler	0.05 (1)	0.05 (1)	0.06 (2)	0.10 (6)	0.06 (2)	0.06 (2)	0.05 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Black-billed Cuckoo	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Blue Jay	0.05 (—)	0.14 (4)	0.29 (9)	0.24 (7)	0.06 (2)	0.06 (2)	0.21 (11)	0.10 (3)	0.10 (1)	0.29 (9)	0.15 (7)	0.20 (10)	0.05 (1)
Blue-winged Warbler*	0.05 (1)	0.05 (1)	0.06 (2)	0.10 (6)	0.06 (2)	0.06 (2)	0.05 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Broad-winged Hawk	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0.05 (—)	0 (0)	0 (0)	0 (0)	0 (0)
Brown Thrasher	0 (0)	0 (0)	0 (0)	0.05 (2)	0.06 (2)	0.06 (2)	0.05 (2)	0 (0)	0 (0)	0.10 (3)	0 (0)	0.07 (4)	0.05 (1)
Carolina Chickadee	0.05 (1)	0.14 (4)	0.06 (2)	0.24 (11)	0.06 (2)	0.06 (3)	0.21 (6)	0.30 (27)	0.10 (3)	0.24 (9)	0.05 (1)	0.13 (6)	0.05 (3)
Chimney Swift	0 (0)	0 (0)	0.12 (—)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Chipping Sparrow	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.07 (2)	0 (0)
Cliff Swallow	0 (0)	0 (0)	0 (0)	0.05 (—)	0 (0)	0.06 (3)	0.05 (—)	0.10 (—)	0 (0)	0 (0)	0.05 (—)	0.07 (2)	0 (0)
Common Grackle	0 (0)	0.05 (—)	0.12 (2)	0 (0)	0 (0)	0 (0)	0.05 (2)	0 (0)	0 (0)	0.05 (—)	0 (0)	0 (0)	0 (0)
Common Yellowthroat	0 (0)	0.24 (9)	0.18 (7)	0.24 (9)	0.06 (2)	0.06 (2)	0.16 (5)	0 (0)	0.10 (3)	0.14 (7)	0.10 (3)	0.13 (4)	0.05 (1)
Cooper's Hawk	0 (0)	0.05 (—)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Dickcissel	0.05 (1)	0.10 (4)	0.12 (7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.10 (7)	0.05 (1)	0.13 (4)	0.10 (3)
Downy Woodpecker	0.05 (3)	0 (0)	0 (0)	0.14 (6)	0.17 (5)	0.06 (2)	0 (0)	0 (0)	0.05 (1)	0.10 (3)	0 (0)	0.13 (4)	0 (0)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 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 50-m of plot center) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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 outside of 50 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)												
	2008 n=20	2009 n=21	2010 n=17	2011 n=21	2012 n=18	2013 n=18	2014 n=19	2015 n=10	2016 n=20	2017 n=21	2018 n=20	2019 n=15	2020 n=20
Eastern Bluebird	0 (0)	0.05 (1)	0.06 (2)	0.10 (3)	0 (0)	0.28 (10)	0 (0)	0 (0)	0 (0)	0.05 (1)	0.05 (1)	0 (0)	0 (0)
Eastern Kingbird	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.11 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Eastern Meadowlark	0 (0)	0.14 (4)	0.18 (4)	0.05 (1)	0 (0)	0.06 (2)	0.05 (2)	0 (0)	0 (0)	0.05 (3)	0 (0)	0 (0)	0 (0)
Eastern Phoebe	0 (0)	0.10 (3)	0.12 (5)	0.05 (1)	0 (0)	0 (0)	0.16 (5)	0 (0)	0 (0)	0.10 (3)	0 (0)	0 (0)	0.10 (3)
European Starling	0 (0)	0.05 (–)	0 (0)	0.05 (1)	0 (0)	0 (0)	0.16 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Fish Crow	0 (0)	0 (0)	0.06 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.10 (3)	0 (0)	0.13 (4)	0 (0)
Grasshopper Sparrow	0 (0)	0.05 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Gray Catbird	0.05 (1)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0.16 (5)	0 (0)	0.05 (1)	0 (0)	0.05 (1)	0 (0)	0 (0)
Great Blue Heron	0 (0)	0 (0)	0 (0)	0.10 (–)	0 (0)	0 (0)	0.11 (–)	0 (0)	0 (0)	0.05 (–)	0 (0)	0 (0)	0 (0)
Great Crested Flycatcher	0.05 (1)	0.19 (7)	0.24 (7)	0.24 (7)	0.17 (5)	0.17 (5)	0.16 (5)	0 (0)	0.10 (3)	0.10 (3)	0.05 (1)	0.13 (4)	0.10 (3)
Hairy Woodpecker	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Hooded Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0.10 (3)	0 (0)	0 (0)	0 (0)	0.05 (1)
House Wren	0 (0)	0.05 (1)	0 (0)	0.05 (1)	0.06 (3)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Kentucky Warbler*	0.35 (12)	0.05 (1)	0.06 (5)	0.14 (6)	0.06 (2)	0.11 (5)	0.26 (8)	0 (0)	0 (0)	0.14 (4)	0 (0)	0.20 (8)	0 (0)
Killdeer	0 (0)	0 (0)	0 (0)	0.05 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Lark Sparrow	0 (0)	0.05 (1)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Louisiana Waterthrush	0 (0)	0.14 (4)	0 (0)	0.10 (3)	0 (0)	0 (0)	0.05 (2)	0 (0)	0.05 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Mourning Dove	0 (0)	0.05 (1)	0 (0)	0.10 (3)	0 (0)	0.11 (3)	0 (0)	0 (0)	0.10 (–)	0.24 (10)	0.10 (3)	0.20 (6)	0 (0)
Northern Bobwhite	0.05 (–)	0.10 (3)	0 (0)	0.05 (1)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Northern Flicker	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Northern Mockingbird	0.10 (1)	0.05 (1)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.10 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Northern Rough-winged Swallow	0 (0)	0 (0)	0.12 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Orchard Oriole	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (1)	0 (0)	0 (0)
Ovenbird	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Pileated Woodpecker	0.05 (1)	0.10 (3)	0.06 (–)	0 (0)	0 (0)	0.06 (3)	0 (0)	0 (0)	0 (0)	0.19 (6)	0.05 (1)	0 (0)	0.10 (3)

*Species of conservation concern for the Central Hardwoods Bird Conservation Region (USFWS 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 50-m of plot center) of each species at Wilson's Creek National Battlefield during the 2008 to 2020 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 outside of 50 m from the plot center.

Common Name	Proportion of Plots Occupied (Abundance)												
	2008 n=20	2009 n=21	2010 n=17	2011 n=21	2012 n=18	2013 n=18	2014 n=19	2015 n=10	2016 n=20	2017 n=21	2018 n=20	2019 n=15	2020 n=20
Prothonotary Warbler	0 (0)	0 (0)	0 (0)	0.05 (1)	0 (0)	0 (0)	0.05 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Red-headed Woodpecker*	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.07 (2)	0 (0)
Red-shouldered Hawk	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (1)	0 (0)	0.07 (4)	0 (0)
Red-tailed Hawk	0 (0)	0.10 (–)	0 (0)	0 (0)	0.06 (2)	0.06 (2)	0.05 (2)	0.10 (3)	0 (0)	0 (0)	0.05 (–)	0.07 (4)	0 (0)
Red-winged Blackbird	0 (0)	0.10 (3)	0 (0)	0.05 (1)	0 (0)	0 (0)	0.05 (2)	0 (0)	0 (0)	0.10 (3)	0 (0)	0 (0)	0 (0)
Ruby-throated Hummingbird	0 (0)	0 (0)	0.06 (2)	0.05 (–)	0 (0)	0.17 (5)	0 (0)	0.10 (6)	0 (0)	0 (0)	0.05 (1)	0.13 (4)	0 (0)
Scissor-tailed Flycatcher	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.07 (2)	0 (0)
Song Sparrow	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.05 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Summer Tanager	0.15 (4)	0.24 (7)	0.06 (2)	0.33 (13)	0.28 (10)	0.11 (5)	0.11 (3)	0 (0)	0.15 (4)	0.14 (4)	0 (0)	0.07 (4)	0 (0)
Turkey Vulture	0.05 (–)	0.05 (1)	0.12 (2)	0.05 (1)	0 (0)	0.06 (–)	0.11 (–)	0 (0)	0.05 (–)	0 (0)	0 (0)	0.13 (–)	0.05 (0)
Warbling Vireo	0 (0)	0.05 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
White-breasted Nuthatch	0 (0)	0.10 (3)	0 (0)	0.10 (3)	0 (0)	0.06 (2)	0.05 (2)	0 (0)	0 (0)	0 (0)	0.05 (1)	0 (0)	0 (0)
White-eyed Vireo	0.15 (6)	0.29 (10)	0.29 (9)	0.14 (4)	0.11 (3)	0.28 (8)	0.21 (6)	0 (0)	0.10 (4)	0.38 (16)	0.15 (4)	0 (0)	0 (0)
Wild Turkey	0.25 (7)	0.05 (1)	0.12 (–)	0.19 (3)	0.17 (17)	0.11 (3)	0.16 (5)	0.20 (6)	0.15 (4)	0.24 (9)	0.10 (3)	0.20 (2)	0 (0)
Wood Thrush*	0 (0)	0.05 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Yellow-throated Vireo	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.11 (3)	0 (0)	0 (0)	0.05 (1)	0 (0)	0.05 (1)	0.07 (2)	0.10 (3)
Yellow-throated Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Yellow Warbler	0 (0)	0 (0)	0.06 (2)	0 (0)	0 (0)	0 (0)	0.05 (2)	0 (0)	0.05 (1)	0 (0)	0 (0)	0 (0)	0 (0)

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

Appendix F. Wilson's Creek National Battlefield Trends

Table F1. Trends, annual change in abundance (individuals), of breeding birds recorded on Wilson's Creek National Battlefield from 2008 through 2020. "—" denotes when annual trend values could not be calculated resulting in an undetermined trend classification.

Habitat	Bird Common Name	Trend ^A	SE of Slope	Trend Classification ^B
Grassland	American Crow	1.05	0.10	Uncertain
	Brown-headed Cowbird	0.93	0.07	Uncertain
	Common Yellowthroat	0.95	0.03	Uncertain
	Dickcissel	1.03	0.04	Uncertain
	Eastern Meadowlark	0.98	0.06	Uncertain
	Eastern Towhee	0.98	0.05	Uncertain
	Field Sparrow	0.98	0.02	Uncertain
	Indigo Bunting	1.00	0.02	Stable
	Northern Cardinal	1.01	0.03	Uncertain
	Red-bellied Woodpecker	1.09	0.07	Uncertain
	Tufted Titmouse	1.02	0.06	Uncertain
	Yellow-breasted Chat	1.02	0.32	Uncertain
Woodland	American Crow	—	—	Undetermined
	Blue-gray Gnatcatcher	0.99	0.04	Uncertain
	Brown-headed Cowbird	1.00	0.03	Uncertain
	Carolina Wren	1.00	0.03	Uncertain
	Eastern Towhee	0.93	0.03	Moderate decline
	Eastern Wood-pewee	0.88	0.04	Moderate decline
	Field Sparrow	0.96	0.06	Uncertain
	Indigo Bunting	0.92	0.04	Uncertain
	Northern Cardinal	1.03	0.02	Uncertain
	Northern Parula	0.88	0.20	Uncertain
	Red-bellied Woodpecker	1.13	0.08	Uncertain
	Red-eyed Vireo	0.98	0.03	Uncertain
	Tufted Titmouse	1.03	0.04	Uncertain
	Yellow-billed Cuckoo	1.17	0.92	Uncertain
	Yellow-breasted Chat	0.90	0.06	Uncertain

^A Trends were determined using the statistical software TRIM Version 3.54 (2006).

^B Trend classification types depend on statistical significance and magnitude (Pannekoek and Van Strien 2005; Van Strien et al. 2001) and follow 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 that 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 Bird Conservation Region trends for breeding birds recorded on Wilson's Creek National Battlefield for years 2005 through 2015. Regional trend data was obtained from BBS surveys (Sauer et al. 2017). Trend is defined as an interval-specific geometric mean of proportional changes in population size (Link and Sauer 1998), expressed as a percentage.

Common Name	Annual Percent Change in Population Size	95% Confidence Interval	
		Lower	Upper
Acadian Flycatcher	1.66	0.79	2.74
American Coot	–	–	–
American Crow	-0.43	-1.23	0.39
American Goldfinch	-0.70	-2.11	0.63
American Redstart	5.61	1.62	10.74
American Robin	-1.01	-1.88	-0.12
Baltimore Oriole ^B	0.23	-1.99	2.25
Bank Swallow	9.08	-5.51	27.01
Barn Swallow	-2.37	-3.35	-1.32
Barred Owl	3.47	-0.96	7.95
Bell's Vireo^A	7.84	1.97	15.42
Belted Kingfisher	-3.39	-6.32	-0.33
Bewick's Wren^A	-9.08	-15.39	-3.94
Black and White Warbler	-2.81	-6.05	0.22
Black-billed Cuckoo	-2.12	-6.70	3.91
Blue-gray Gnatcatcher	-0.86	-2.15	0.28
Blue Grosbeak	2.44	1.21	3.70
Blue Jay	-1.38	-2.17	-0.54
Blue-winged Warble^A	-1.91	-5.15	0.93
Brown-headed Cowbird	-1.41	-2.36	-0.55
Broad-winged Hawk	2.31	-1.19	5.56
Brown Thrasher	-0.90	-1.79	0.06
Canada Goose	15.45	5.93	23.40
Carolina Chickadee	-1.33	-2.73	0.04
Carolina Wren	-3.80	-5.07	-2.51
Cedar Waxwing	-6.18	-9.96	-2.49
Chimney Swift	-3.10	-4.33	-1.72
Chipping Sparrow	0.76	-0.28	1.75
Cliff Swallow	20.60	14.34	26.01
Common Grackle	-3.78	-4.87	-2.85
Common Yellowthroat	-0.84	-1.68	0.01
Cooper's Hawk	3.71	0.81	6.08
Dickcissel	-2.29	-4.73	0.26
Downy Woodpecker	0.09	-1.50	1.73
Eastern Bluebird	-5.40	-6.95	-3.84

^A Species 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-min survey periods.

Table G1 (continued). Central Hardwoods Bird Conservation Region trends for breeding birds recorded on Wilson's Creek National Battlefield for years 2005 through 2015. Regional trend data was obtained from BBS surveys (Sauer et al. 2017). Trend is defined as an interval-specific geometric mean of proportional changes in population size (Link and Sauer 1998), expressed as a percentage.

Common Name	Annual Percent Change in Population Size	95% Confidence Interval	
		Lower	Upper
Eastern Kingbird	-1.21	-2.13	-0.29
Eastern Meadowlark	-3.53	-4.16	-2.36
Eastern Phoebe	-1.11	-2.38	0.11
Eastern Towhee	-1.17	-2.21	-0.09
Eastern Wood-pewee	-0.50	-1.35	0.37
European Starling	-0.18	-1.54	0.96
Field Sparrow	-2.77	-3.78	-1.77
Fish Crow	6.95	-1.52	13.53
Grasshopper Sparrow	-4.72	-7.42	-2.23
Gray Catbird	-2.21	-3.50	-0.87
Great Blue Heron	3.47	1.31	5.57
Great Crested Flycatcher	-0.29	-1.35	0.78
Green Heron	-1.99	-3.09	-0.74
Hairy Woodpecker	1.30	-0.50	3.29
Henslow's Sparrow^A	3.05	-4.54	8.25
Hooded Warbler	3.79	1.26	7.06
Horned Lark	-1.02	-3.98	1.59
House Sparrow	-4.81	-6.04	-3.57
House Wren	0.97	-1.18	3.10
Indigo Bunting	-0.91	-1.41	-0.43
Kentucky Warbler^A	-0.16	-1.57	1.24
Killdeer	-1.14	-2.63	0.31
Lark Sparrow	3.05	-3.47	13.52
Louisiana Waterthrush	3.33	1.40	6.00
Mourning Dove	0.56	-0.22	1.39
Northern Bobwhite	-3.68	-4.87	-2.46
Northern Cardinal	-0.24	-0.73	0.26
Northern Flicker	-2.64	-4.32	-1.01
Northern Harrier ^B	0.73	-16.64	12.18
Northern Mockingbird	0.90	-0.13	1.97
Northern Parula	3.35	2.06	4.45
Northern Rough-winged Swallow	1.07	-0.74	2.81
Orchard Oriole	-0.97	-2.08	0.23
Ovenbird	1.65	-0.51	3.99
Pileated Woodpecker	0.78	-0.56	2.10
Prairie Warbler^A	-1.56	-2.62	-0.49
Prothonotary Warbler	0.38	-2.51	3.07

^A Species 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-min survey periods.

Table G1 (continued). Central Hardwoods Bird Conservation Region trends for breeding birds recorded on Wilson's Creek National Battlefield for years 2005 through 2015. Regional trend data was obtained from BBS surveys (Sauer et al. 2017). Trend is defined as an interval-specific geometric mean of proportional changes in population size (Link and Sauer 1998), expressed as a percentage.

Common Name	Annual Percent Change in Population Size	95% Confidence Interval	
		Lower	Upper
Red-bellied Woodpecker	0.99	0.01	1.97
Red-eyed Vireo	0.07	-0.89	1.03
Red-headed Woodpecker^A	0.36	-1.93	2.77
Red-shouldered Hawk	4.24	1.35	6.77
Red-tailed Hawk	0.82	-1.21	2.56
Red-winged Blackbird	-1.83	-2.85	-0.77
Rose-breasted Grosbeak ^B	1.63	-7.07	8.90
Ruby-throated Hummingbird	0.91	-1.17	2.84
Scarlet Tanager	1.90	0.39	3.45
Scissor-tailed Flycatcher	7.54	3.87	11.17
Song Sparrow	0.15	-1.32	1.66
Summer Tanager	0.75	-0.20	1.74
Tree Swallow	12.00	7.37	16.76
Tufted titmouse	2.19	1.08	3.32
Turkey Vulture	4.31	2.56	6.14
Warbling Vireo	-0.15	-1.86	1.48
White-breasted Nuthatch	-0.88	-2.92	1.07
White-eyed Vireo	0.49	-0.63	1.63
Wild Turkey	7.29	1.50	12.93
Willow Flycatcher ^B	0.99	-3.37	5.17
Wood Thrush^A	0.07	-1.06	1.28
Yellow-billed Cuckoo	-0.23	-1.99	1.58
Yellow-breasted Chat	-0.086	-1.87	0.11
Yellow-throated Vireo	1.63	0.39	2.96
Yellow-throated Warbler	3.05	1.48	4.59
Yellow Warbler	-2.02	-4.99	0.94

^A Species 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-min 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 Wilson's Creek National Battlefield from 2008 through 2020.

Table H1. Average ($\pm$ std dev) percent cover of each habitat type in 50-m plots in the grassland areas at Wilson's Creek National Battlefield during the bird breeding seasons from 2008 to 2020. 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	2012	2016	2020
Crop Fields (%)	5.31 ($\pm$ 21.25)	3.68 ($\pm$ 15.16)	3.68 ($\pm$ 15.16)	0
Old Field/Prairie (%)	65.66 ($\pm$ 36.19)	73.68 ($\pm$ 27.50)	71.65 ($\pm$ 31.34)	83.17 ($\pm$ 18.55)
Lawn (%)	0.38 ($\pm$ 1.02)	0	0.88 ($\pm$ 3.64)	0.20 ($\pm$ 0.78)
Pasture Road (%)	0	0	0.35 ($\pm$ 1.00)	0.20 ($\pm$ 0.77)
Paved Road (%)	0	0.06 ($\pm$ 0.17)	0	0.23 ($\pm$ 0.78)
Shrub (%)	8.59 ($\pm$ 22.62)	1.06 ($\pm$ 3.67)	1.24 ($\pm$ 3.68)	1.20 ($\pm$ 3.90)
Stream (%)	0.94 ($\pm$ 3.75)	3.68 ($\pm$ 15.16)	2.21 ($\pm$ 9.10)	0
Trail (%)	0	0.35 ($\pm$ 1.00)	0	0.43 ($\pm$ 1.05)
Woodland (%)	12.28 ($\pm$ 19.92)	7.06 ($\pm$ 12.85)	14.47 ($\pm$ 24.76)	6.43 ($\pm$ 13.19)

Table H2. Average ($\pm$ std dev) 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 Wilson's Creek National Battlefield during the bird breeding seasons from 2008 to 2020. 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	2012	2016	2020
Canopy Cover	Hardwood (%)	11.34 ($\pm$ 27.64)	15.65 ($\pm$ 30.01)	10.45 ($\pm$ 28.97)	11.06 ($\pm$ 21.76)
	Total cover (%)	11.34 ($\pm$ 27.64)	15.65 ($\pm$ 30.01)	10.45 ($\pm$ 28.97)	11.06 ($\pm$ 21.76)
Canopy Height	Hardwood (m)	2.29 ($\pm$ 5.86)	3.98 ($\pm$ 6.44)	2.31 ($\pm$ 4.62)	0.87 ($\pm$ 3.36)
Basal Area	Hardwood (m ² /ha)	1.25 ($\pm$ 2.74)	2.50 ($\pm$ 5.93)	1.76 ($\pm$ 4.03)	1.83 ($\pm$ 4.27)
	Total (m ² /ha)	1.25 ($\pm$ 2.74)	2.50 ($\pm$ 5.93)	1.76 ($\pm$ 4.03)	1.83 ($\pm$ 4.27)
Horizontal Vegetation Profile—measured at 15 m north of plot center (percent cover at different height increments)	0.00–0.25 m (%)	96.72 ($\pm$ 3.13)	97.50 ($\pm$ 0)	95.29 ($\pm$ 4.91)	97.50 ($\pm$ 0)
	0.25–0.50 m (%)	87.06 ($\pm$ 27.01)	92.35 ($\pm$ 6.34)	81.38 ($\pm$ 30.92)	92.00 ($\pm$ 21.30)
	0.50–0.75 m (%)	51.78 ($\pm$ 40.78)	51.47 ($\pm$ 39.32)	23.38 ($\pm$ 34.83)	60.23 ($\pm$ 39.42)
	0.75–1.00 m (%)	36.00 ($\pm$ 42.29)	30.21 ($\pm$ 36.92)	15.38 ($\pm$ 31.16)	33.73 ($\pm$ 43.41)
	1.00–1.25 m (%)	28.09 ($\pm$ 42.46)	9.94 ($\pm$ 24.61)	6.85 ($\pm$ 23.64)	20.47 ($\pm$ 35.17)
	1.25–1.50 m (%)	18.47 ($\pm$ 35.47)	4.76 ($\pm$ 15.32)	0.06 ($\pm$ 0.17)	6.73 ($\pm$ 25.12)
	1.50–1.75 m (%)	12.59 ($\pm$ 33.16)	3.91 ($\pm$ 15.11)	0.18 ($\pm$ 0.73)	6.73 ($\pm$ 25.12)
	1.75–2.00 m (%)	12.38 ($\pm$ 33.24)	4.56 ($\pm$ 15.37)	2.38 ($\pm$ 9.08)	6.53 ($\pm$ 25.17)
Vertical Structure Diversity (%)	n/a	13.88 ($\pm$ 9.09)	17.00 ($\pm$ 16.44)	18.06 ($\pm$ 13.63)	16.73 ($\pm$ 16.14)

Table H3. Average percent of soil substrate cover and plant guild cover ($\pm$ std dev) in 1.78-m sample plots in the grassland areas at Wilson's Creek National Battlefield during the bird breeding seasons from 2008 to 2020. 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	2012	2016	2020
Deciduous Litter (%)	5.53 ($\pm$ 15.64)	2.09 ($\pm$ 4.91)	0.59 ($\pm$ 0.94)	4.37 ($\pm$ 16.08)
Conifer Litter (%)	0.03 ($\pm$ 0.13)	0	0	0.20 ($\pm$ 0.77)
Grass Litter (%)	43.47 ($\pm$ 26.18)	34.74 ($\pm$ 21.51)	22.12 ($\pm$ 16.66)	76.07 ($\pm$ 34.08)
Bare Soil (%)	45.03 ($\pm$ 26.55)	4.03 ($\pm$ 9.33)	6.38 ($\pm$ 15.23)	0.77 ($\pm$ 0.92)
Rock (%)	0.28 ($\pm$ 0.75)	3.68 ($\pm$ 15.16)	5.79 ($\pm$ 23.63)	0
Woody Debris (%)	0.63 ($\pm$ 1.19)	1.35 ($\pm$ 3.65)	0.41 ($\pm$ 0.99)	2.63 ($\pm$ 9.65)
Unvegetated (%)	80.94 ($\pm$ 11.76)	47.79 ($\pm$ 12.68)	73.97 ($\pm$ 28.74)	86.67 ($\pm$ 4.40)
Warm-season Grass (%)	2.03 ($\pm$ 3.70)	14.89 ($\pm$ 25.55)	8.50 ($\pm$ 12.53)	16.07 ($\pm$ 25.87)
Cool-season Grass (%)	23.09 ($\pm$ 18.17)	33.47 ($\pm$ 26.30)	42.85 ($\pm$ 30.51)	48.93 ($\pm$ 36.16)
Forb (%)	15.41 ($\pm$ 10.03)	16.53 ($\pm$ 14.93)	21.82 ($\pm$ 21.59)	21.40 ($\pm$ 22.46)
Moss and Lichen (%)	0.50 ($\pm$ 0.71)	–	0.29 ($\pm$ 0.73)	0.03 ($\pm$ 0.13)
Woody Shrub and Vine (%)	7.59 ($\pm$ 17.57)	8.18 ($\pm$ 12.71)	8.38 ($\pm$ 14.35)	17.40 ($\pm$ 25.43)
Tree Seedling (%)	–	0.09 ($\pm$ 0.20)	0.21 ($\pm$ 0.73)	0.07 ($\pm$ 0.18)
Total Foliar (%)	56.09 ($\pm$ 18.46)	71.03 ($\pm$ 19.02)	82.09 ($\pm$ 24.17)	87.00 ($\pm$ 11.62)

Appendix I. Habitat Parameters in Woodland Areas

Table I1. Average ($\pm$ std dev) percent cover of each habitat type in 50-m plots in the woodland areas at Wilson's Creek National Battlefield during the bird breeding seasons from 2008 to 2020. 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	2012	2016	2020
Corn Field (%)	0.79 ($\pm$ 3.44)	0	0	0
Old Field/Prairie (%)	5.68 ($\pm$ 12.15)	5.56 ($\pm$ 20.14)	12.38 ($\pm$ 26.54)	6.65 ($\pm$ 19.23)
Lawn (%)	0.32 ($\pm$ 0.95)	0.03 ($\pm$ 0.12)	0.75 ($\pm$ 3.35)	0.15 ($\pm$ 0.67)
Parking Lot (%)	0.16 ($\pm$ 0.69)	0	0.15 ($\pm$ 0.67)	0.15 ($\pm$ 0.67)
Pasture Road (%)	0.79 ($\pm$ 3.44)	0.83 ($\pm$ 3.54)	1.50 ($\pm$ 4.62)	0.75 ($\pm$ 3.35)
Paved Road (%)	2.76 ($\pm$ 9.09)	1.69 ($\pm$ 4.84)	2.63 ($\pm$ 8.87)	2.70 ($\pm$ 8.84)
Shrub (%)	10.00 ($\pm$ 25.78)	1.67 ($\pm$ 4.85)	0	0
Stream (%)	2.92 ($\pm$ 9.06)	0.17 ($\pm$ 0.71)	2.03 ($\pm$ 8.38)	1.05 ($\pm$ 3.41)
Trail (%)	0.95 ($\pm$ 3.47)	0.33 ($\pm$ 0.97)	0.15 ($\pm$ 0.67)	0.30 ($\pm$ 0.92)
Woodland (%)	72.00 ($\pm$ 30.61)	78.5 ($\pm$ 26.91)	82.13 ($\pm$ 26.11)	23.85 ($\pm$ 29.04)

Table I2. Average ($\pm$ std dev) 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 Wilson's Creek National Battlefield during the bird breeding seasons from 2008 to 2020. 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	2012	2016	2020
Canopy Cover	Hardwood (%)	69.53 ($\pm$ 26.09)	79.34 ($\pm$ 26.88)	83.17 ($\pm$ 23.96)	78.47 ($\pm$ 15.17)
	Conifer (%)	7.21 ($\pm$ 18.41)	15.66 ($\pm$ 24.87)	6.00 ($\pm$ 14.39)	4.00 ($\pm$ 9.16)
	Total cover (%)	75.32 ($\pm$ 25.07)	88.78 ($\pm$ 19.35)	84.47 ($\pm$ 21.24)	81.84 ($\pm$ 13.90)
Canopy Height	Hardwood (m)	14.03 ($\pm$ 5.27)	18.51 ($\pm$ 8.86)	17.81 ($\pm$ 6.60)	19.40 ($\pm$ 6.00)
	Conifer (m)	2.59 ($\pm$ 4.75)	2.77 ($\pm$ 5.24)	2.90 ($\pm$ 4.83)	2.90 ($\pm$ 5.13)
Basal Area	Hardwood (m ² /ha)	14.74 ($\pm$ 7.81)	21.25 ($\pm$ 10.33)	19.63 ($\pm$ 9.94)	18.50 ($\pm$ 8.17)
	Conifer (m ² /ha)	1.45 ($\pm$ 2.40)	1.25 ($\pm$ 2.14)	1.38 ($\pm$ 2.36)	1.75 ($\pm$ 3.25)
	Total (m ² /ha)	16.18 ($\pm$ 7.65)	22.50 ($\pm$ 10.29)	21.00 ($\pm$ 9.95)	20.25 ($\pm$ 7.86)
Horizontal Vegetation Profile—measured at 15 m north of plot center (percent cover at different height increments)	0.00–0.25 m (%)	97.50 ($\pm$ 0)	97.50 ($\pm$ 0)	94.50 ($\pm$ 13.42)	97.50 ($\pm$ 0)
	0.25–0.50 m (%)	97.50 ($\pm$ 0)	92.78 ($\pm$ 9.23)	87.13 ($\pm$ 29.93)	95.13 ($\pm$ 8.17)
	0.50–0.75 m (%)	85.00 ($\pm$ 23.80)	65.19 ($\pm$ 34.23)	75.05 ($\pm$ 36.98)	61.40 ($\pm$ 37.60)
	0.75–1.00 m (%)	74.90 ($\pm$ 30.24)	49.97 ($\pm$ 36.21)	63.80 ($\pm$ 40.06)	51.70 ($\pm$ 40.14)
	1.00–1.25 m (%)	61.24 ($\pm$ 32.87)	26.56 ($\pm$ 36.21)	58.15 ($\pm$ 37.15)	37.90 ($\pm$ 34.05)
	1.25–1.50 m (%)	47.13 ($\pm$ 39.43)	28.47 ($\pm$ 34.86)	43.33 ($\pm$ 40.32)	45.50 ($\pm$ 39.58)
	1.50–1.75 m (%)	56.47 ($\pm$ 38.77)	32.69 ($\pm$ 39.19)	34.38 ($\pm$ 39.88)	48.56 ($\pm$ 41.17)
Vertical Structure Diversity (%)	1.75–2.00 m (%)	54.47 ($\pm$ 42.17)	33.00 ($\pm$ 41.98)	24.50 ($\pm$ 33.94)	43.80 ($\pm$ 37.31)
	n/a	35.98 ($\pm$ 18.41)	49.61 ($\pm$ 24.07)	48.48 ($\pm$ 10.45)	41.84 ($\pm$ 16.25)

Table I3. Average percent of soil substrate cover and plant guild cover ($\pm$ std dev) in 1.78-m sample plots in the woodland areas at Wilson's Creek National Battlefield during the bird breeding seasons from 2008 to 2020. 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	2012	2016	2020
Deciduous Litter (%)	40.71 ($\pm$ 31.85)	34.08 ($\pm$ 30.52)	39.20 ($\pm$ 35.57)	48.50 ($\pm$ 35.71)
Conifer Litter (%)	1.95 ($\pm$ 4.69)	1.22 ($\pm$ 3.57)	0.25 ($\pm$ 0.68)	0.35 ($\pm$ 0.92)
Grass Litter (%)	6.39 ($\pm$ 11.84)	8.89 ($\pm$ 12.21)	7.68 ($\pm$ 14.31)	11.88 ($\pm$ 26.45)
Bare Soil (%)	29.92 ($\pm$ 27.74)	7.33 ($\pm$ 9.76)	7.10 ($\pm$ 9.19)	9.33 ($\pm$ 16.98)
Rock (%)	2.05 ($\pm$ 3.41)	4.42 ($\pm$ 12.06)	4.90 ($\pm$ 11.23)	3.03 ($\pm$ 8.77)
Woody Debris (%)	7.08 ($\pm$ 9.01)	9.50 ($\pm$ 9.76)	9.78 ($\pm$ 13.86)	13.15 ($\pm$ 12.21)
Unvegetated (%)	82.24 ($\pm$ 15.65)	63.61 ($\pm$ 24.41)	81.75 ($\pm$ 24.80)	96.25 ($\pm$ 3.85)
Warm-season Grass (%)	0.84 ($\pm$ 3.43)	0.03 ($\pm$ 0.12)	1.88 ($\pm$ 8.39)	0.15 ($\pm$ 0.67)
Cool-season Grass (%)	8.95 ($\pm$ 11.72)	12.06 ($\pm$ 15.19)	18.28 ($\pm$ 25.26)	11.58 ($\pm$ 19.57)
Forb (%)	15.40 ($\pm$ 11.15)	8.69 ($\pm$ 7.28)	13.38 ($\pm$ 15.88)	8.75 ($\pm$ 13.04)
Moss and Lichen (%)	4.50 ($\pm$ 9.16)	3.08 ($\pm$ 9.27)	3.10 ($\pm$ 5.24)	0.98 ($\pm$ 3.31)
Woody Shrub and Vine (%)	22.34 ($\pm$ 20.18)	27.00 ($\pm$ 22.40)	15.83 ($\pm$ 13.90)	39.93 ($\pm$ 27.10)
Tree Seedling (%)	1.24 ($\pm$ 1.40)	1.25 ($\pm$ 1.29)	3.00 ($\pm$ 4.31)	2.33 ($\pm$ 4.47)
Total Foliar (%)	55.66 ($\pm$ 22.08)	55.42 ($\pm$ 21.18)	57.28 ($\pm$ 25.78)	67.63 ($\pm$ 21.27)

Appendix J. Trees Found on Wilson's Creek National Battlefield

Tables J1 and J2 show stems per hectare for trees in Wilson's Creek National Battlefield in grassland and woodland areas, respectively.

Table J1. Stems per hectare for trees found in the grassland areas at Wilson's Creek National Battlefield by size class during the 2008 to 2020 bird breeding seasons. Tree stems per hectare are reported by family.

Stem Size Class	Family	2008	2012	2016	2020
< 1.0 cm	Anacardiaceae	119	0	0	0
	Cupressaceae	8	0	0	0
	Rosaceae	40	150	45	0
	Rutaceae	0	0	7	0
1.1–2.85 cm	Cupressaceae	0	0	7	0
	Fagaceae	0	0	7	0
	Juglandaceae	0	0	7	0
	Moraceae	0	15	0	0
	Oleaceae	0	0	0	8
	Rosaceae	48	30	82	0
	Rutaceae	0	0	15	0
	Snag	16	0	60	0
2.6–8.0 cm	Cannabaceae	8	0	0	0
	Cupressaceae	0	0	0	17
	Fagaceae	0	0	0	17
	Juglandaceae	8	30	7	0
	Moraceae	8	0	7	0
	Rosaceae	286	60	52	0
	Snag	72	7	45	0
8.1–15.0 cm	Cupressaceae	0	0	0	8
	Fagaceae	0	0	7	0
	Juglandaceae	16	22	22	0
	Moraceae	16	0	7	0
	Rosaceae	8	7	7	8
15.1–23.0 cm	Fabaceae	0	7	0	0
	Fagaceae	0	0	0	8
	Juglandaceae	0	0	15	0
	Rosaceae	0	0	7	8
	Snag	0	0	0	8
23.1–38.0 cm	None	–	–	–	–
> 38.0 cm	Moraceae	0	0	7	0

Table J2. Stems per hectare for trees found in the woodland areas at Wilson's Creek National Battlefield by size class during the 2008 to 2020 bird breeding seasons. Tree stems per hectare are reported by family.

Stem Size Class	Family	2008	2012	2016	2020
<1.0 cm	Anacardiaceae	7	0	6	0
	Cannabaceae	20	7	6	0
	Celastraceae	0	7	0	0
	Cornaceae	0	7	0	0
	Fagaceae	54	14	25	0
	Juglandaceae	0	7	6	6
	Lauraceae	7	21	0	0
	Moraceae	7	0	0	0
	Oleaceae	0	42	6	19
	Rosaceae	13	50	32	6
	Sapindaceae	7	28	0	6
	Snag	0	0	0	19
	Ulmaceae	0	28	76	13
1.1–2.85 cm	Adoxaceae	7	0	6	0
	Anacardiaceae	0	0	38	0
	Cannabaceae	0	50	25	45
	Celastraceae	0	21	0	0
	Cupressaceae	20	7	0	0
	Fabaceae	0	71	0	0
	Fagaceae	40	71	121	83
	Juglandaceae	7	21	51	25
	Lauraceae	0	21	6	0
	Moraceae	7	7	57	13
	Oleaceae	27	57	6	45
	Rosaceae	60	262	45	0
	Sapindaceae	0	42	6	6
	Snag	47	50	32	70
	Ulmaceae	7	14	25	45
2.6–8.0 cm	Adoxaceae	20	0	38	0
	Anacardiaceae	127	0	0	0
	Betulaceae	0	0	0	19
	Cannabaceae	141	99	146	121
	Celastraceae	0	21	0	0
	Cupressaceae	34	7	19	32
	Fagaceae	60	78	89	102
	Juglandaceae	40	28	38	19
	Lauraceae	13	7	6	13
	Moraceae	34	35	64	140
	Oleaceae	20	0	19	38
	Rosaceae	127	141	45	95
	Sapindaceae	20	0	6	0

Table J2 (continued). Stems per hectare for trees found in the woodland areas at Wilson's Creek National Battlefield by size class during the 2008 to 2020 bird breeding seasons. Tree stems per hectare are reported by family.

Stem Size Class	Family	2008	2012	2016	2020
2.6–8.0 cm (continued)	Snag	154	99	159	159
	Ulmaceae	107	50	102	89
8.1–15.0 cm	Betulaceae	0	0	0	6
	Cannabaceae	40	42	83	51
	Cupressaceae	20	21	6	25
	Fabaceae	0	7	13	13
	Fagaceae	27	0	38	25
	Juglandaceae	40	57	57	45
	Lauraceae	0	21	0	0
	Moraceae	7	50	25	64
	Oleaceae	0	0	6	0
	Rosaceae	20	35	0	6
	Sapindaceae	13	0	0	0
	Snag	127	78	102	25
	Ulmaceae	54	7	45	51
15.1–23.0 cm	Cannabaceae	7	14	13	13
	Cupressaceae	13	0	19	6
	Fabaceae	0	7	0	0
	Fagaceae	13	21	32	51
	Juglandaceae	27	7	13	32
	Lauraceae	0	7	6	0
	Moraceae	47	28	32	51
	Oleaceae	0	0	0	6
	Rosaceae	7	7	6	6
	Sapindaceae	0	0	13	6
	Snag	13	28	6	6
	Ulmaceae	0	7	6	6
23.1–38.0 cm	Cannabaceae	7	0	6	0
	Cupressaceae	0	21	13	19
	Fabaceae	0	0	0	6
	Fagaceae	20	28	51	51
	Juglandaceae	20	57	25	32
	Moraceae	7	7	6	0
	Snag	27	0	25	0
	Ulmaceae	13	7	0	13
>38.0 cm	Cupressaceae	7	7	0	0
	Fagaceae	0	7	6	19
	Juglandaceae	7	28	6	13
	Ulmaceae	7	0	13	0

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