



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

Status Report

Natural Resource Report NPS/HTLN/NRR—2017/1435



ON THE COVER

Cannon at Wilson's Creek National Battlefield

Photograph courtesy of Heartland Inventory and Monitoring Network

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

Status Report

Natural Resource Report NPS/HTLN/NRR—2017/1435

David G. Peitz

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

May 2017

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

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Report Series is used to disseminate comprehensive information and analysis about natural resources and related topics concerning lands managed by the National Park Service. The series supports the advancement of science, informed decision-making, and the achievement of the National Park Service mission. The series also provides a forum for presenting more lengthy results that may not be accepted by publications with page limitations.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols. This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available in digital format from the [Heartland Inventory and Monitoring Network website](#) and the [Natural Resource Publications Management website](#). To receive this report in a format that is optimized to be accessible using screen readers for the visually or cognitively impaired, please email irma@nps.gov.

Please cite this publication as:

Peitz, D. G. 2017. Bird community monitoring at Wilson's Creek National Battlefield, Missouri: Status report. Natural Resource Report NPS/HTLN/NRR—2017/1435. National Park Service, Fort Collins, Colorado.

Contents

	Page
Figures.....	iv
Tables.....	iv
Appendices.....	Error! Bookmark not defined.
Executive Summary.....	v
Acknowledgments.....	vi
Introduction.....	1
Methods.....	4
Site Selection	4
Bird Surveys	5
Data Analysis.....	6
Results.....	8
Bird Surveys	8
Discussion	14
Conclusions.....	17

Figures

	Page
Figure 1. Location of Wilson’s Creek National Battlefield (WICR), Missouri within the Central Hardwoods Bird Conservation Region.	2
Figure 2. Bird plot locations on Wilson’s Creek National Battlefield, Missouri.....	5
Figure 3. Trends in bird community Diversity, Richness, and species distribution Evenness on Wilson’s Creek National Battlefield, Missouri in 2008 through 2016.....	13

Tables

	Page
Table 1. Number of plots sampled and sampling dates for breeding bird surveys conducted at Wilson’s Creek National Battlefield, Missouri, by year.	4
Table 2. Bird species recorded during breeding bird surveys at Wilson’s Creek National Battlefield, Missouri in 2008 through 2016.	8
Table 3. Trends, annual change in abundance (individuals) of breeding birds recorded on Wilson’s Creek National Battlefield, Missouri in 2008 through 2016.	12

Appendices

	Page
Appendix A.....	A-1
Appendix B.....	B-1
Appendix C.....	C-1

Executive Summary

In 2008, the Heartland I&M Network (HTLN) initiated breeding bird surveys on Wilson's Creek National Battlefield (WICR), Missouri to address three objectives: (1) to monitor changes in bird community composition and abundance, (2) to improve our understanding of breeding bird – habitat relationships and the effects of management actions on such relationships, and (3) to make our bird monitoring datasets for WICR available to the larger bird conservation community. This report evaluates trends in the park's breeding bird populations in the context of trends observed within the North American Bird Conservation Initiative's (NABCI) Central Hardwoods Bird Conservation Region, the bird conservation region in which the park is located. By doing so, we can assess the influence of habitat management on the park on bird populations with an understanding of what population trends are doing regionally, outside the influence of WICR natural resource management activities.

One hundred and fifteen species of birds were recorded during May-June site visits in the nine years since initiating monitoring. Ninety-seven of the species are considered breeding species because they are permanent or summer residents. Seven of the breeding species recorded on WICR are species of concern for the Central Hardwoods Bird Conservation Region. Eighteen species were observed during the survey period in sufficient numbers to calculate annual abundances and trends with some degree of confidence. The Blue-gray Gnatcatcher, Northern Cardinal, and Indigo Bunting were the most common and widely distributed species on WICR. Population trends of all 18 species recorded in sufficient numbers to calculate trends were found to be uncertain within the park. Regionally, 12 species had uncertain population trends similar to that of the park. The Carolina Wren, Northern Parula, and Wild Turkey were found to have increasing populations regionally and the Eastern Wood-pewee, Indigo Bunting, and Yellow-breasted Chat had declining populations across the region. For the most part, our findings suggest that the habitat on WICR mirrors that of the region in supporting the 18 most common species recorded.

Results from our most recent bird surveys (2016) showed that three grassland obligate species were recorded, the Dickcissel, Eastern Meadowlark, and Grasshopper Sparrow. However, no woodland obligates were reported on the park.

This report provides current regional and local trends for breeding birds for future comparisons with bird data collected as part of the long-term monitoring efforts at WICR. With this report, park staff will be able to better plan management objectives, and assess the effectiveness of management alternatives. Monitoring data also provides park staff with additional information useful for interpreting natural resources.

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 volunteers: April McDonough, Dorthy J. Thurman, Myra Scroggs, Ann Liles, Dean R. Rising Audrey M. Menninga, Rachelle M. Pollock, Caleb L. Thyer, and Jeff M. Williams who assisted with bird surveys on the park.

Introduction

Birds are an important component of park ecosystems, as 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, such as neotropical migrants, can have the added benefit of preserving entire ecosystems and their attendant ecosystem services (Karr 1991, Maurer 1993). Moreover, birds 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 (WICR) is located in the western edge of the Ozark Highland section of the Central Hardwoods Bird Conservation Region (Figure 1). This section of the Central Hardwoods Bird Conservation Region 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, the NABCI is a coalition of government agencies and private organizations in the United States working to ensure the long-term health of North America's native bird populations (NABCI 2012).

Topography of the area in and around WICR 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 116 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 2008 and 2013 indicate that a number of potential breeding species occurring at WICR show evidence of population decline (Sauer et al. 2014). In fact, 43% of the recorded species have populations reported to be in decline, with species such as the Blue-winged Warbler (*Vermivora pinus*), Cedar waxwing (*Bombycilla cedrorum*), Chimney Swift (*Chaetura pelagica*), Grasshopper Sparrow (*Ammodramus savannarum*), Little Blue Heron (*Egretta caerulea*), Northern Bobwhite (*Colinus virginianus*), Wood Thrush (*Hylocichla mustelina*), and Yellow Warbler (*Dendroica petechia*) declining at alarming rates.

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

changes in the numbers and composition of bird communities may reflect the effectiveness of management in restoring and maintaining bird habitat at WICR.



Figure 1. Location of Wilson's Creek National Battlefield (WICR), Missouri within the Central Hardwoods Bird Conservation Region.

There are three 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 at WICR during the breeding season.
- Improve our understanding of breeding bird – habitat relationships and the effects of management actions such as stand thinning or prescribed fire on bird populations, by correlating changes in bird community composition and abundance with changes in specific habitat variables (e.g., vegetation structure, ground cover).
- Make bird monitoring datasets for WICR available to the avian conservation community and to the general public through the Avian Knowledge Network (AKN) and Data.Gov through the NPS Integrated Resource Management Applications (IRMA)

As a first step in meeting monitoring objectives, this report summarizes population trends for birds recorded during the first nine years of monitoring.

Methods

Site Selection

Permanent monitoring locations or 'plots' were selected by overlaying a systematic grid of 400 x 400 meter cells (originating from a random start point). 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 in the various habitats across the park (Figure 2). Monitoring occurred on the majority of the 38 sites in each year (Table 1).

Table 1. Number of plots sampled and sampling dates for breeding bird surveys conducted at Wilson's Creek National Battlefield, Missouri, by year. Also listed are observer(s) who conducted the surveys and whether or not habitat data were collected during the survey 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.O. Thurman, M.J. Scroggs, and A. McDonough	No
2011	May 19 – June 8	38	D.O. 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.O. Thurman, M.J. Scroggs, A.S. Liles, and D.R. Rising	No
2014	May 2 – May 7	35	D.O. 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

*Heartland I&M Network staff.

During bird surveys in 2008 and 2012, monitoring plots were located using navigation waypoints (Peitz et al. 2009) in a Trimble Geo XT GPS unit and temporarily marked with 36-inch pin flags to aid in re-locating the plots for habitat assessment, eliminating the need for permanent plot markers. We collected pin flags from each plot once the habitat work was completed. In 2016, the habitat assessment crews worked independent of the birder and monitoring plots were located using a GPS unit but not marked with pin flags. During bird surveys in 2009 – 2011 and 2013 - 2015, years when habitat assessments were not conducted, monitoring plots were located using a GPS unit. However, plots were not marked with pin flags.

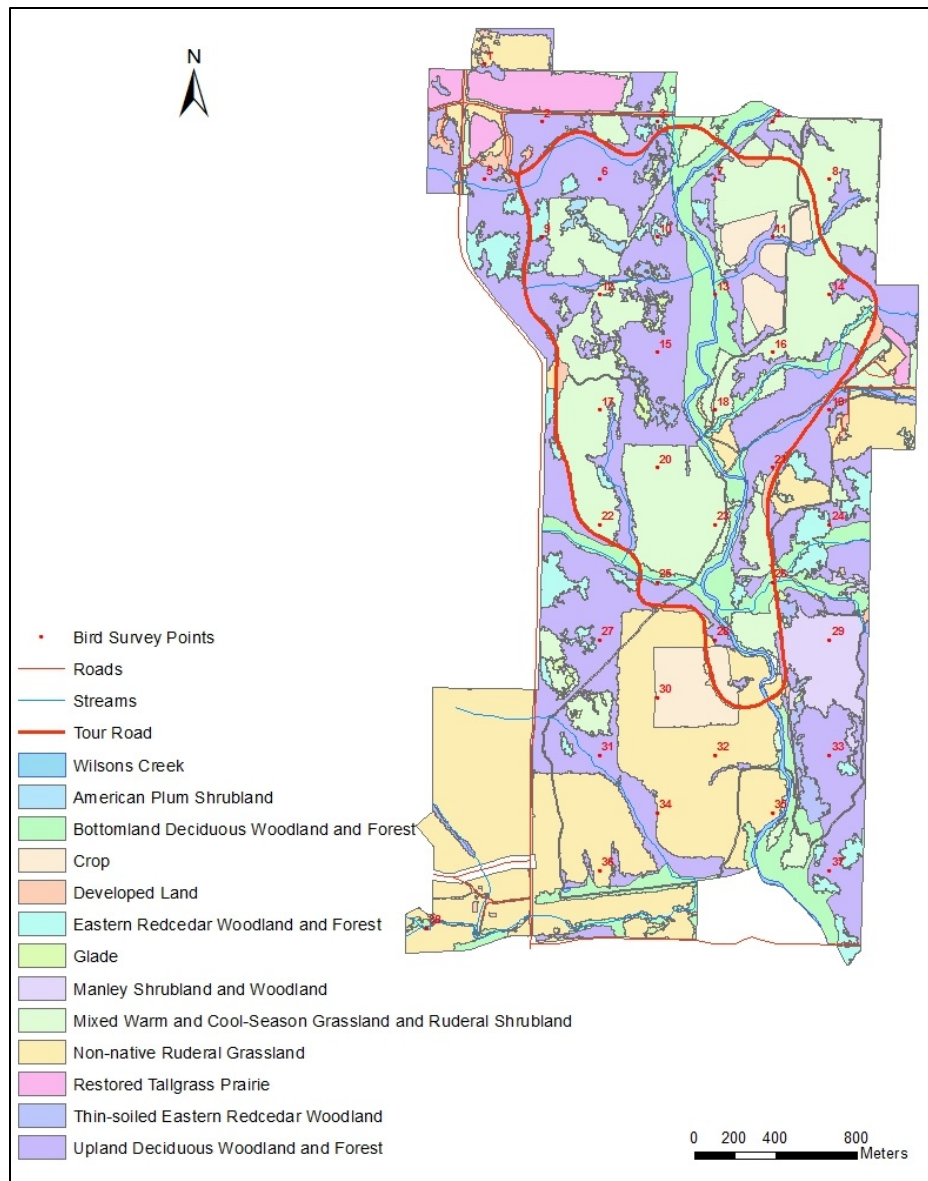


Figure 2. Bird plot locations on Wilson's Creek National Battlefield, Missouri. Vegetation mapping and classification provided by Diamond et.al. (2013).

Bird Surveys

Bird surveys followed methods outlined in the bird monitoring protocol by Peitz et al. (2008) and summarized below. 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 observer. Bird observations were separated into two time segments: those detected during the first three minutes of the count (to allow for comparisons with the national Breeding Bird Survey data), and any new birds detected during the final two minutes of the count. 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. After completing a count at a plot and filling out the data sheet, the observer navigated to the next plot using a GPS 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. We sampled birds during a period when it was light enough to observe birds to 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 full 5-min are included.

Data Analysis

Prior to summary analysis, the residency status (permanent resident, summer resident, transient, and winter resident) of each bird species recorded was determined. Identifying the residency of each species helps to exclude transients and winter residents from analysis of breeding birds within WICR. Proportion of plots occupied by each bird species was calculated (total number of plots occupied by a species/plots surveyed) and reported in Appendix A and B. For species with greater than 60 observations recorded, Distance software (Distance 6.0 Release 2) was used to determine the park-wide abundance of each (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 + hermite 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. The hazard-rate + simple polynomial function was selected for 17 species: American Crow, American Goldfinch, Blue-gray Gnatcatcher, Brown-headed Cowbird, Carolina Wren, Common Yellowthroat, Eastern Towhee, Eastern Wood-peewee, Field Sparrow, Indigo Bunting, Northern Cardinal, Northern Parula, Red-bellied Woodpecker, Red-eyed Vireo, Tufted Titmouse, Wild Turkey, and Yellow-breasted Chat. The uniform-normal + cosine function was selected for one species: Dickcissel. Abundances for these species are reported in Appendix A. For species with fewer than 60 observations, park-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. Park-wide abundances for species with less than 60 observations are reported in Appendix B.

For species with adequate abundance, those with greater than 60 observations (18 species), trends were calculated by regressing abundance against survey years in the statistical software TRIM Version 3.54 (Pannekoek and Van Strien 2005). TRIM is a program developed for the analysis of count data obtained from the monitoring of wildlife populations. It analyses time series of counts using Poisson regression and produces estimates of yearly indices and trends. Autocorrelation in count data between years and the independent Poisson distribution of this data are taken into account

within this software. For this report we also obtained regional breeding bird trends for the Central Hardwoods Bird Conservation Region during the periods between 2008 and 2013 (Appendix C; Sauer et al. 2014), and compared these trends with those seen in the bird populations at WICR. Regional trends with a confidence interval that straddled zero were classified as uncertain for comparison with results from WICR.

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 2010, and then graphing the results. The slope of the linear regression equation equals the trend in a metric.. Prior to trend analysis, bird community diversity values were calculated annually using the Shannon Diversity Index:

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

where n_i/N is the proportion of the total number of individuals in a population consisting of the i^{th} species (Shannon, 1949). Species richness values were determined as the total number of bird taxa recorded annually. Species distribution evenness values were calculated using Pielou (J):

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

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).

Results

Bird Surveys

Between 2008 and 2016, 21 to 38 plots on WICR were surveyed annually for breeding birds (Table 1). During this nine year period, 306 cumulative plots were surveyed and 115 different bird species were recorded, 97 of which are species with the potential to breed within the park (Table 2; Robbins and Easterla 1992). Six breeding species, Baltimore Oriole (*Icterus galbula*), Blue Grosbeak (*Passerina caerulea*), Cedar Waxwing (*Bombycilla cedrorum*), Northern Harrier (*Circus cyaneus*), Rose-breasted Grosbeak (*Pheucticus ludovicianus*), and Willow Flycatcher (*Empidonax traillii*), were only observed outside 5-min survey periods. Seven of the breeding species recorded, Bell's Vireo (*Vireo bellii*), Bewick's Wren (*Thryomanes bewickii*), Henslow's Sparrow (*Ammodramus henslowii*), Kentucky Warbler (*Oporornis formosus*), Prairie Warbler (*Dendroica discolor*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), and Wood Thrush (*Hylocichla mustelina*) are considered species of regional concern for the Central Hardwoods Bird Conservation Region (U.S.

Table 2. Bird species recorded during breeding bird surveys at Wilson's Creek National Battlefield, Missouri in 2008 through 2016. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Bolded species names are those species considered of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008). Fish and Wildlife Service. 2008).

Common name	Species name	AOU code	Residency ¹
Acadian Flycatcher	<i>Empidonax virescens</i>	ACFL	SR
American Crow	<i>Corvus brachyrhynchos</i>	AMCR	R
American Goldfinch	<i>Carduelis tristis</i>	AMGO	R
American Redstart	<i>Setophaga ruticilla</i>	AMRE	SR
American Robin	<i>Turdus migratorius</i>	AMRO	R
Baltimore Oriole*	<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	<i>Vireo bellii</i>	BEVI	SR
Belted Kingfisher	<i>Megasceryle alcyon</i>	BEKI	R
Bewick's Wren	<i>Thryomanes bewickii</i>	BEWR	R
Black and White Warbler	<i>Mniotiltavaria</i>	BAWW	SR
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	BBCU	SR
Black-throated Green Warbler*	<i>Dendroica virens</i>	BTNW	T
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>	BGGN	SR
Blue Grosbeak*	<i>Passerina caerulea</i>	BLGR	SR
Blue Jay	<i>Cyanocitta cristata</i>	BLJA	R
Blue-winged Warbler	<i>Vermivora pinus</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	R
Canada Goose	<i>Branta canadensis</i>	CAGO	R
Carolina Chickadee	<i>Parus carolinensis</i>	CACH	R

Table 2, continued. Bird species recorded during breeding bird surveys at Wilson's Creek National Battlefield, Missouri in 2008 through 2016. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Bolded species names are those species considered of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008).Fish and Wildlife Service. 2008).

Common name	Species name	AOU code	Residency ¹
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 passerine</i>	CHSP	SR
Cliff Swallow	<i>Hirundo 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	R
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
Hairy Woodpecker	<i>Picoides villosus</i>	HAWO	R
Henslow's Sparrow	<i>Ammodramus henslowii</i>	HESP	SR
Hooded Warbler	<i>Wilsonia citrina</i>	HOWA	SR
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	<i>Oporornis formosus</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*	<i>Melospiza lincolni</i>	LISP	T
Little Blue Heron	<i>Egretta caerulea</i>	LBHE	SR
Louisiana Waterthrush	<i>Seiurus 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

Table 2, continued. Bird species recorded during breeding bird surveys at Wilson's Creek National Battlefield, Missouri in 2008 through 2016. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Bolded species names are those species considered of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008). Fish and Wildlife Service. 2008).

Common name	Species name	AOU code	Residency ¹
Northern Cardinal	<i>Cardinalis cardinalis</i>	NOCA	R
Northern Flicker	<i>Colaptes auratus</i>	YSFL	R
Northern Harrier*	<i>Circus cyaneus</i>	NOHA	SR
Northern Mockingbird	<i>Minus polyglottos</i>	NOMO	R
Northern Parula	<i>Parula 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 aurocapillus</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	<i>Dendroica 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	<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*	<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	SR
Swainson's Thrush	<i>Limnithlypis swainsonii</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
Turkey Vulture	<i>Cathartes aura</i>	TUVU	R
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

Table 2, continued. Bird species recorded during breeding bird surveys at Wilson's Creek National Battlefield, Missouri in 2008 through 2016. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Bolded species names are those species considered of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008). Fish and Wildlife Service. 2008).

Common name	Species name	AOU code	Residency ¹
Wild Turkey	<i>Meleagris gallopavo</i>	WITU	R
Willow Flycatcher*	<i>Empidonax traillii</i>	WIFL	SR
Wilson's Warbler	<i>Cardellina pusilla</i>	WIWA	T
Wood Thrush	<i>Hylocichla mustelina</i>	WOTH	SR
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	YBCU	SR
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	YBSA	T
Yellow-breasted Chat	<i>Icteria virens</i>	YBCH	SR
Yellow Warbler	<i>Dendroica petechia</i>	YWAR	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

* Species recorded only while traveling between point transects or at other times outside of 5-min survey periods.

¹ Residency: R = year around resident; SR = summer resident; T = transient; WR = winter resident; According to Robbins and Easterla (1992).

Species names are valid and verified names taken from the Integrated Taxonomic Information System web site (ITIS 2016).

Eighteen breeding species were observed during the survey period in sufficient numbers to calculate annual abundances with some degree of confidence (Appendix A). Of these eighteen species, Blue-gray Gnatcatcher (*Polioptila caerulea*), Brown-headed Cowbird (*Molothrus ater*), Eastern Towhee (*Pipilo erythrophthalmus*), Field Sparrow (*Spizella pusilla*), Indigo Bunting (*Passerina cyanea*), Northern Cardinal (*Cardinalis cardinalis*), and Tufted Titmouse (*Baeolophus bicolor*) were the most abundant and widespread species on WICR. However, we were unable to detect with certainty either positive or negative population trends in any of the species reported (Table 3). Regional trends (2008-2013) reported by Sauer et al. (2014, Appendix C) for the Central Hardwoods Bird Conservation Region were uncertain for twelve of the eighteen species. The Carolina Wren (*Thryothorus ludovicianus*), Northern Parula (*Parula americana*), and Wild Turkey (*Meleagris gallopavo*) had a regional population that increased, while the Eastern Wood-pewee (*Contopus virens*), Indigo Bunting (*Passerina cyanea*), and Yellow-breasted Chat (*Icteria virens*) had populations that declined.

Table 3. Trends, annual change in abundance (individuals) of breeding birds recorded on Wilson's Creek National Battlefield, Missouri in 2008 through 2016.

Common name	Trend*	SE of slope	Trend Classification**
American Crow	0.97	0.08	Uncertain
American Goldfinch	1.05	0.12	Uncertain
Blue-gray Gnatcatcher	0.97	0.06	Uncertain
Brown-headed Cowbird	1.07	0.06	Uncertain
Carolina Wren	0.98	0.04	Uncertain
Common Yellowthroat	0.98	0.03	Uncertain
Dickcissel	0.98	0.05	Uncertain
Eastern Towhee	0.95	0.05	Uncertain
Eastern Wood-pewee	0.96	0.06	Uncertain
Field Sparrow	0.97	0.03	Uncertain
Indigo Bunting	0.96	0.03	Uncertain
Northern Cardinal	1.06	0.03	Uncertain
Northern Parula	1.09	0.06	Uncertain
Red-bellied Woodpecker	1.03	0.06	Uncertain
Red-eyed Vireo	0.94	0.08	Uncertain
Tufted-titmouse	1.05	0.05	Uncertain
Wild Turkey	1.04	0.16	Uncertain
Yellow-breasted Chat	0.93	0.06	Uncertain

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

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

Diversity, richness, and the evenness that individuals were distributed across species in the breeding bird community on WICR were unchanged over the nine monitoring years since 2008 (Figure 3). For the bird community on WICR richness averaged 49 species annually.

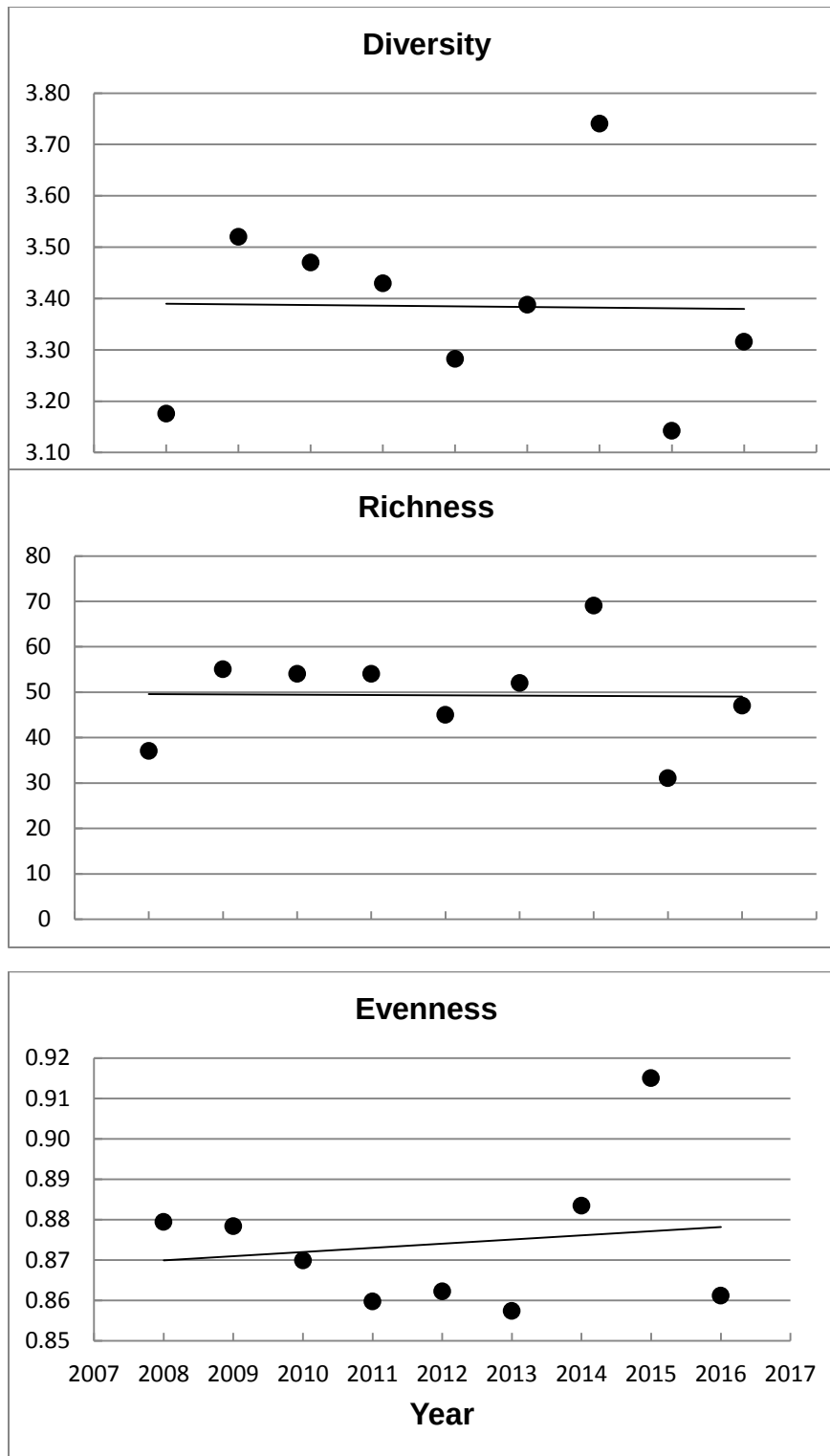


Figure 3. Trends in bird community Diversity ($y = -0.001x + 3.391$; $p = 0.96$), Richness ($y = -0.067x + 49.667$; $p = 0.97$), and species distribution Evenness ($y = -0.001x - 0.869$; $p = 0.69$) on Wilson's Creek National Battlefield, Missouri in 2008 through 2016.

Discussion

Breeding bird surveys were initiated at WICR in 2008, to assist the park in assessing the integrity of their grasslands and woodlands through time. During the nine years of monitoring since 2008, 115 bird species have been recorded. Ninety-seven are permanent or summer residents to the area (Robbins and Easterla 1992). Therefore, these 97 species have some value in characterizing the breeding bird community of WICR, and the habitat in which they rely. The seven breeding species of concern for the Central Hardwoods Bird Conservation Region, Bell's Vireo, Bewick's Wren, Henslow's Sparrow, Kentucky Warbler, Prairie Warbler, Red-headed Woodpecker, and Wood Thrush should be given additional consideration in the management of natural resources on the park. However, all seven species were recorded on WICR in low numbers making it difficult to assess the influences of managing for their needs (Table 2, Appendix B). 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 needs. For example, complete remove of woodland habitat would be detrimental to the Bell's Vireo, Bewick's Wren, Kentucky Warbler, and Wood Thrush.

Grasslands dominate the bird habitat at WICR by only a slight margin over woodlands (Diamond et al. 2013). This is very similar to what occurs within the Ozark Highlands 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 the other habitat types present, positively influenced the number of bird species observed. For breeding birds recorded on the park, the only habitat obligate species were the grassland obligates; Dickcissel, Eastern Meadowlark, and Grasshopper Sparrow. The remaining resident species are mostly habitat generalist or edge species, favored by the mix and positioning of habitats at the park. Habitat diversity (structural composition) is especially important for the high priority species, as their microhabitat requirements vary (Pashley and Barrow 1993). For example, Red-headed Woodpeckers prefer farmlands, open woodlands, orchards, and urban/suburban forest, Kentucky Warblers prefer moist deciduous bottomlands and ravines, and Wood Thrush deciduous woodlands, but most other species of regional concern require thick shrubby or old field habitat (Stokes and Stokes 1996).

Habitat availability and quality dictate bird population trends within a region. However, when suitable habitat of a sufficient area to meet a bird's needs is found locally, then population trends in that area may differ from that of the region. The opposite may be true as well. Identifying regional trends in breeding birds observed on WICR is the first step in assessing the potential effects habitat management for those species might have. For instance, if the prevailing trend in a species regionally is negative, and their numbers are low, then efforts to manage habitat for that species will in all likelihood have little success. However, for species that are regionally common or have populations trending upward, WICR may be able to influence their populations positively through habitat management. Efforts to manage habitat on the park to an oak savanna would meet the grassland requirements of many species including the Dickcissel, Eastern Meadowlark, Grasshopper Sparrow, and Northern Bobwhite as well as the sparse open woodland requirements of species such as the Red-headed Woodpecker (Stokes and Stokes 1996).

Although breeding birds have only been monitored on WICR for nine years, some important trend comparisons can be made. Of the 18 breeding species with sufficient numbers to calculate population trends, 12 had uncertain trends similar to that of the region. Three species, Carolina Wren, Northern Parula, and Wild Turkey were found to have increasing population regionally although their trends on WICR were uncertain. Three additional species, Eastern Wood-pewee, Indigo Bunting, and Yellow-breasted Chat with uncertain population trends on WICR had declining trends across the region. Although inconclusive, our findings suggest that the habitat on WICR mirrors that of the region in supporting the 18 most common species recorded.

Similar to 2008 values reported by Peitz (2009), the Blue-gray Gnatcatcher, Northern Cardinal, and Indigo Bunting are some of the most common and widely distributed species on WICR. Changes in population sizes of the most common and widely distributed species on the park make them good species for assessing changing habitat conditions locally. For example, species like the Northern Cardinal and Indigo Bunting have improved reproductive success when shrub cover is dense and mid-canopy trees are present (Stokes and Stokes 1996). Therefore, a decline in either species' numbers could very well indicate changes in the understory and mid-story of the riparian woodlands or control of woody species in the prairie. The fact that both the Indigo Bunting and Northern Cardinal have uncertain population trends could very well be the results of management efforts to control woody encroachment from forested areas into the grasslands. Only the continued collection of breeding bird data will enlighten us on the influence of habitat management on these two species. Less common and widely distributed species will likely occur so infrequently that strong species-habitat relationships may not be established.

Although the mix of habitats provides potentially satisfactory habitat for all the birds of regional concern as well as most other bird species, this habitat is easily altered if trees are thinned, insect infestations occur, or brushy fields are burned. Similar to the habitat requirements listed above for the Red-headed Woodpecker and Kentucky Warbler, the habitat requirements of most species can be identified: ie. Blue-gray Gnatcatcher, woods, swamps, and shrubby areas; Field Sparrow, open areas with scattered shrubs and small trees; Grasshopper Sparrow, open areas of prairie, dry weedy fields, old fields or hayfields; and Yellow-billed Cuckoo, open woods, thickets, and riparian habitat; etc. (Stokes and Stokes 1996). Habitat management decisions aimed at influencing bird populations should center on those identified as species of regional concern for the Central Hardwoods Bird Conservation Region if possible. However, habitat obligates such as the Dickcissel, Eastern Meadowlark, and Grasshopper Sparrow and those common to the park such as the Blue-gray Gnatcatcher, Indigo Bunting and Northern Cardinal need consideration in a broader context of bird conservation when making management decisions.

Since 2008, community diversity, richness, and evenness values have not changed significantly on WICR (Figure 3). However, differential sampling effort (different numbers of plots sampled in different years) may have had some influence on the lack of change. For example, the fewest plots were sampled in 2015, and 2015 was the year with the lowest richness and diversity, and highest evenness values, causing a greater dispersion of data points and hence a reduced ability to identify significant changes. Therefore, these results should be interpreted with caution as the variation in

sampling effort and the short length of the sampling period (nine years) may not reflect patterns that may appear in these metrics over more even annual sampling effort and a longer time period.

Conclusions

Since initiating breeding bird surveys on WICR in 2008, HTLN staff and volunteers have surveyed between 21 and 38 plots annually, and recorded 115 different species. Ninety-seven of the species recorded are permanent or summer residents to the area with the potential to breed within the park. The Blue-gray Gnatcatcher, Northern Cardinal, and Indigo Bunting are the most common and widely distributed species on WICR. Eighteen species were observed during the survey period in sufficient numbers to calculate annual abundances and trends with some degree of confidence. However, population trends on all 18 species were found to be uncertain within the park. Regionally, 12 species had uncertain population trends similar to that of the park. The Carolina Wren, Northern Parula, and Wild Turkey were found to have increasing population regionally and the Eastern Wood-pewee, Indigo Bunting, and Yellow-breasted Chat had declining populations across the region. For the most part, our findings suggest that the habitat on WICR mirrors that of the region in supporting the 18 most common species recorded. The limited number of survey years within the park may provide a trend that will change as more years of data are collected. However, our reported data is a baseline for placing bird populations at the park into the context of those seen in the larger Central Hardwoods Bird Conservation Region and should help the park make more informed natural resource management decisions. Our reported data also contributes information to efforts by other agencies (Partners in Flight, US Geological Survey, US Fish and Wildlife Service, Cornell Lab, Bird Conservancy of the Rockies, etc.) researching the full life cycle of migratory birds.

Literature Cited

- Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford University Press. 432 pp.
- Cairns Jr., J., P. V. McCormick and B. R. Niederlehner. 2004. A proposed framework for developing indicators of ecosystem health. *Hydrobiologia* 263:1-44.
- Diamond, D. D., L. F. Elliott, M. D. DeBacker, K. M. James, D. L. Pursell and A. Struckhoff. 2013. Vegetation mapping and classification of Wilson's Creek National Battlefield. Natural Resource Report NPS/WICR/NRR—2013/650. National Park Service, Fort Collins, Colorado.
- Fancy, S. G. 1997. A new approach for analyzing bird densities from variable circular-plot counts. *Pacific Science* 51:107-114.
- Fitzgerald, J. A. and D. N. Pashley. 2000. Partners in Flight bird conservation plan for the Ozarks/Ouachita (Physiographic Area 19). Cornell Lab of Ornithology, Ithaca, New York.
- Gregory R. D, J. Reif, L. Fornasari, I. J. Burfield, P. Chylarecki, A. Van Strien, P. Vorisek, F. D. R. Jiguet, A. W. Gmelig Meyling. 2007. Population trends of widespread woodland birds in Europe. *Ibis* 149: 78-97.
- Integrated Taxonomic Information System (ITIS). 2016. USGS plant name verification web site. <http://www.itis.usda.gov/> (accessed 31 October 2016).
- Karr, J. R. 1991. Biological integrity: a long-neglected aspect of water resource management. *Ecological Applications* 1:66-84.
- Karr, J. R. and D. R. Dudley. 1981. Ecological perspective on water quality goals. *Environmental Management* 5:55-68.
- Mallory, M. L., H. G. Gilchrist, B. M. Braune and A. J. Gaston. 2006. Marine birds as indicators of arctic marine ecosystem health: linking the northern ecosystem initiative to long-term studies. *Environmental Monitoring and Assessment* 113:31-48.
- Maurer, B. A. 1993. Biological diversity, ecological integrity, and neotropical migrants: New perspectives for wildlife managers. Pages 24-31 in D.M. Finch and P.W. Stangel, editors. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229.
- National Park Service (NPS). 2012. NPScape GIS data store web site. http://science.nature.nps.gov/im/monitor/npscape/gis_data.cfm (accessed 8 November 2012).
- North American Bird Conservation Initiative (NABCI). 2012. North American Bird Conservation Initiative web site. <http://www.nabci-us.org/about.htm> (accessed 8 November 2012).

- Pannekoek J. and A. J. Van Strien. 2005. TRIM 3 manual (TRends and Indices for Monitoring data). Statistics Netherlands, Voorburg, The Netherlands.
- Pashley, D. N. and W. C. Barrow. 1993. Effects of land use practices on neotropical migratory birds in bottomland hardwood forests. Pages 315-320 in D.M. Finch and P.W. Stangel, eds. Status and management of neotropical migratory birds. U.S. Forest Service General Technical Report RM-229.
- Peitz, D. G., G. A. Rowell, J. L. Haack, K. M. James, L. W. Morrison, and M. D. Debacker. 2008. Breeding bird monitoring protocol for the Heartland Network Inventory and Monitoring Program. Natural Resource Report NPS/HTLN/NRR-2008/044. National Park Service, Fort Collins, Colorado.
- Peitz, D. G. 2009. Bird monitoring at Wilson's Creek National Battlefield, Missouri 2008 status report. Natural Resource Technical Report NPS/HTLN/NRTR—2009/195. National Park Service, Fort Collins, Colorado.
- Pielou, E. C. 1969. An introduction to mathematical ecology. John Wiley and Sons, New York, New York. 286pp.
- Robbins, M. B. and D. A. Easterla. 1992. Birds of Missouri: their distribution and abundance. University of Missouri Press, Columbia.
- Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2014. The North American Breeding Bird Survey, Results and Analysis 1966 - 2013. Version 01.30.2015 USGS Patuxent Wildlife Research Center, Laurel, MD. Available from <http://www.mbr-pwrc.usgs.gov/bbs/> (accessed 30 November 2016).
- Shannon, C. E. 1949. The mathematical theory of communication. University of Illinois Press, Urbana, Illinois. 177 pp.
- Stokes, D. W. and L. Q. Stokes. 1996. Stokes Field Guide to Birds: Eastern Region. Little, Brown and Company, New York, New York.
- U.S. Fish and Wildlife Service. 2008. Birds of Conservation Concern 2008. United States Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. 85 pp. [Online version available at <<http://www.fws.gov/migratorybirds/>>].
- Van Strien, A. J., J. Pannekoek, and D. W. Gibbons. 2001. Indexing European bird population trends using results of national monitoring schemes: a trial of a new method. *Bird Study* 48: 200–213.
- Wood, J. K., N. Nur, C. A. Howell and G. R. Geupel. 2006. Overview of Cosumnes riparian bird study and recommendations for monitoring and management. A Report to the California Bay-Delta Authority Ecosystem Restoration Program. Petaluma, California.

Appendix A

Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using Distance Software) of breeding bird species at Wilson's Creek National Battlefield during the 2008-2016 spring bird surveys (n=number of plots sample).

Common name	<u>Proportion of plots occupied</u> <u>Abundance</u>								
	2008 n=36	2009 n=38	2010 n=33	2011 n=38	2012 n=35	2013 n=33	2014 n=35	2015 n=21	2016 n=37
American Crow	0.14 15	0.29 157	0.58 410	0.42 228	0.17 46	0.30 197	0.37 170	0.48 309	0.22 44
American Goldfinch	0.03 0	0.24 522	0.27 944	0.11 298	0.06 0	0.24 429	0.29 890	0.19 944	0 0
Blue-gray Gnatcatcher	0.33 853	0.24 559	0.49 1503	0.40 1305	0.31 742	0.55 1718	0.46 1552	0.10 225	0.16 447
Brown-headed Cowbird	0.22 341	0.32 503	0.39 703	0.29 575	0.17 273	0.24 372	0.37 546	0.19 390	0.22 295
Carolina Wren	0.22 202	0.58 598	0.30 358	0.13 120	0.20 182	0.55 606	0.46 468	0 0	0.22 197
Common Yellowthroat	0.14 119	0.26 270	0.24 233	0.32 360	0.31 367	0.21 233	0.23 196	0 0	0.24 208
Dickcissel	0.17 130	0.21 123	0.36 298	0.11 74	0.34 388	0.24 227	0.06 80	0.33 245	0.14 126
Eastern Towhee	0.25 193	0.47 387	0.42 446	0.45 407	0.23 199	0.39 563	0.49 509	0.24 184	0.14 125
Eastern Wood-pewee	0.14 126	0.34 358	0.24 220	0.21 215	0.14 155	0.27 247	0.09 78	0.24 259	0.05 49
Field Sparrow	0.22 138	0.61 481	0.52 419	0.58 510	0.46 316	0.67 537	0.49 316	0.38 290	0.32 209
Indigo Bunting	0.67 1469	0.58 1233	0.52 1145	0.58 1114	0.34 864	0.58 1145	0.51 993	0.19 432	0.59 1430
Northern Cardinal	0.33 366	0.61 670	0.64 718	0.68 901	0.54 652	0.79 1091	0.69 953	0.43 627	0.78 783

Common name	<u>Proportion of plots occupied</u>								
	Abundance								
	2008 n=36	2009 n=38	2010 n=33	2011 n=38	2012 n=35	2013 n=33	2014 n=35	2015 n=21	2016 n=37
Northern Parula	0.11	0.21	0.21	0.29	0.23	0.21	0.26	0	0.41
	114	216	280	352	235	280	352	0	444
Red-bellied Woodpecker	0.08	0.18	0.36	0.16	0.23	0.61	0.31	0.19	0.19
	46	87	218	73	126	402	158	105	119
Red-eyed Vireo	0.11	0.42	0.21	0.18	0.11	0.15	0.17	0.05	0.19
	145	654	277	241	149	238	336	62	247
Tufted-titmouse	0.14	0.40	0.55	0.37	0.40	0.70	0.60	0.24	0.35
	88	301	404	301	272	596	580	181	257
Wild Turkey	0.19	0.05	0.12	0.11	0.14	0.12	0.17	0.10	0.16
	452	122	352	184	266	282	399	221	440
Yellow-breasted Chat	0.19	0.50	0.06	0.32	0.31	0.39	0.26	0	0.05
	96	318	35	288	230	244	197	0	31

Appendix B

Annual proportion of plots occupied (includes flyovers) by, and estimated abundance (determined using birds within 200-m of plot center) of breeding bird species at Wilson's Creek National Battlefield during the 2008-2016 spring bird surveys (n=number of plots sample).

Common name	<u>Proportion of plots occupied</u> Abundance								
	2008 n=36	2009 n=38	2010 n=33	2011 n=38	2012 n=35	2013 n=33	2014 n=35	2015 n=21	2016 n=37
Acadian Flycatcher	0	0.16	0.15	0.08	0	0.15	0.06	0	0
	0	10	10	7	0	12	4	0	0
American Redstart	0	0	0	0.05	0	0	0.03	0	0.03
	0	0	0	3	0	0	2	0	2
American Robin	0	0.11	0.03	0.03	0	0.09	0.06	0.10	0.03
	0	7	4	2	0	6	7	6	2
Bank Swallow	0.03	0	0.06	0.03	0.03	0	0.06	0	0.03
	--*	0	4	2	--	0	16	0	0
Barn Swallow	0	0.03	0.03	0.03	0	0	0	0.10	0
	0	--	2	3	0	0	0	9	0
Barred Owl	0	0	0.03	0	0	0	0.03	0	0.03
	0	0	4	0	0	0	2	0	--
Bell's Vireo	0	0.05	0.06	0.05	0.03	0	0.03	0	0
	0	3	4	3	2	0	--	0	0
Belted Kingfisher	0	0	0	0.03	0	0	0	0	0
	0	0	0	--	0	0	0	0	0
Bewick's Wren	0.03	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0
Black and White Warbler	0.03	0.03	0.03	0.05	0.03	0.03	0.06	0	0
	0	0	0	0	0	2	0	0	7
Black-billed Cuckoo	0	0	0	0	0	0	0	0	0.03
	0	0	0	0	0	0	0	0	3
Blue Jay	0.08	0.16	0.24	0.18	0.06	0.09	0.23	0.14	0.14
	4	12	19	12	2	8	20	9	10

Common name	<u>Proportion of plots occupied</u>								
	Abundance								
	2008 n=36	2009 n=38	2010 n=33	2011 n=38	2012 n=35	2013 n=33	2014 n=35	2015 n=21	2016 n=37
Blue-winged Warbler	0.03	0.03	0.03	0.05	0.03	0.03	0.06	0	0
	2	2	2	7	2	2	4	0	0
Broad-winged Hawk	0	0	0	0	0	0.03	0	0	0.05
	0	0	0	0	0	2	0	0	2
Brown Thrasher	0.06	0.03	0.06	0.03	0.03	0.03	0.06	0	0.05
	2	2	8	2	2	2	7	0	3
Canada Goose	0.03	0.03	0	0	0	0	0.03	0	0
	--	--	0	0	0	0	9	0	0
Carolina Chickadee	0.11	0.11	0.06	0.16	0.11	0.15	0.17	0.24	0.14
	7	7	10	17	9	12	11	36	9
Chimney Swift	0	0	0.06	0	0	0.03	0	0	0
	0	0	4	0	0	2	0	0	0
Chipping Sparrow	0	0.05	0	0.05	0	0.06	0	0	0
	0	3	0	5	0	4	0	0	0
Cliff Swallow	0	0.03	0	0.03	0	0.09	0.09	0.14	0
	0	--	0	--	0	8	27	51	0
Common Grackle	0.03	0.03	0.09	0.03	0.03	0	0.06	0.14	0
	--	--	6	3	2	0	2	24	0
Cooper's Hawk	0	0.03	0	0	0	0	0	0	0
	0	--	0	0	0	0	0	0	0
Downy Woodpecker	0.03	0.03	0	0.11	0.11	0.09	0.06	0	0.03
	4	2	0	8	7	6	4	0	2
Eastern Bluebird	0	0.11	0.06	0.16	0.03	0.21	0	0.05	0
	0	8	4	13	2	21	0	3	0
Eastern Kingbird	0	0.03	0	0	0.03	0	0.09	0	0.05
	0	2	0	0	2	0	24	0	9
Eastern Meadowlark	0.06	0.26	0.21	0.11	0.09	0.09	0.29	0.05	0.05
	4	25	12	7	2	8	20	6	3

Common name	<u>Proportion of plots occupied</u>								
	Abundance								
	2008 n=36	2009 n=38	2010 n=33	2011 n=38	2012 n=35	2013 n=33	2014 n=35	2015 n=21	2016 n=37
Eastern Phoebe	0.03	0.13	0.09	0.08	0.03	0	0.09	0	0.03
	2	10	8	7	2	0	5	0	2
European Starling	0	0.05	0	0.05	0.03	0.03	0.11	0	0
	0	--	0	3	5	2	11	0	0
Fish Crow	0	0	0.03	0	0	0	0	0	0
	0	0	4	0	0	0	0	0	0
Grasshopper Sparrow	0	0.05	0.06	0.03	0.09	0.03	0.09	0	0.05
	0	3	4	3	5	2	5	0	5
Gray Catbird	0.03	0	0.06	0	0	0	0.09	0	0.05
	2	0	4	0	0	0	5	0	3
Great Blue Heron	0.03	0.03	0	0	0.09	0	0.14	0	0.03
	--	2	0	0	--	0	7	0	--
Great Crested Flycatcher	0.14	0.18	0.18	0.18	0.09	0.24	0.23	0	0.11
	5	13	12	12	5	15	15	0	5
Hairy Woodpecker	0	0	0	0	0.06	0.03	0	0	0
	0	0	0	0	4	2	0	0	0
Henslow's Sparrow	0	0	0.03	0	0	0	0.06	0	0
	0	0	4	0	0	0	5	0	0
Hooded Warbler	0	0	0	0	0.03	0	0	0	0.11
	0	0	0	0	2	0	0	0	7
House Sparrow	0	0.03	0	0	0	0	0	0	0
	0	2	0	0	0	0	0	0	0
House Wren	0	0.08	0	0.03	0.03	0.03	0.03	0	0.05
	0	5	0	2	4	2	2	0	3
Kentucky Warbler	0.19	0.03	0.03	0.08	0.03	0.06	0.23	0	0
	14	2	6	7	2	6	15	0	0
Killdeer	0	0	0	0.05	0	0	0	0.05	0
	0	0	0	3	0	0	0	3	0

Common name	<u>Proportion of plots occupied</u>								
	Abundance								
	2008 n=36	2009 n=38	2010 n=33	2011 n=38	2012 n=35	2013 n=33	2014 n=35	2015 n=21	2016 n=37
Lark Sparrow	0	0.03	0.06	0	0	0	0	0	0
	0	2	4	0	0	0	0	0	0
Little Blue Heron	0	0	0	0	0.03	0	0	0	0
	0	0	0	0	2	0	0	0	0
Louisiana Waterthrush	0	0.13	0	0.05	0	0	0.06	0	0.03
	0	10	0	3	0	0	4	0	3
Mourning Dove	0	0.08	0.03	0.05	0	0.18	0	0.14	0.05
	0	3	--	3	0	15	0	9	--
Northern Bobwhite	0.08	0.18	0.03	0.08	0.14	0	0	0.10	0.03
	5	13	2	5	5	0	0	12	2
Northern Flicker	0	0	0.03	0	0	0	0.03	0	0
	0	0	2	0	0	0	2	0	0
Northern Mockingbird	0.19	0.05	0.03	0.05	0.03	0.03	0.09	0.14	0.22
	11	3	2	3	--	4	5	9	14
Northern Rough-winged Swallow	0	0	0.09	0.03	0.03	0	0.03	0	0
	0	0	2	2	--	0	--	0	0
Orchard Oriole	0	0	0	0	0	0	0.03	0	0
	0	0	0	0	0	0	2	0	0
Ovenbird	0.03	0	0.03	0	0	0	0	0	0
	2	0	2	0	0	0	0	0	0
Pileated Woodpecker	0.03	0.08	0.09	0	0	0.03	0	0	0
	2	3	2	0	0	4	0	0	0
Prairie Warbler	0.06	0	0	0	0.03	0	0	0	0
	4	0	0	0	4	0	0	0	0
Prothonotary Warbler	0	0.05	0.03	0	0	0	0.03	0	0
	0	3	2	0	0	0	2	0	0
Red-headed Woodpecker	0	0	0	0	0.06	0	0.03	0.05	0
	0	0	0	0	4	0	2	3	0

Common name	<u>Proportion of plots occupied</u>								
	Abundance								
	2008 n=36	2009 n=38	2010 n=33	2011 n=38	2012 n=35	2013 n=33	2014 n=35	2015 n=21	2016 n=37
Red-shouldered Hawk	0	0	0.03	0	0	0	0	0	0
	0	0	--	0	0	0	0	0	0
Red-tailed Hawk	0.03	0.11	0	0.03	0.11	0.06	0.03	0.10	0
	4	5	0	--	4	4	2	6	0
Red-winged Blackbird	0	0.05	0	0.05	0.03	0	0.06	0.05	0.03
	0	3	0	3	2	0	5	15	2
Ruby-throated Hummingbird	0	0.03	0.03	0.03	0	0.12	0.03	0.05	0
	0	2	2	2	0	8	2	6	0
Scarlet Tanager	0	0.03	0	0	0	0	0	0	0
	0	2	0	0	0	0	0	0	0
Scissor-tailed Flycatcher	0	0	0.03	0	0	0.09	0	0	0.03
	0	0	2	0	0	8	0	0	2
Song Sparrow	0.03	0	0	0	0	0	0	0	0.03
	2	0	0	0	0	0	0	0	2
Summer Tanager	0.08	0.18	0.03	0.11	0.14	0.09	0.11	0	0.08
	5	12	2	10	11	10	7	0	5
Swainson's Hawk	0	0.03	0	0	0	0	0	0	0
	0	--	0	0	0	0	0	0	0
Tree Swallow	0	0.03	0	0	0.03	0	0.03	0	0
	0	--	0	0	--	0	--	0	0
Turkey Vulture	0.06	0.08	0.12	0.05	0	0.06	0.06	0.19	0.05
	--	2	8	3	0	2	--	15	--
Warbling Vireo	0	0.05	0	0	0	0	0.03	0	0
	0	3	0	0	0	0	2	0	0
White-breasted Nuthatch	0	0.05	0	0.05	0	0.03	0.06	0	0
	0	3	0	3	0	2	4	0	0
White-eyed Vireo	0.11	0.18	0.24	0.16	0.09	0.18	0.14	0	0.08
	9	13	15	10	5	13	9	0	7

Common name	<u>Proportion of plots occupied</u>								
	Abundance								
	2008 n=36	2009 n=38	2010 n=33	2011 n=38	2012 n=35	2013 n=33	2014 n=35	2015 n=21	2016 n=37
Wood Thrush	0	0.03	0	0	0	0	0	0	0.03
	0	2	0	0	0	0	0	0	2
Yellow-billed Cuckoo	0.20	0.50	0.06	0.32	0.31	0.39	0.26	0	0.05
	--	10	13	15	36	25	--	0	2
Yellow-throated Vireo	0	0	0	0	0	0.06	0	0	0.03
	0	0	0	0	0	4	0	0	2
Yellow-throated Warbler	0	0	0	0	0	0	0.06	0	0
	0	0	0	0	0	0	4	0	0
Yellow Warbler	0	0	0.03	0	0	0	0.03	0	0.03
	0	0	2	0	0	0	2	0	2

* — denotes when a species was present on a plot but outside 50-m of plot center therefore their annual abundance value could not be calculated.

Bolded species names are those species considered of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008).

Appendix C

Regional trends in breeding birds recorded on Wilson's Creek National Battlefield, Missouri for years 2008 through 2013.

Common name	Trend	Central Hardwoods	
		95% Confidence Interval	
		Lower	Upper
Acadian Flycatcher	1.05	-0.63	2.72
American Coot	NA	NA	NA
American Crow	1.21	-0.38	2.83
American Goldfinch	1.60	-0.99	4.29
American Redstart	4.85	-2.43	15.01
American Robin	1.52	-0.13	3.27
Baltimore Oriole	-0.01	-4.32	4.13
Bank Swallow	2.03	-38.03	37.70
Barn Swallow	-1.66	-3.57	0.08
Barred Owl	7.67	0.48	17.62
Bell's Vireo	8.60	-3.36	22.51
Belted Kingfisher	-0.00	-6.12	6.57
Bewick's Wren	-2.07	-10.87	9.95
Black and White Warbler	-1.69	-7.82	4.80
Black-billed Cuckoo	-2.31	-12.80	7.57
Blue-gray Gnatcatcher	-0.53	-2.86	1.65
Blue Grosbeak	1.94	-0.41	4.46
Blue Jay	-0.38	-1.92	1.36
Blue-winged Warbler	-7.88	-15.41	-0.99
Broad-winged Hawk	3.16	-2.78	11.41
Brown-headed Cowbird	-0.69	-2.45	1.00
Brown Thrasher	-1.05	-2.80	0.78
Canada Goose	18.61	4.85	33.81
Carolina Chickadee	1.75	-0.81	4.51
Carolina Wren	5.75	3.17	8.33
Cedar Waxwing	-16.13	-22.46	-9.61
Chimney Swift	-3.49	-5.84	-1.07
Chipping Sparrow	2.99	1.00	4.94
Cliff Swallow	21.79	7.85	31.68
Common Grackle	-2.72	-4.44	-0.91
Common Yellowthroat	-1.33	-2.86	0.23
Cooper's Hawk	3.55	-2.51	8.72

Common name	Central Hardwoods		
	Trend	95% Confidence Interval	
		Lower	Upper
Dickcissel	0.91	-3.76	5.73
Downy Woodpecker	4.07	0.77	7.72
Eastern Bluebird	3.67	0.71	6.91
Eastern Kingbird	-0.15	-1.95	1.81
Eastern Meadowlark	-2.55	-4.32	-0.88
Eastern Phoebe	0.87	-1.62	3.38
Eastern Towhee	0.28	-1.74	2.35
Eastern Wood-pewee	-2.26	-4.01	-0.61
European Starling	1.14	-1.14	3.92
Field Sparrow	-2.02	-3.95	0.06
Fish Crow	7.61	-10.43	21.91
Grasshopper Sparrow	-3.68	-9.03	0.95
Gray Catbird	-2.74	-5.30	-0.23
Great Blue Heron	3.27	-0.81	6.92
Great Crested Flycatcher	-0.42	-2.43	1.81
Hairy Woodpecker	1.59	-2.08	5.69
Henslow's Sparrow	4.55	-6.90	12.23
Hooded Warbler	3.17	-1.56	8.54
House Sparrow	-0.47	-3.05	2.43
House Wren	-1.09	-4.92	2.49
Indigo Bunting	-1.17	-2.20	-0.20
Kentucky Warbler	-0.13	-2.90	2.81
Killdeer	0.57	-2.13	3.37
Lark Sparrow	5.35	-9.89	29.82
Little Blue Heron	-8.98	-39.40	25.04
Louisiana Waterthrush	2.02	-1.68	5.65
Mourning Dove	1.78	0.22	3.49
Northern Bobwhite	-3.18	-5.52	-0.85
Northern Cardinal	0.66	-0.31	1.72
Northern Flicker	NA	NA	NA
Northern Harrier	2.42	-24.04	37.69
Northern Mockingbird	3.65	1.66	5.73
Northern Parula	3.20	0.67	5.03
Northern Rough-winged Swallow	1.39	-1.74	4.86
Orchard Oriole	-0.82	-2.99	1.51
Ovenbird	-2.19	-6.59	2.23

Common name	Central Hardwoods		
	Trend	95% Confidence Interval	
		Lower	Upper
Pileated Woodpecker	1.71	-0.76	4.62
Prairie Warbler	-1.78	-3.63	0.17
Prothonotary Warbler	1.26	-2.98	6.09
Red-bellied Woodpecker	0.96	-1.03	2.98
Red-eyed Vireo	-0.60	-2.48	1.11
Red-headed Woodpecker	0.59	-3.92	5.45
Red-shouldered Hawk	7.07	2.79	12.04
Red-tailed Hawk	3.94	0.77	7.71
Red-winged Blackbird	-1.55	-3.58	0.55
Rose-breasted Grosbeak	1.68	-14.09	16.23
Ruby-throated Hummingbird	0.73	-3.10	4.28
Scarlet Tanager	-0.61	-3.64	2.26
Scissor-tailed Flycatcher	8.88	0.69	15.65
Song Sparrow	0.84	-1.93	3.66
Summer Tanager	-0.06	-2.02	1.94
Swainson's Hawk	NA	NA	NA
Tree Swallow	7.25	-1.63	15.49
Tufted Titmouse	-0.02	-2.24	2.16
Turkey Vulture	4.24	0.68	7.64
Warbling Vireo	-1.40	-5.05	1.77
White-breasted Nuthatch	1.95	-1.83	5.91
White-eyed Vireo	-2.69	-4.91	-0.54
Wild Turkey	10.35	0.19	19.19
Willow Flycatcher	2.64	-4.31	12.86
Wood Thrush	-3.41	-5.71	-1.15
Yellow-billed Cuckoo	-2.56	-6.22	1.23
Yellow-breasted Chat	-1.93	-3.73	-0.18
Yellow-throated Vireo	1.93	-0.71	4.61
Yellow-throated Warbler	3.82	1.01	6.81
Yellow Warbler	-4.06	-10.52	1.38

Bolded species names are those species considered of regional concern for the Central Hardwoods Bird Conservation Region (U.S. Fish and Wildlife Service. 2008).

Regional trend data from BBS surveys (Sauer et al. 2014).

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

NPS 410/138153, May 2017

National Park Service
U.S. Department of the Interior



Natural Resource Stewardship and Science

1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov

EXPERIENCE YOUR AMERICA™