



Bird Community Monitoring at Arkansas Post National Memorial, Arkansas

Status Report 2007–2019

Natural Resource Report NPS/HTLN/NRR—2020/2161



ON THE COVER
Great Egret (*Ardea alba*)
Photography by NPS, Heartland Network

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July 2020

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 K. A. Kull. 2020. Bird community monitoring at Arkansas Post National Memorial, Arkansas: Status report 2007–2019. Natural Resource Report NPS/HTLN/NRR—2020/2161. National Park Service, Fort Collins, Colorado. <https://doi.org/10.36967/nrr-2278003>.

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Executive Summary

Breeding bird surveys were initiated on Arkansas Post National Memorial, Arkansas, in 2007 to assess temporal changes in the species composition and abundance of birds on the park. These data also improve our understanding of relationships between breeding birds and their habitat and the effects of management actions, such as invasive plant species control and timber stand thinning, on bird populations. Birds were sampled using point counts with 36 variable circular plots located on a systematic grid of 200 x 200-m cells (originating from a random start point). All birds seen or heard on a plot during a 5-min sampling period were recorded.

Birds were surveyed on as many of the 36 variable circular plots as possible in 11 of the last 13 years, resulting in 367 plot visits. Surveys have yielded records for 105 different species of birds. Ninety-three of the species recorded are classified as permanent or summer residents, four are classified as migrants through the area, four are classified as winter residents, and four as transient in the area. Eight species recorded are considered *species of conservation concern* for the Mississippi Alluvial Valley Bird Conservation Region, the bird conservation region in which Arkansas Post National Memorial is located. Seventeen of the 93 resident species were recorded on the park frequently enough to determine trends in their populations. With 71% of the 212 ha of terrestrial vegetation on Arkansas Post National Memorial in various woodland types, it is not surprising that about 32 of the breeding bird species recorded utilize this habitat type.

Based on population trends, the bird community at Arkansas Post National Memorial is faring similarly to or better than the bird communities in the Mississippi Alluvial Valley Bird Conservation Region as a whole. Only the Red-winged Blackbird (*Agelaius phoeniceus*) population on the park is faring poorer at the park scale than at the regional scale. Increasing diversity and richness values, along with stable evenness values, suggest that the park's habitat is improving in terms of its ability to meet the needs of more breeding bird species, and the habitat currently present provides for the rich array of breeding species observed annually. However, this species-rich community structure could be altered if significant portions of the park's woodlands were removed or if some of the less common habitats were lost.

Acknowledgments

We would like to thank the staff of Arkansas Post National Memorial, Arkansas, for allowing us access to the park during our breeding bird surveys and for assisting with coordinating many of the bird survey efforts. We would also like to thank the staff and volunteers who assisted with bird surveys on the park: K. N. McCallie, J. B. McCallie, J. A. Allely, S. T. Allely, C. N. Koleser, E. E. Wood, E. F. Ditzler, B. E. Sheets, and G. M. (Clemmens) Hargrove.

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. 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. Management activities that preserve 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). The National Park Service plays a role in bird conservation under the authority of the Migratory Bird Treaty Act of 1918 (as amended) and Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. Bird monitoring is also critical as widespread habitat loss to agriculture and urban and industrial development threaten the integrity of the region for birds.

Arkansas Post National Memorial, Arkansas, is centrally located in the Mississippi Alluvial Valley Bird Conservation Region (Figure 1). This is the 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 2019).

The Mississippi Alluvial Valley Bird Conservation Region consists of millions of acres of alluvial floodplain south of the Mississippi River's confluence with the Ohio River (NABCI 2019). Historically this was the greatest bottomland hardwood forest on earth and was subject to massive annual flood events from the Mississippi River and its tributaries. Threats to the region include flood control and deforestation for agriculture. Today, less than 25 percent of the region remains forested, and flooding has been reduced by about 90 percent. High priority birds of the region include Least Bittern (*Ixobrychus exilis*), Swallow-tailed Kite (*Elanoides forficatus*), Bald Eagle

(*Haliaeetus leucocephalus*), Peregrine Falcon (*Falco peregrinus*), Black Rail (*Laterallus jamaicensis*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Wood Thrush (*Hylocichla mustelina*), Cerulean Warbler (*Setophaga cerulea*), Prothonotary Warbler (*Protonotaria citrea*), Swainson's Warbler (*Limnothlypis swainsonii*), Kentucky Warbler (*Geothlypis formosa*), Painted Bunting (*Passerina ciris*), Dickcissel (*Spiza americana*), and Orchard Oriole (*Icterus spurius*; U.S. Fish and Wildlife Service 2008). Approximately 102 species of breeding birds can be found in the habitats of the Mississippi Alluvial Valley Bird Conservation Region around Arkansas Post National Memorial (James and Neal 1986).

Data collected during the U.S. Geological Survey's annual North American Breeding Bird Surveys (BBS) between 1966 and 2015 indicate that a number of bird species breeding at Arkansas Post National Memorial show evidence of long-term population decline (Sauer et al. 2017). In fact, 42% of the species have populations reported to be in decline throughout the Mississippi Alluvial Valley Bird Conservation Region, with species such as the Common Grackle (*Quiscalus quiscula*), Common Yellowthroat (*Geothlypis trichas*), and Northern Bobwhite (*Colinus virginianus*) declining at alarming rates.

We will use long-term trends in the composition and abundance of bird populations as indicators of ecosystem integrity at Arkansas Post National Memorial. 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 Arkansas Post National Memorial.

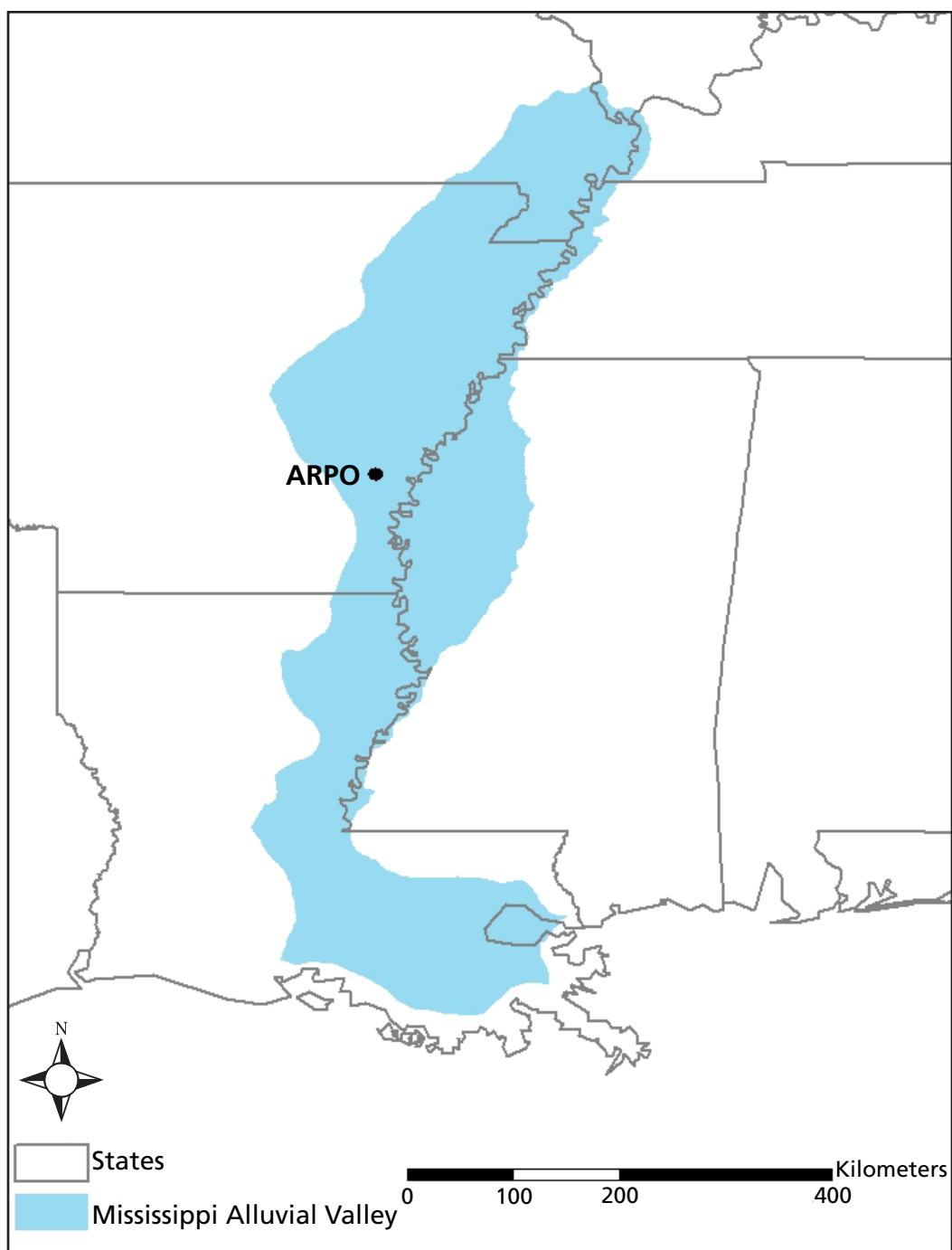


Figure 1. Location of Arkansas Post National Memorial (ARPO), Arkansas, within the Mississippi Alluvial Valley Bird Conservation Region.

Objectives

There are two primary objectives for monitoring breeding birds at Arkansas Post National Memorial:

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

effects of management actions (such as forest restoration 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 11 years of monitoring (2007–2019, excluding 2008 and 2009).



American Coots (*Fulica americana*) are year-round residents at Arkansas Post National Memorial. NPS

Methods

Site Selection

Permanent monitoring locations or *plots* were selected by overlaying a systematic grid of 200 x 200-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 36 permanent plots on Arkansas Post National Memorial for monitoring bird population sizes and community composition (Figure 2). Monitoring occurred on 27 to 36 sites annually depending the severity of flood events during sampling each year (Table 1).

Starting in 2010, breeding bird monitoring was conducted by park staff and volunteers three out of every four years, allowing Heartland Inventory and Monitoring (I&M) Network to modify their sampling schedule to visit the park every fourth year. To facilitate this change, park staff and volunteers were asked to visit as many plots annually as their schedules would allow. Heartland I&M Network monitored all available plots during their fourth-year visits—2007, 2011, 2015 and 2019.

During bird surveys in 2007, 2011, 2015, and 2019, monitoring plots were located using navigation waypoints (Peitz et al. 2008) in a GPS 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. During bird surveys in other years when habitat assessments were not conducted, monitoring plots were located using a GPS unit, but plot locations 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 rather than individual birds. 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.

Table 1. Number of plots sampled and sampling dates for breeding bird surveys conducted at Arkansas Post National Memorial, Arkansas, by year. Also listed are observer(s) who conducted the surveys.

Year	Sampling Dates	Number of Plots Sampled	Observer(s)
2007	June 5–June 7	36	D.G. Peitz*
2010	May 12–May 19	36	K.N. McCallie, J.B. McCallie, J.A. Allely, S.T. Allely
2011	June 7–June 8	27	D.G. Peitz*
2012	May 15–May 17	36	K.N. McCallie, S.T. Allely, C.N. Kolesar
2013	May 28–May 31	36	K.N. McCallie, E.E. Wood
2014	June 4–June 8	36	K.N. McCallie, J.B. McCallie, E.E. Wood
2015	May 18–May 20	36	D.G. Peitz*
2016	June 6–June 9	36	K.N. McCallie, J.B. McCallie
2017	May 31–June 9	27	K.N. McCallie, J.B. McCallie
2018	June 6–June 11	34	K.N. McCallie, E.F. Ditzler, B.E. Sheets, G.M. (Clemmens) Hargrove
2019	May 19–May 21	27	D.J. Marcum*

*Heartland I&M Network staff.

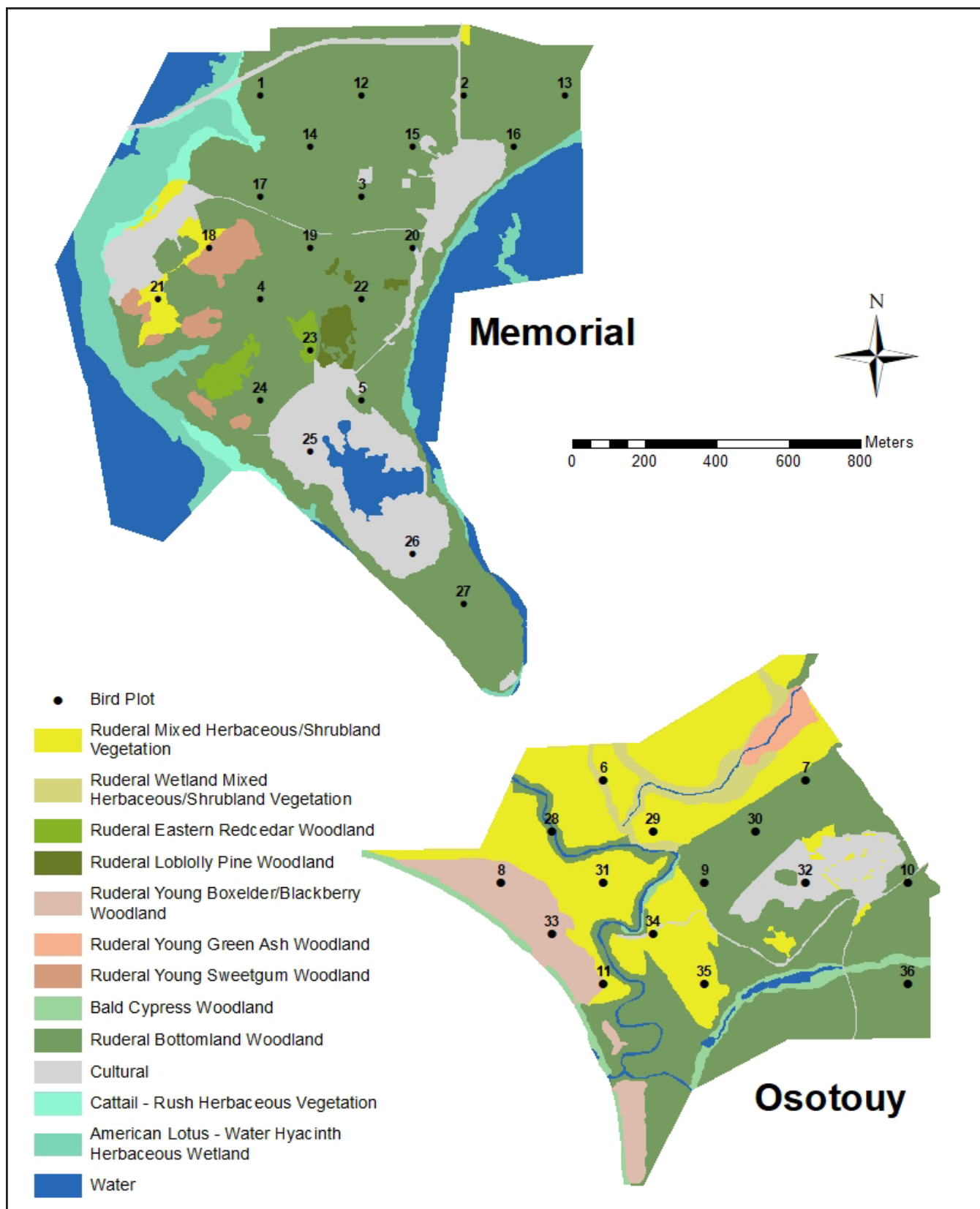


Figure 2. Bird plot locations on the Memorial and Osotouy units of Arkansas Post National Memorial, Arkansas. Vegetation mapping and classification provided by Diamond et al. (2015).

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 in the morning from 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 5-min survey are included. Individual birds recorded from a previous plot were noted and excluded from analysis except when developing detection functions using Distance software.

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 2007, 2011, 2015, and 2019. 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. They also set up 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 were 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-radius plot were recorded. As 5-m-radius subplots were sampled, horizontal vegetation cover was estimated in 0.25-m intervals from 0.0 to 2.0 meters above the 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-radius sample plot nested within the subplot, ground and foliar cover were estimated. Ground cover classes included deciduous and grass litter, bare soil, rock, woody debris (>2.5 cm diameter), and unvegetated. Foliar cover was estimated for six plant guilds, including warm-season grasses, 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, or 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 Arkansas Post National Memorial. Proportion of plots occupied by each bird species was calculated (total number of plots occupied by a species/plots surveyed) and reported in Appendices B and C.

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 + 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.

The Hazard-rate + Simple polynomial function was selected for 12 species: Acadian Flycatcher (*Empidonax virens*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Blue Jay (*Cyanocitta cristata*), Canada Goose (*Branta canadensis*), Carolina Wren (*Thryothorus ludovicianus*), Eastern Wood-Pewee (*Contopus virens*), Great Crested Flycatcher (*Myiarchus crinitus*), Indigo Bunting (*Passerina cyanea*), Northern Cardinal (*Cardinalis cardinalis*), Pileated



Arkansas Post National Memorial, Arkansas. NPS

Woodpecker (*Dryocopus pileatus*), Red-winged Blackbird (*Agelaius phoeniceus*), and Tufted Titmouse (*Baeolophus bicolor*). The Uniform + Cosine function was chosen for three species: Brown-Headed Cowbird (*Molothrus ater*), Prothonotary Warbler (*Protonotaria citrea*), and Summer Tanager (*Piranga rubra*). The Half-normal + Cosine function was chosen for two species: Mourning Dove (*Zenaidura macroura*) and Yellow-billed Cuckoo (*Coccyzus americanus*). The Half Normal + Hermite polynomial function was chosen for one species: Red-bellied Woodpecker (*Melanerpes carolinus*). Abundances for these species are reported in Appendix B. For species with fewer than 60 observations, park-wide abundance (Appendix C) was calculated by first deriving a species density from observations recorded within a 100-m radius (3.14 ha) around each plot center and then calculating abundance based on average plot densities.

For species with adequate abundance (those with greater than 60 observations), 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 D. 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. This software takes into account serial correlation in count data among years and overdispersion. In flood years when data were not collected from a plot, its abundance values were extrapolated from years in which data were collected.

For this report, we also obtained regional breeding bird trends for the Mississippi Alluvial Valley Bird Conservation Region during the period of 2005 to 2015 from the Breeding Bird Survey (BBS) website of the USGS Patuxent Wildlife Research Center (Appendix E; 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 Arkansas Post National Memorial.

We compared regional trends with those calculated using TRIM for the habitats of Arkansas Post National Memorial (Figure 3). Regional trends with a confidence interval that straddled zero were classified as uncertain for comparison with results from Arkansas Post National Memorial. It should be noted that trends determined by the BBS were calculated using a different methodology; due to limitations in the BBS field data collections, hierarchical modeling was used to produce an annual index of abundance, and trends were then estimated as constant annual rates based only on the first and last years of the intervals selected. Since all but the first and last year indices are ignored in this approach, trends based on BBS data tend to display variability when compared among different broadly overlapping intervals, and interpretation of BBS results should be made with caution.

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

were calculated annually using the Shannon Diversity Index:

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

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

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

Red-headed Woodpecker (*Melanerpes erythrocephalus*) is a species of conservation concern for the Mississippi Alluvial Valley Bird Conservation Region and a year-round resident on Arkansas Post National Memorial. NPS



useful in comparing surveys with unequal sampling effort (e.g., different numbers of plots) since more species are usually discovered with greater sampling effort. Different species richness estimators will produce varying estimates, however, and no single estimator is consistently superior to others. Nonparametric statistical estimators have generally performed better than parametric types (Walther and Moore 2005). Reese et al. (2014) recently reviewed nonparametric species richness estimators and found that two coverage-based estimators, the Abundance Coverage-based Estimator (ACE) and Incidence Coverage-based Estimator (ICE), provided less biased and more accurate estimates than many of the others. Thus, we employed these two species richness estimators and report estimated species richness along with observed species richness. The software application EstimateS (Colwell 2013) was used to calculate the ACE and ICE estimators.

Location and permanent abiotic measures on each plot were reported by Peitz et al. (2008). Annual averages ($\pm$ std dev) for semi-permanent plot data, including road and water cover, were calculated from plot estimates (Appendix F). In 2007, averages ($\pm$ std dev) for horizontal vegetation cover between 0–0.50, 0.25–0.75, 0.5–1.0, 0.75–1.25, 1.0–1.50, 1.25–1.75, and 1.5–2.00 m were calculated across plots, and in 2011, 2015, and 2019, 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 and reported. Average ($\pm$ std dev) annual vertical structure diversity was estimated and reported by habitat type as well. Vertical structure diversity was calculated as

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

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

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

Results

Bird Surveys

Since initiating breeding bird surveys in 2007 on Arkansas Post National Memorial, as many of the 36 variable circular plots as possible were sampled in each of the 11 survey years (there were no surveys in 2008 and 2009), resulting in a total of 367 plot visits (Table 1). During surveys, we recorded 105 species (Table 2). Ninety-three of the 105 species recorded are classified as permanent or summer residents to the area (James and Neal 1986). Four species—Least Flycatcher (*Empidonax minimus*), Snowy Egret (*Egretta thula*), Sora (*Porzana carolina*), and Yellow Warbler (*Setophaga petechia*)—are classified as migrants through the area. Four additional species—Cedar Waxwing (*Bombycilla cedrorum*), Double-crested Cormorant (*Phalacrocorax auritus*), Ruby-crowned Kinglet (*Regulus calendula*),

and Song Sparrow (*Melospiza melodia*) are classified as winter residents to the area. The remaining four species—Blackburnian Warbler (*Setophaga fusca*), Black-capped Chickadee (*Poecile atricapillus*), Nashville Warbler (*Leiothlypis ruficapilla*) and White Ibis (*Eudocimus albus*)—are classified as transients in the area.

Eight species recorded—Bald Eagle (*Haliaeetus leucocephalus*), Dickcissel (*Spiza americana*), Kentucky Warbler (*Geothlypis formosa*), Least Bittern (*Ixobrychus exilis*), Orchard Oriole (*Icterus spurius*), Prothonotary Warbler (*Protonotaria citrea*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), and Wood Thrush (*Hylocichla mustelina*)—are considered species of conservation concern for the Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008).

Table 2. Bird species recorded during breeding bird surveys at Arkansas Post National Memorial, Arkansas, from 2007 through 2019. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System website (ITIS 2019, accessed 2 August 2019).

Common Name	Scientific Name	AOU Code	Residency ^A
Acadian Flycatcher	<i>Empidonax virescens</i>	ACFL	SR
American Coot	<i>Fulica americana</i>	AMCO	R
American Crow	<i>Corvus brachyrhynchos</i>	AMCR	R
American Goldfinch	<i>Spinus tristis</i>	AMGO	R
American Kestrel	<i>Falco sparverius</i>	AMKE	R
American Redstart	<i>Setophaga ruticilla</i>	AMRE	SR
American Robin	<i>Turdus migratorius</i>	AMRO	R
Anhinga	<i>Anhinga anhinga</i>	ANHI	SR
Bachman's Sparrow	<i>Peucaea aestivalis</i>	BACS	SR
Bald Eagle^B	<i>Haliaeetus leucocephalus</i>	BAEA	R
Baltimore Oriole	<i>Icterus galbula</i>	BAOR	SR
Barn Swallow	<i>Hirundo rustica</i>	BARS	SR
Barred Owl	<i>Strix varia</i>	BDOW	R
Black-and-white Warbler	<i>Mniotilta varia</i>	BAWW	SR
Blackburnian Warbler ^C	<i>Setophaga fusca</i>	BLBW	T
Black-capped Chickadee	<i>Poecile atricapillus</i>	BCCH	T
Black-crowned Night-Heron	<i>Nycticorax nycticorax</i>	BCNH	SR

^A Residency: M = late migrant; T = transient; SR = summer resident; R = year-round resident; WR = winter resident per James and Neal (1986).

^B Species of conservation concern for the Lower Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

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

Table 2 (continued). Bird species recorded during breeding bird surveys at Arkansas Post National Memorial, Arkansas, from 2007 through 2019. The American Ornithologists' Union Code (AOU code) and residency status of each species is given. Species names are valid and verified names taken from the Integrated Taxonomic Information System website (ITIS 2019, accessed 2 August 2019).

Common Name	Scientific Name	AOU Code	Residency ^A
Black Vulture	<i>Coragyps atratus</i>	BLVU	R
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
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>Poecile carolinensis</i>	CACH	R
Carolina Wren	<i>Thryothorus ludovicianus</i>	CARW	R
Cattle Egret	<i>Bubulcus ibis</i>	CAEG	SR
Cedar Waxwing	<i>Bombicilla cedrorum</i>	CEDW	WR
Chimney Swift	<i>Chaetura pelagica</i>	CHSW	SR
Chipping Sparrow	<i>Spizella passerina</i>	CHSP	R
Common Grackle	<i>Quiscalus quiscula</i>	COGR	R
Common Moorhen	<i>Gallinula chloropus</i>	COMO	SR
Common Yellowthroat	<i>Geothlypis trichas</i>	COYE	SR
Dickcissel^B	<i>Spiza americana</i>	DICK	SR
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	DCCO	WR
Downy Woodpecker	<i>Picoides pubescens</i>	DOWO	R
Eastern Bluebird	<i>Sialis 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
Fish Crow	<i>Corvus ossifragus</i>	FICR	R
Grasshopper Sparrow ^C	<i>Ammodramus savannarum</i>	GRSP	SR
Gray Catbird	<i>Dumetella carolinensis</i>	GRCA	SR
Great Blue Heron	<i>Ardea herodias</i>	GBHE	R
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	GCFL	SR
Great Egret	<i>Ardea alba</i>	GREG	SR
Great Horned Owl	<i>Bubo virginianus</i>	GHOW	R
Green Heron ^C	<i>Butorides virescens</i>	GRHE	SR

^A Residency: M = late migrant; T = transient; SR = summer resident; R = year-round resident; WR = winter resident per James and Neal (1986).

^B Species of conservation concern for the Lower Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

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

Table 2 (continued). Bird species recorded during breeding bird surveys at Arkansas Post National Memorial, Arkansas, from 2007 through 2019. 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 2019, accessed 2 August 2019).

Common Name	Scientific Name	AOU Code	Residency ^A
Hairy Woodpecker	<i>Picoides villosus</i>	HAWO	R
Hooded Warbler	<i>Setophaga citrina</i>	HOWA	SR
House Sparrow	<i>Passer domesticus</i>	HOSP	R
House Wren	<i>Troglodytes aedon</i>	HOWR	R
Indigo Bunting	<i>Passerina cyanea</i>	INBU	SR
Kentucky Warbler^B	<i>Geothlypis formosa</i>	KEWA	SR
Killdeer	<i>Charadrius vociferus</i>	KILL	R
King Rail	<i>Rallus elegans</i>	KIRA	SR
Least Bittern^{B,C}	<i>Ixobrychus exilis</i>	LEBI	SR
Least Flycatcher	<i>Empidonax minimus</i>	LEFL	M
Least Tern	<i>Sternula antillarum</i>	LETE	SR
Little Blue Heron	<i>Egretta caerulea</i>	LBHE	SR
Loggerhead Shrike	<i>Lanius ludovicianus</i>	LOSH	R
Mallard	<i>Anas platyrhynchos</i>	MALL	R
Mississippi Kite	<i>Ictinia mississippiensis</i>	MIKI	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 Mockingbird	<i>Mimus polyglottos</i>	NOMO	R
Northern Parula	<i>Setophaga americana</i>	NOPA	SR
Orchard Oriole^B	<i>Icterus spurius</i>	OROR	SR
Pied-billed Grebe	<i>Podilymbus podiceps</i>	PBGR	R
Pileated Woodpecker	<i>Dryocopus pileatus</i>	PIWO	R
Pine Warbler	<i>Setophaga pinus</i>	PIWA	R
Prothonotary Warbler^B	<i>Protonotaria citrea</i>	PROW	SR
Purple Gallinule	<i>Porphyrio martinica</i>	PUGA	SR
Purple Martin	<i>Progne subis</i>	PUMA	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

^A Residency: M = late migrant; T = transient; SR = summer resident; R = year-round resident; WR = winter resident per James and Neal (1986).

^B Species of conservation concern for the Lower Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

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

Table 2 (continued). Bird species recorded during breeding bird surveys at Arkansas Post National Memorial, Arkansas, from 2007 through 2019. 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 2019, accessed 2 August 2019).

Common Name	Scientific Name	AOU Code	Residency ^A
Ruby-crowned Kinglet	<i>Regulus calendula</i>	RCKI	WR
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	RTHU	SR
Snowy Egret	<i>Egretta thula</i>	SNEG	M
Song Sparrow	<i>Melospiza melodia</i>	SOSP	WR
Sora	<i>Porzana carolina</i>	SORA	M
Summer Tanager	<i>Piranga rubra</i>	SUTA	SR
Tufted Titmouse	<i>Baeolophus bicolor</i>	TUTI	R
Turkey Vulture	<i>Cathartes aura</i>	TUVU	R
Warbling Vireo	<i>Vireo gilvus</i>	WAVI	SR
White-breasted Nuthatch	<i>Sitta carolinensis</i>	WBNU	R
White-eyed Vireo	<i>Vireo griseus</i>	WEVI	SR
White Ibis ^C	<i>Eudocimus albus</i>	WHIB	T
Wild Turkey	<i>Meleagris gallopavo</i>	WITU	R
Wood Duck	<i>Aix sponsa</i>	WODU	R
Wood Thrush^B	<i>Hylocichla mustelina</i>	WOTH	SR
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	YBCU	SR
Yellow-breasted Chat	<i>Icteria virens</i>	YBCH	SR
Yellow-throated Vireo	<i>Vireo flavifrons</i>	YTVI	SR
Yellow-throated Warbler ^C	<i>Setophaga dominica</i>	YTWA	SR
Yellow Warbler	<i>Setophaga petechia</i>	YEWA	M

^A Residency: M = late migrant; T = transient; SR = summer resident; R = year-round resident; WR = winter resident per James and Neal (1986).

^B Species of conservation concern for the Lower Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

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

Eighteen breeding species on Arkansas Post National Memorial were observed in sufficient numbers to calculate annual abundances with some degree of confidence (Appendix B). These 18 species offer the best opportunities for monitoring the influence of changing habitats on bird species within the park. Thirteen of these species—Acadian Flycatcher (*Empidonax virens*), Blue-gray Gnatcatcher (*Poliophtila caerulea*), Blue Jay (*Cyanocitta cristata*), Brown-headed Cowbird (*Molothrus ater*), Carolina Wren (*Thryothorus ludovicianus*), Eastern Wood-pewee (*Contopus virens*), Great Crested Flycatcher (*Myiarchus crinitus*), Mourning Dove (*Zenaida macroura*), Northern Cardinal (*Cardinalis cardinalis*), Prothonotary Warbler, Red-bellied Woodpecker

(*Melanerpes carolinus*), Tufted Titmouse (*Baeolophus bicolor*), and Yellow-billed Cuckoo (*Coccyzus americanus*)—have increasing populations (Figure 3; Appendix D). Three species—Indigo Bunting (*Passerina cyanea*), Pileated Woodpecker (*Dryocopus pileatus*), and Summer Tanager (*Piranga rubra*)—have stable populations. One species—Red-winged Blackbird (*Agelaius phoeniceus*)—has a declining population. Due to many years (5 of 11) with no observations, we were unable to calculate a population trend for Canada Goose (*Branta canadensis*).

For breeding species recorded, trends within the larger Mississippi Alluvial Valley Bird Conservation Region for the period of 2005 to 2015 (roughly

coinciding with the surveys on Arkansas Post National Memorial) are generally stable (Figure 3; Appendix E). The exceptions are Mourning Dove and Red-bellied Woodpecker, which have populations that have increased slightly.

For the bird community on Arkansas Post National Memorial, a significant increase in richness ($P = 0.01$) and a marginally significant increase in diversity ($P = 0.05$) were observed over the 11 monitoring

years since 2007 (Figure 4). The evenness ($P = 0.77$) in distribution of individuals across species in the breeding bird community was unchanged. Richness averaged 43 species annually. Average estimated species richness was 55 by the ACE estimator and 58 by the ICE estimator. However, these results should be interpreted with some degree of caution as inter-annual variability in the number of plots sampled may have influenced these metrics.

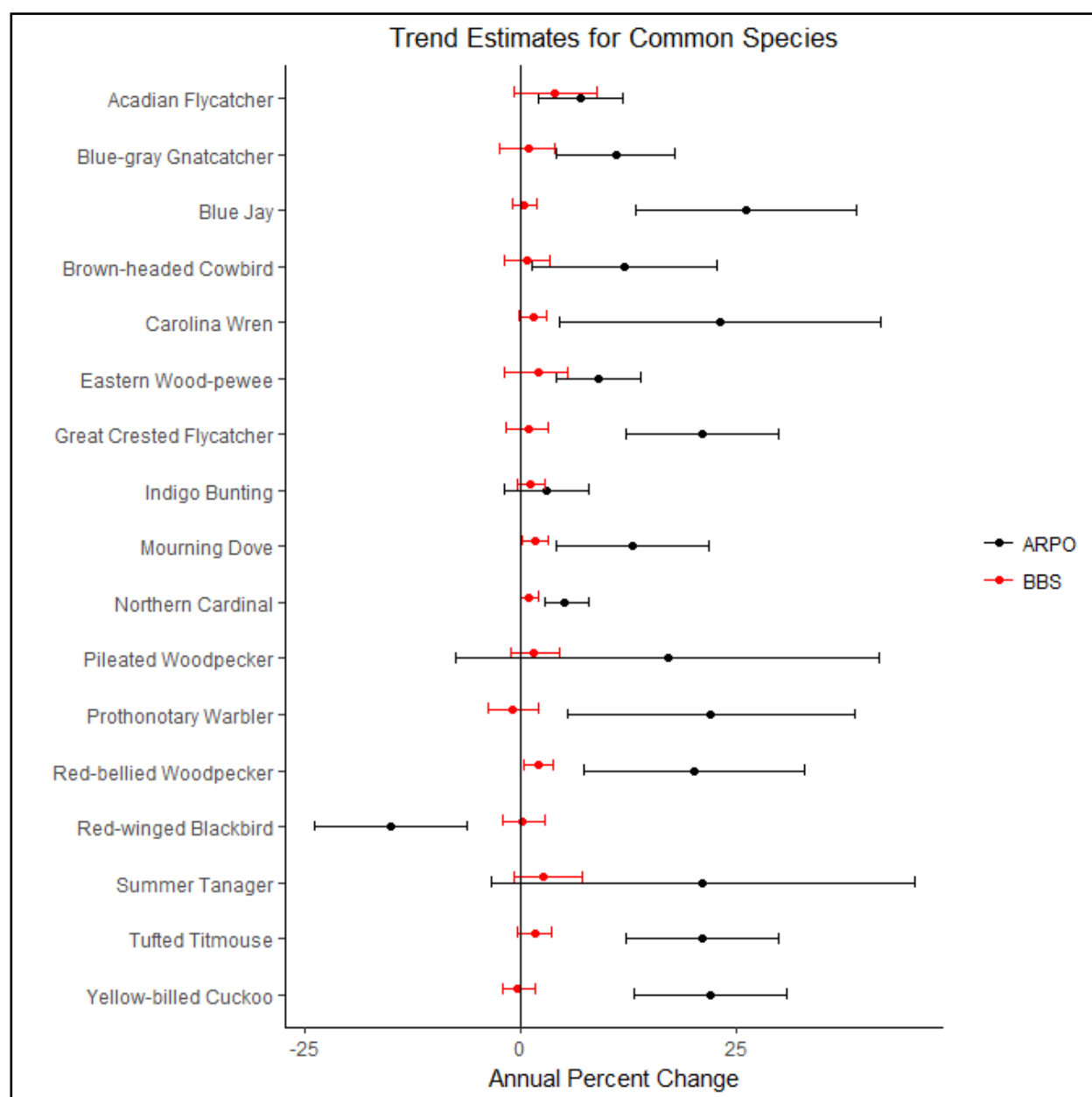


Figure 3. Comparison of bird population trends from Arkansas Post National Memorial (ARPO), Arkansas, (2007 through 2019, excluding 2008 and 2009) with those of the larger Mississippi Alluvial Valley Bird Conservation Region (2005 through 2015; from Breeding Bird Surveys [BBS]). Error bars represent 95% confidence intervals.

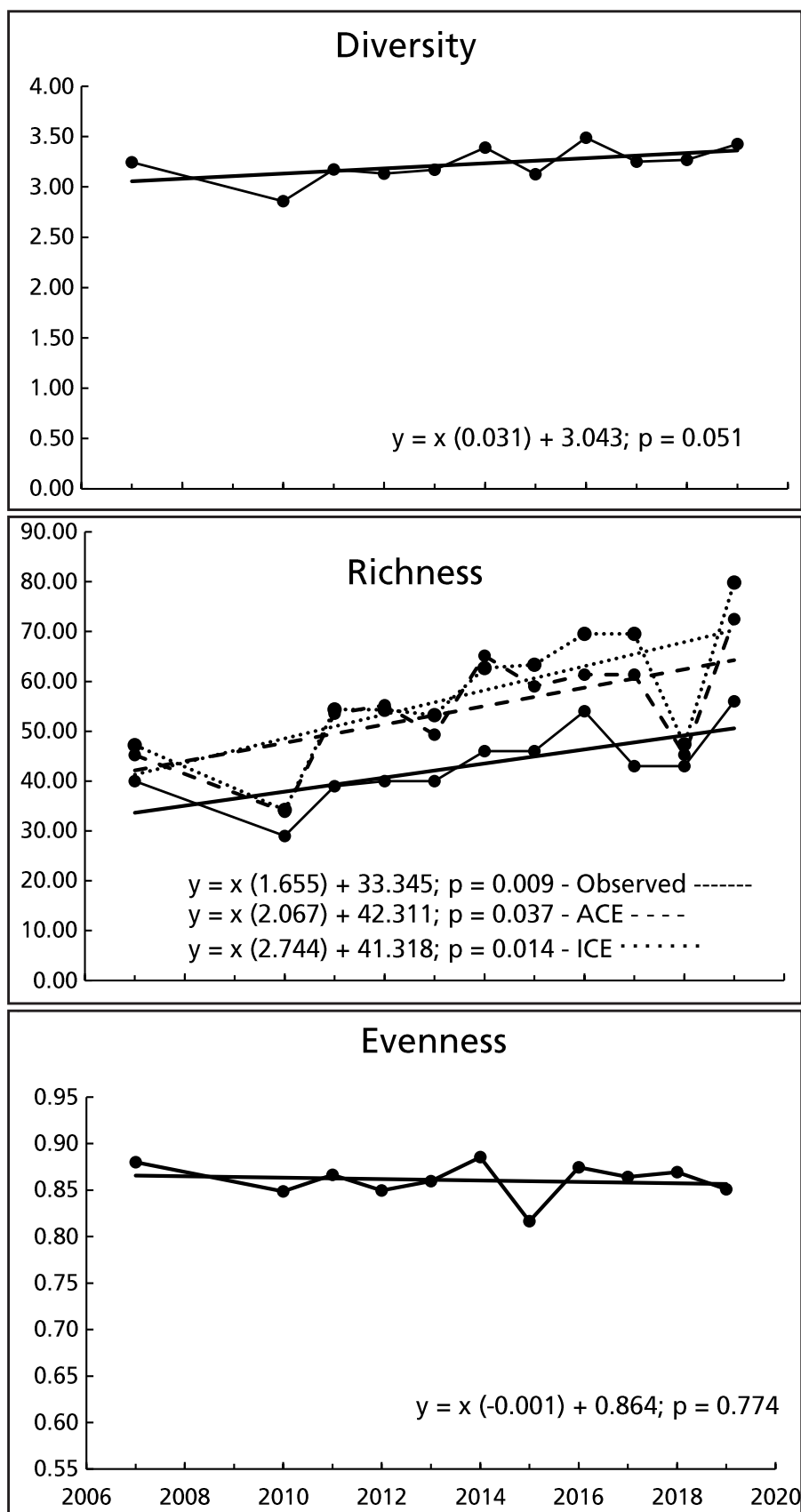


Figure 4. Trends in bird community diversity, richness, and species distribution evenness for Arkansas Post National Memorial, Arkansas, between 2007 and 2019, excluding 2008 and 2009.

Habitat Assessment

When sampled, habitat plots consisted primarily of the woodland type (56–82%), with lesser amounts of other types present (Appendix F). Total canopy cover averaged 63–81% on plots, with cover provided mostly by hardwood trees (62–75%). Basal area of hardwood trees averaged 10.56–21.85 m²/ha, and canopy height averaged 13.07–24.50 m. Hardwood tree species greater than 15.1 cm in diameter from 10 different families contributed primarily to the canopy cover and basal area (Appendix G). However, most of the largest trees occurred in the Fagaceae (oak) family. Canopy cover of conifers averaged 1–6% on plots. Basal area of conifer trees averaged 0.6–1.8 m²/ha, and canopy height averaged 0.8–1.5 m.

Across all plots, the horizontal profile height of vegetation at the time of assessment (mid-May to early-June) was generally below 0.75 m, when sampled (Appendix F). However, it should be noted that horizontal vegetation cover was recorded in all profile height classes to 2.00 m. Average vertical structure diversity estimates across years ranged

from 20–30% for plots. Plots were primarily unvegetated (73–87%) at ground level, with some bare soil (4–18%) exposed (Appendix F). Deciduous litter (40–58%) covered plots, with lesser amounts of grass litter (4–10%), woody debris (<1–10%), conifer litter (<1–4%), and rock (<1–2%) present. Foliar cover on plots was dominated by cool-season grasses (4–18%) and woody shrubs and vines (7–12%), followed by forbs (2–7%), warm-season grasses (<1–7%), tree seedlings (<1–3%), and mosses and lichens (<1–1%; Appendix F). Total foliar coverage averaged 29–39% across plots.

It should be noted that since different numbers of plots were sampled in different years (i.e., 27 in 2011 and 2019; 36 in 2007 and 2015), any patterns in habitat variables over time likely reflect the loss of sampling plots due to flooding in some years rather than actual changes in habitat. The values reported represent reasonable descriptors of habitat present and available to birds during a specific survey year at the group of sites sampled, although they are not directly comparable across years.



Prothonotary Warbler (*Protonotaria citrea*) is a species of conservation concern in the Mississippi Alluvial Valley Bird Conservation Region and lives in riparian woodlands on Arkansas Post National Memorial. NPS

Discussion

Breeding bird surveys that were initiated at Arkansas Post National Memorial in 2007 assist the park in assessing the integrity of habitat through time. During the 11 monitoring years since 2007, 105 bird species were recorded. Ninety-three are permanent or summer residents to the area (James and Neal 1986). Therefore, these 93 species have some value in characterizing the breeding bird community of Arkansas Post National Memorial and the habitat they rely on. These 93 species represent approximately 91% of the breeding species known from the area (James and Neal 1986).

The eight resident species on Arkansas Post National Memorial that are species of conservation concern for the Mississippi Alluvial Valley Bird Conservation Region should be given special consideration in natural resource management decisions. One of these species of conservation concern—the Prothonotary Warbler (*Protonotaria citrea*)—was recorded in sufficient numbers to track trends. The Prothonotary Warbler primarily uses riparian woodland habitat. Therefore, the needs of this species in riparian woodland habitat management decisions should be given additional considerations because we can track the influence of management efforts on its population.

With 71% of the 212 ha of terrestrial vegetation on Arkansas Post National Memorial in various woodland types (Diamond et al. 2015), properly managing woodland habitat for the approximately 32 bird species that breed in it is of high importance. By doing so, management also benefits migrant woodland obligates on the park as well as a host of other species. Six of the eight species of conservation concern occur in the various woodland habitats on the park, with Dickcissel (*Spiza americana*) and Least Bittern (*Ixobrychus exilis*) being the exceptions. Dickcissel requires the ruderal mixed herbaceous/shrubland habitat, and Least Bittern requires the cattail-rush vegetation found on the park. Both

vegetation types occur in lesser amounts on the park than woodland, suggesting the importance of managing for them as well.

Comparing population trends on the park with regional trends for the Mississippi Alluvial Valley Bird Conservation Region (Figure 3) suggests that the bird community at Arkansas Post National Memorial is faring similarly to or better than bird communities in the region as a whole. Eleven species with stable populations region-wide have increasing populations on the park. Three species have stable populations on both the park and within the region. Two species have increasing populations on the park and within the region. Only the Red-winged Blackbird (*Agelaius phoeniceus*) population on the park is declining while remaining stable in the region. Subtle losses in cattails and rushes that bird habitat monitoring did not identify may be driving the decline in Red-winged Blackbirds. Therefore, vegetation management decisions should consider the potential impacts to bird habitat, especially for those species identified as species of conservation concern for the Mississippi Alluvial Valley Bird Conservation Region. However, species once common to the park, such as the Red-winged Blackbird, may need consideration within the broader context of bird conservation when making management decisions.

Over the 13 years of bird monitoring on Arkansas Post National Memorial, the increasing diversity and richness values, along with stable evenness values, suggest that the park's habitat is improving in terms of its ability to meet the needs of more breeding bird species (Figure 4). The habitat currently present provides for the rich array of breeding species seen (average of 43 species observed annually). However, this species-rich community structure could be altered if significant portions of the park's woodlands were removed or if some of the less common habitats were lost.

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Appendix A. Plots Sampled

Table A1. Plots sampled on Arkansas Post National Memorial, Arkansas, between 2007 and 2019 and gross habitat type. “Yes” indicates plot was sampled; “No” indicates it was not.

Plot	2007	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Plot Type
ARPO1	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO3	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO4	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Woodland
ARPO6	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	No	No	Grass/Shrub
ARPO7	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO8	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Woodland
ARPO9	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO10	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO11	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Woodland
ARPO12	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO13	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO14	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO15	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO16	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO17	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO18	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO19	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO20	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO21	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grass/Shrub
ARPO22	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO23	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO24	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO25	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Cultural

Table A1 (continued). Plots sampled on Arkansas Post National Memorial, Arkansas, between 2007 and 2019 and gross habitat type. "Yes" indicates plot was sampled; "No" indicates it was not.

Plot	2007	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Plot Type
ARPO26	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Cultural
ARPO27	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO28	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Woodland
ARPO29	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Grass/Shrub
ARPO30	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Woodland
ARPO31	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Grass/Shrub
ARPO32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Cultural
ARPO33	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Woodland
ARPO34	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Grass/Shrub
ARPO35	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Grass/Shrub
ARPO36	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Woodland

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

Table B1. Annual proportion of plots occupied (includes flyovers) by year and estimated abundance (determined using Distance software) of breeding bird species at Arkansas Post National Memorial, Arkansas, during the 2007 through 2019 (excluding 2008–2009) breeding bird surveys.

Common Name	Proportion of Plots Occupied (Abundance)										
	2007 n=36	2010 n=36	2011 n=27	2012 n=36	2013 n=36	2014 n=36	2015 n=36	2016 n=36	2017 n=27	2018 n=34	2019 n=27
Acadian Flycatcher	0.33 (220)	0 (0)	0.41 (294)	0.11 (74)	0.06 (54)	0.19 (140)	0.11 (68)	0.25 (203)	0.59 (565)	0.17 (162)	0.70 (633)
Blue-gray Gnatcatcher	0.28 (320)	0.08 (86)	0.26 (295)	0.22 (242)	0.08 (78)	0.19 (202)	0.42 (467)	0.25 (246)	0.37 (394)	0.28 (365)	0.48 (426)
Blue Jay	0.11 (39)	0.06 (23)	0.07 (26)	0.14 (64)	0.14 (52)	0.25 (121)	0.14 (59)	0.25 (107)	0.30 (130)	0.25 (134)	0.67 (352)
Brown-headed Cowbird	0.08 (74)	0.22 (142)	0.30 (294)	0.19 (187)	0.39 (312)	0.17 (126)	0.11 (98)	0.28 (392)	0.30 (523)	0.28 (415)	0.67 (621)
Canada Goose	0 (0)	0.06 (39)	0 (0)	0.11 (49)	0 (0)	0 (0)	0.08 (68)	0.06 (23)	0.07 (30)	0 (0)	0.19 (75)
Carolina Wren	0.11 (52)	0.03 (15)	0.30 (174)	0.14 (85)	0.11 (55)	0.44 (228)	0.28 (143)	0.19 (104)	0.37 (243)	0.31 (166)	0.85 (469)
Eastern Wood-pewee	0.33 (67)	0 (0)	0.48 (113)	0.42 (126)	0 (0)	0.08 (19)	0.42 (139)	0.31 (73)	0.56 (194)	0.44 (186)	0.85 (242)
Great Crested Flycatcher	0.08 (31)	0 (0)	0.11 (41)	0 (0)	0.03 (22)	0 (0)	0.39 (154)	0.11 (41)	0.37 (178)	0.17 (76)	0.67 (315)
Indigo Bunting	0.28 (185)	0.28 (174)	0.26 (169)	0.19 (88)	0.25 (232)	0.33 (190)	0.44 (277)	0.31 (173)	0.30 (277)	0.28 (147)	0.26 (138)
Mourning Dove	0.17 (20)	0.11 (12)	0.07 (14)	0.56 (133)	0.14 (27)	0.31 (63)	0.11 (31)	0.31 (92)	0.44 (122)	0.39 (124)	0.33 (82)
Northern Cardinal	0.61 (395)	0.17 (143)	0.52 (345)	0.64 (404)	0.47 (222)	0.50 (330)	0.42 (247)	0.58 (419)	0.63 (510)	0.53 (340)	0.81 (444)
Pileated Woodpecker	0.06 (4)	0.03 (4)	0.26 (34)	0.31 (52)	0.19 (31)	0.33 (45)	0.03 (4)	0.17 (33)	0.30 (53)	0.28 (58)	0.26 (49)

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

Table B1 (continued). Annual proportion of plots occupied (includes flyovers) by year and estimated abundance (determined using Distance software) of breeding bird species at Arkansas Post National Memorial, Arkansas, during the 2007 through 2019 (excluding 2008–2009) breeding bird surveys.

Common Name	Proportion of Plots Occupied (Abundance)										
	2007 n=36	2010 n=36	2011 n=27	2012 n=36	2013 n=36	2014 n=36	2015 n=36	2016 n=36	2017 n=27	2018 n=34	2019 n=27
Prothonotary Warbler*	0.08 (47)	0 (0)	0 (0)	0.14 (85)	0.11 (66)	0.11 (64)	0.06 (31)	0.17 (109)	0.48 (478)	0.11 (116)	0.15 (104)
Red-bellied Woodpecker	0.33 (107)	0.11 (52)	0.26 (95)	0.03 (10)	0.14 (38)	0.19 (73)	0.28 (98)	0.33 (133)	0.52 (225)	0.42 (235)	0.93 (403)
Red-winged Blackbird	0.17 (95)	0.31 (242)	0 (0)	0.11 (52)	0.28 (90)	0.22 (88)	0.14 (38)	0.06 (47)	0 (0)	0.08 (30)	0.04 (13)
Summer Tanager	0.28 (193)	0.03 (19)	0.11 (64)	0.14 (70)	0.19 (119)	0.25 (231)	0.39 (225)	0.28 (273)	0.41 (385)	0.39 (323)	0.37 (257)
Tufted Titmouse	0.22 (82)	0.06 (36)	0.33 (124)	0.08 (34)	0.08 (55)	0.36 (170)	0.39 (175)	0.22 (124)	0.56 (220)	0.25 (164)	0.89 (426)
Yellow-billed Cuckoo	0.33 (64)	0 (0)	0.33 (76)	0.06 (7)	0 (0)	0.33 (92)	0.39 (108)	0.72 (274)	0.81 (373)	0.69 (411)	0.52 (136)

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

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

Table C1. Annual proportion of plots occupied (includes flyovers) by year, and estimated abundance (determined using birds within 100 m of plot center) of breeding bird species at Arkansas Post National Memorial, Arkansas, during the 2007 through 2019 (excluding 2008–09) breeding bird surveys. An en-dash (–) denotes when an annual abundance value could not be calculated because the species was present but the distance measures from observers were beyond the plot perimeter.

Common Name	Proportion of Plots Occupied (Abundance)										
	2007 n=36	2010 n=36	2011 n=27	2012 n=36	2013 n=36	2014 n=36	2015 n=36	2016 n=36	2017 n=27	2018 n=34	2019 n=27
American Coot	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.14 (8)	0 (0)	0 (0)	0.26 (25)	0.06 (11)	0 (0)
American Crow	0.06 (3)	0.11 (–)	0 (0)	0.17 (3)	0.14 (11)	0 (0)	0 (0)	0.11 (11)	0.04 (4)	0.14 (9)	0.19 (–)
American Goldfinch	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (4)
American Kestrel	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
American Redstart	0.03 (3)	0 (0)	0.15 (14)	0 (0)	0.03 (3)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0.04 (4)
American Robin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)
Anhinga	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (–)	0.03 (–)	0 (0)	0 (0)	0 (0)	0 (0)
Bachman's Sparrow	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Bald Eagle*	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (–)	0 (0)	0 (0)	0.03 (3)	0.07 (4)	0 (0)	0.04 (–)
Baltimore Oriole	0 (0)	0.06 (–)	0 (0)	0.03 (3)	0.22 (24)	0.22 (27)	0.08 (11)	0.14 (19)	0.04 (7)	0.19 (29)	0.19 (18)
Barn Swallow	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Barred Owl	0 (0)	0 (0)	0.04 (–)	0.03 (–)	0 (0)	0.03 (3)	0 (0)	0 (0)	0.04 (4)	0.03 (6)	0.04 (7)
Black and White Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0.03 (3)	0.04 (4)	0 (0)	0 (0)

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

Table C1 (continued). Annual proportion of plots occupied (includes flyovers) by year, and estimated abundance (determined using birds within 100 m of plot center) of breeding bird species at Arkansas Post National Memorial, Arkansas, during the 2007 through 2019 (excluding 2008–09) breeding bird surveys. An en-dash (–) denotes when an annual abundance value could not be calculated because the species was present but the distance measures from observers were beyond the plot perimeter.

Common Name	Proportion of Plots Occupied (Abundance)										
	2007 n=36	2010 n=36	2011 n=27	2012 n=36	2013 n=36	2014 n=36	2015 n=36	2016 n=36	2017 n=27	2018 n=34	2019 n=27
Black-crowned Night-heron	0.03 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Black Vulture	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Blue Grosbeak	0 (0)	0 (0)	0 (0)	0 (0)	0.08 (19)	0 (0)	0.03 (3)	0.03 (5)	0 (0)	0 (0)	0.04 (4)
Brown Thrasher	0 (0)	0.06 (5)	0 (0)	0.03 (3)	0.03 (–)	0.14 (14)	0 (0)	0.08 (8)	0 (0)	0.06 (–)	0.04 (4)
Carolina Chickadee	0.17 (16)	0 (0)	0.04 (4)	0.17 (11)	0 (0)	0.08 (11)	0 (0)	0.28 (38)	0 (0)	0.08 (9)	0.30 (40)
Cattle Egret	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (14)	0 (0)	0 (0)	0 (0)
Chimney Swift	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (–)	0 (0)	0 (0)	0 (0)	0.04 (–)
Chipping Sparrow	0 (0)	0.14 (24)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.06 (8)	0 (0)	0 (0)	0 (0)
Common Grackle	0 (0)	0.14 (51)	0.04 (–)	0.03 (3)	0 (0)	0 (0)	0.08 (3)	0 (0)	0.15 (7)	0 (0)	0 (0)
Common Moorhen	0.06 (–)	0 (0)	0 (0)	0.11 (–)	0.06 (3)	0.06 (5)	0 (0)	0.03 (–)	0.04 (4)	0.06 (6)	0 (0)
Common Yellowthroat	0.03 (3)	0.06 (5)	0 (0)	0 (0)	0.03 (3)	0.03 (3)	0.11 (14)	0.03 (5)	0 (0)	0.08 (9)	0.04 (4)
Dickcissel*	0.14 (22)	0.06 (5)	0 (0)	0 (0)	0.03 (–)	0.03 (3)	0 (0)	0.03 (3)	0 (0)	0.03 (3)	0 (0)
Downy Woodpecker	0 (0)	0 (0)	0.07 (7)	0.06 (5)	0.03 (3)	0.03 (3)	0.03 (3)	0.08 (11)	0.04 (4)	0 (0)	0.19 (18)
Eastern Bluebird	0.06 (5)	0 (0)	0.04 (4)	0 (0)	0 (0)	0.03 (3)	0 (0)	0.06 (5)	0 (0)	0 (0)	0 (0)

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

Table C1 (continued). Annual proportion of plots occupied (includes flyovers) by year, and estimated abundance (determined using birds within 100 m of plot center) of breeding bird species at Arkansas Post National Memorial, Arkansas, during the 2007 through 2019 (excluding 2008–09) breeding bird surveys. An en-dash (–) denotes when an annual abundance value could not be calculated because the species was present but the distance measures from observers were beyond the plot perimeter.

Common Name	Proportion of Plots Occupied (Abundance)										
	2007 n=36	2010 n=36	2011 n=27	2012 n=36	2013 n=36	2014 n=36	2015 n=36	2016 n=36	2017 n=27	2018 n=34	2019 n=27
Eastern Kingbird	0.06 (–)	0 (0)	0 (0)	0.03 (3)	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (4)
Eastern Meadowlark	0.03 (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Eastern Phoebe	0 (0)	0 (0)	0 (0)	0.03 (3)	0.11 (14)	0.14 (16)	0 (0)	0.14 (14)	0.04 (4)	0 (0)	0.07 (7)
Eastern Towhee	0.06 (5)	0 (0)	0.04 (4)	0 (0)	0.03 (5)	0 (0)	0.03 (3)	0.03 (3)	0 (0)	0.11 (14)	0 (0)
European Starling	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (4)	0 (0)	0 (0)
Fish Crow	0 (0)	0 (0)	0.11 (–)	0.03 (3)	0.03 (–)	0.03 (–)	0 (0)	0.06 (5)	0 (0)	0 (0)	0.15 (–)
Gray Catbird	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0.03 (3)	0 (0)	0 (0)	0 (0)	0.06 (6)	0.04 (4)
Great Blue Heron	0 (0)	0.06 (–)	0.04 (–)	0 (0)	0.08 (–)	0 (0)	0.06 (–)	0.08 (8)	0.11 (–)	0.03 (–)	0.11 (–)
Great Egret	0.06 (–)	0.17 (3)	0.11 (–)	0.36 (–)	0.31 (–)	0.14 (–)	0.11 (–)	0.28 (49)	0.44 (–)	0.08 (–)	0.07 (–)
Great Horned Owl	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (–)	0 (0)	0 (0)
Hairy Woodpecker	0.03 (5)	0 (0)	0.07 (7)	0 (0)	0.06 (5)	0 (0)	0.06 (5)	0 (0)	0 (0)	0.14 (14)	0.07 (7)
Hooded Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)
House Sparrow	0 (0)	0 (0)	0 (0)	0.03 (–)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
House Wren	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Kentucky Warbler*	0.06 (5)	0 (0)	0.15 (14)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0.15 (14)	0 (0)

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

Table C1 (continued). Annual proportion of plots occupied (includes flyovers) by year, and estimated abundance (determined using birds within 100 m of plot center) of breeding bird species at Arkansas Post National Memorial, Arkansas, during the 2007 through 2019 (excluding 2008–09) breeding bird surveys. An en-dash (–) denotes when an annual abundance value could not be calculated because the species was present but the distance measures from observers were beyond the plot perimeter.

Common Name	Proportion of Plots Occupied (Abundance)										
	2007 n=36	2010 n=36	2011 n=27	2012 n=36	2013 n=36	2014 n=36	2015 n=36	2016 n=36	2017 n=27	2018 n=34	2019 n=27
Killdeer	0 (0)	0 (0)	0.04 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
King Rail	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (7)
Least Tern	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (5)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Little Blue Heron	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0.03 (–)	0.03 (3)	0.07 (–)	0 (0)	0 (0)
Loggerhead Shrike	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (4)
Mallard	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Mississippi Kite	0 (0)	0.03 (3)	0 (0)	0 (0)	0.06 (3)	0.03 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (–)
Northern Bobwhite	0 (0)	0 (0)	0.04 (–)	0 (0)	0 (0)	0 (0)	0.08 (8)	0.08 (19)	0 (0)	0 (0)	0.04 (4)
Northern Mockingbird	0.31 (19)	0.08 (8)	0.11 (7)	0.14 (14)	0.08 (5)	0.11 (14)	0.03 (3)	0.11 (11)	0.07 (4)	0.08 (9)	0.11 (7)
Northern Parula	0.19 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0.03 (3)	0.07 (7)	0.11 (9)	0.19 (18)
Orchard Oriole*	0.03 (–)	0 (0)	0.07 (7)	0.08 (8)	0.11 (14)	0.11 (11)	0 (0)	0.11 (11)	0.04 (4)	0.03 (3)	0 (0)
Pied-billed Grebe	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.08 (3)	0 (0)	0.03 (3)	0.04 (4)	0.06 (6)	0 (0)
Pine Warbler	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0.03 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Purple Gallinule	0 (0)	0 (0)	0 (0)	0.03 (–)	0 (0)	0 (0)	0 (0)	0.08 (16)	0 (0)	0.09 (11)	0.04 (4)
Purple Martin	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (4)	0 (0)	0 (0)

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

Table C1 (continued). Annual proportion of plots occupied (includes flyovers) by year, and estimated abundance (determined using birds within 100 m of plot center) of breeding bird species at Arkansas Post National Memorial, Arkansas, during the 2007 through 2019 (excluding 2008–09) breeding bird surveys. An en-dash (–) denotes when an annual abundance value could not be calculated because the species was present but the distance measures from observers were beyond the plot perimeter.

Common Name	Proportion of Plots Occupied (Abundance)										
	2007 n=36	2010 n=36	2011 n=27	2012 n=36	2013 n=36	2014 n=36	2015 n=36	2016 n=36	2017 n=27	2018 n=34	2019 n=27
Red-eyed Vireo	0.03 (3)	0 (0)	0.04 (4)	0 (0)	0 (0)	0.03 (3)	0.06 (5)	0.06 (8)	0.15 (14)	0.03 (3)	0.22 (29)
Red-headed Woodpecker*	0 (0)	0 (0)	0.04 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (4)	0 (0)	0.19 (22)
Red-shouldered Hawk	0 (0)	0 (0)	0 (0)	0.03 (–)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (4)
Red-tailed Hawk	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)	0.03 (–)	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)
Ruby-throated Hummingbird	0 (0)	0.14 (11)	0.07 (7)	0.28 (35)	0 (0)	0.22 (11)	0.11 (11)	0.03 (19)	0.07 (4)	0 (0)	0.11 (11)
Turkey Vulture	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (–)	0 (0)	0 (0)	0 (0)	0 (0)
Warbling Vireo	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0.11 (11)
White-breasted Nuthatch	0 (0)	0 (0)	0.04 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (7)
White-eyed Vireo	0.06 (5)	0 (0)	0.04 (4)	0 (0)	0 (0)	0 (0)	0.14 (14)	0.06 (5)	0.11 (11)	0 (0)	0.26 (33)
Wild Turkey	0 (0)	0 (0)	0.04 (–)	0.03 (–)	0 (0)	0 (0)	0 (0)	0.03 (3)	0 (0)	0 (0)	0 (0)
Wood Duck	0 (0)	0.06 (–)	0 (0)	0.06 (–)	0 (0)	0.03 (–)	0.03 (–)	0.03 (5)	0 (0)	0 (0)	0.04 (4)
Wood Thrush*	0 (0)	0 (0)	0.07 (7)	0 (0)	0 (0)	0.03 (3)	0.08 (14)	0.31 (35)	0.48 (76)	0.11 (14)	0.26 (22)
Yellow-breasted Chat	0.19 (16)	0 (0)	0 (0)	0 (0)	0.03 (3)	0.08 (8)	0.22 (30)	0.11 (19)	0.33 (54)	0.11 (11)	0.04 (4)
Yellow-throated Vireo	0.17 (16)	0 (0)	0.04 (4)	0 (0)	0 (0)	0 (0)	0.06 (5)	0 (0)	0 (0)	0 (0)	0.11 (11)

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

Appendix D. Park Trends

Table D1. Trends, annual change in abundance (individuals), of breeding birds recorded on Arkansas Post National Memorial, Arkansas, from 2007 through 2019.

Common Name	Trend ^A	SE of Slope	Trend Classification ^B
Acadian Flycatcher	1.07	0.03	Moderate Increase
Blue-gray Gnatcatcher	1.11	0.04	Moderate Increase
Blue Jay	1.26	0.07	Strong Increase
Brown-headed Cowbird	1.12	0.06	Uncertain
Canada Goose	–	–	–
Carolina Wren	1.23	0.10	Moderate Increase
Eastern Wood-pewee	1.09	0.03	Moderate Increase
Great Crested Flycatcher	1.21	0.05	Strong Increase
Indigo Bunting	1.03	0.03	Uncertain
Mourning Dove	1.13	0.05	Moderate Increase
Northern Cardinal	1.05	0.02	Moderate Increase
Pileated Woodpecker	1.17	0.13	Uncertain
Prothonotary Warbler^C	1.22	0.09	Moderate Increase
Red-bellied Woodpecker	1.20	0.07	Strong Increase
Red-winged Blackbird	0.85	0.05	Steep Decline
Summer Tanager	1.21	0.13	Uncertain
Tufted Titmouse	1.21	0.05	Strong Increase
Yellow-billed Cuckoo	1.22	0.05	Strong Increase

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

^B Trend classification types depending on statistical significance and magnitude (Pannekoek and Van Strien 2005; Van Strien et al. 2001) and following Gregory et. al. (2007). The multiplicative overall slope estimate in TRIM was converted into one of the following categories depending on the overall slope as well as its 95% confidence interval (= slope $\pm$ 1.96 times the standard error of the slope): Strong increase—increase significantly more than 5% per year. Criterion: lower limit of confidence interval > 1.05. Moderate increased—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—significantly more than 5% per year. Criterion: upper limit of confidence interval < 0.95.

^C Species of conservation concern for the Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

Appendix E. Regional Trends

Table E1. Regional trends in breeding birds recorded on Arkansas Post National Memorial, Arkansas, for years 2005 through 2015. Regional trend data from Breeding Bird Surveys (BBS; Sauer et al. 2017).

Common Name	Trend	95% Confidence Interval	
		Lower	Upper
Acadian Flycatcher	4.00	-0.71	8.83
American Coot	–	–	–
American Crow	2.05	0.23	3.85
American Goldfinch	-13.81	-25.43	-0.26
American Kestrel	3.65	-0.15	8.18
American Redstart	7.79	-13.82	34.28
American Robin	0.75	-1.72	2.95
Anhinga	12.27	5.16	23.74
Bachman's Sparrow	–	–	–
Bald Eagle^A	44.88	16.20	75.70
Baltimore Oriole	-1.78	-4.64	1.17
Barn Swallow	2.97	1.06	5.00
Barred Owl	2.50	-2.71	6.30
Black-and-white Warbler	-0.65	-13.96	13.25
Black-crowned Night-Heron	0.39	-16.78	11.77
Black Vulture	4.25	-6.34	16.67
Blue-gray Gnatcatcher	0.84	-2.48	3.91
Blue Grosbeak	5.67	3.14	8.34
Blue Jay	0.31	-0.86	1.79
Brown-headed Cowbird	0.68	-1.98	3.29
Brown Thrasher	-0.42	-2.54	2.28
Canada Goose	18.01	-12.00	41.00
Carolina Chickadee	-0.92	-3.13	1.07
Carolina Wren	1.44	-0.22	3.07
Cattle Egret	0.42	-4.65	6.06
Chimney Swift	-1.47	-3.70	1.02
Chipping Sparrow	9.01	0.04	17.75
Common Grackle	-3.57	-5.21	-2.02
Common Moorhen	–	–	–
Common Yellowthroat	-4.21	-6.32	-2.15
Dickcissel^A	2.42	0.17	5.30
Downy Woodpecker	0.04	-2.61	2.50
Eastern Bluebird	1.88	-1.74	4.69

^A Species of conservation concern for the Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

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

Table E1 (continued). Regional trends in breeding birds recorded on Arkansas Post National Memorial, Arkansas, for years 2005 through 2015. Regional trend data from Breeding Bird Surveys (BBS; Sauer et al. 2017).

Common Name	Trend	95% Confidence Interval	
		Lower	Upper
Eastern Kingbird	-1.26	-3.27	0.79
Eastern Meadowlark	-5.02	-7.65	-2.98
Eastern Phoebe	0.31	-4.67	4.22
Eastern Towhee	0.71	-1.11	2.63
Eastern Wood-Pewee	2.03	-1.89	5.35
European Starling	-1.63	-3.49	0.25
Fish Crow	-0.86	-5.76	3.42
Grasshopper Sparrow ^B	-1.34	-8.28	4.04
Gray Catbird	6.12	-0.47	15.02
Great Blue Heron	5.46	-3.13	14.57
Great Crested Flycatcher	0.89	-1.68	3.17
Great Egret	8.43	3.01	14.74
Great Horned Owl	12.46	-3.02	36.90
Green Heron ^B	-0.18	-3.25	2.57
Hairy Woodpecker	-1.63	-5.83	3.05
Hooded Warbler	-0.06	-7.87	5.54
House Sparrow	-3.73	-5.14	-2.08
House Wren	–	–	–
Indigo Bunting	1.17	-0.40	2.77
Kentucky Warbler^A	1.31	-2.32	6.39
Killdeer	2.62	1.05	4.39
King Rail	-6.36	-42.03	48.85
Least Bittern ^B	–	–	–
Least Tern	13.16	-12.87	43.62
Little Blue Heron	-0.99	-4.30	3.39
Loggerhead Shrike	-0.88	-3.04	1.72
Mallard	6.89	-2.79	20.08
Mississippi Kite	5.61	2.31	9.46
Mourning Dove	1.67	0.19	3.19
Northern Bobwhite	-5.34	-7.59	-3.38
Northern Cardinal	0.93	-0.05	2.08
Northern Mockingbird	-0.14	-1.10	0.94
Northern Parula	-1.90	-4.31	1.68
Orchard Oriole^A	-2.83	-4.55	-0.98
Pied-billed Grebe	7.46	-9.21	29.21

^A Species of conservation concern for the Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

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

Table E1 (continued). Regional trends in breeding birds recorded on Arkansas Post National Memorial, Arkansas, for years 2005 through 2015. Regional trend data from Breeding Bird Surveys (BBS; Sauer et al. 2017).

Common Name	Trend	95% Confidence Interval	
		Lower	Upper
Pileated Woodpecker	1.54	-1.09	4.49
Pine Warbler	-8.02	-14.57	-1.05
Prothonotary Warbler^A	-0.96	-3.78	2.12
Purple Gallinule	–	–	–
Purple Martin	-1.10	-3.42	1.06
Red-bellied Woodpecker	2.00	0.27	3.76
Red-eyed Vireo	-2.71	-6.94	1.25
Red-headed Woodpecker^A	-0.50	-5.27	3.15
Red-shouldered Hawk	2.02	-0.90	5.61
Red-tailed Hawk	4.81	0.58	8.32
Red-winged Blackbird	0.26	-2.14	2.73
Ruby-throated Hummingbird	-0.41	-5.75	5.92
Summer Tanager	2.64	-0.75	7.07
Tufted Titmouse	1.70	-0.47	3.57
Turkey Vulture	7.40	3.33	12.44
Warbling Vireo	2.43	-2.39	11.68
White-breasted Nuthatch	1.42	-16.33	15.51
White-eyed Vireo	-0.53	-2.67	1.83
Wild Turkey	9.01	-5.12	31.24
Wood Duck	1.05	-2.72	5.23
Wood Thrush^A	-1.67	-4.89	1.69
Yellow-billed Cuckoo	-0.38	-2.09	1.60
Yellow-breasted Chat	-1.70	-3.97	0.50
Yellow-throated Vireo	1.93	-2.34	6.73
Yellow-throated Warbler ^B	9.99	-1.81	32.71

^A Species of conservation concern for the Mississippi Alluvial Valley Bird Conservation Region (U.S. Fish and Wildlife Service 2008; also in bold).

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

Appendix F. Habitat Parameters

Tables F1 through F3 show the averages for habitat parameters in three different sized plots in the habitat at Arkansas Post National Memorial, Arkansas, during the bird breeding seasons in 2007, 2011, 2015, and 2019.

Table F1. Average percent cover ($\pm$ std dev) of each habitat type in 50-m-radius plots at Arkansas Post National Memorial, Arkansas, during the bird breeding seasons in 2007, 2011, 2015, and 2019. 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	2007	2011	2015	2019
Lawn (%)	4.22 ($\pm$ 17.32)	10.48 ($\pm$ 27.88)	6.33 ($\pm$ 19.87)	8.63 ($\pm$ 26.61)
Field/Prairie (%)	20.11 ($\pm$ 37.52)	10.72 ($\pm$ 28.48)	15.01 ($\pm$ 30.14)	3.85 ($\pm$ 16.48)
Shrub (%)	2.71 ($\pm$ 16.25)	0	6.53 ($\pm$ 14.63)	1.39 ($\pm$ 7.22)
Woodland (%)	56.39 ($\pm$ 42.31)	74.85 ($\pm$ 36.40)	62.61 ($\pm$ 41.34)	82.33 ($\pm$ 30.89)
Trail (%)	0.11 ($\pm$ 0.51)	1.37 ($\pm$ 4.01)	0.08 ($\pm$ 0.50)	0.46 ($\pm$ 1.08)
Pasture road (%)	0.28 ($\pm$ 0.84)	0.11 ($\pm$ 0.58)	0.42 ($\pm$ 2.50)	0.11 ($\pm$ 0.58)
Paved road (%)	0.61 ($\pm$ 2.56)	1.04 ($\pm$ 2.99)	0.94 ($\pm$ 2.66)	1.28 ($\pm$ 4.00)
Pond (%)	0.97 ($\pm$ 0.50)	0.35 ($\pm$ 0.96)	2.24 ($\pm$ 10.64)	0.02 ($\pm$ 0.10)
Stream (%)	0.10 ($\pm$ 0.50)	0.13 ($\pm$ 0.58)	0	2.54 ($\pm$ 8.05)

Table F2. 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-radius subplots in the habitat at Arkansas Post National Memorial, Arkansas, during the bird breeding seasons in 2007, 2011, 2015, and 2019. 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	2007	2011	2015	2019
Canopy cover	Hardwood (%)	61.84 ($\pm$ 43.51)	75.26 ($\pm$ 36.24)	64.70 ($\pm$ 39.94)	75.01 ($\pm$ 25.44)
	Conifer (%)	1.48 ($\pm$ 7.07)	5.80 ($\pm$ 19.71)	2.51 ($\pm$ 15.08)	1.60 ($\pm$ 5.69)
	Total cover (%)	63.32 ($\pm$ 43.78)	80.83 ($\pm$ 33.69)	67.20 ($\pm$ 39.06)	76.61 ($\pm$ 25.45)
Canopy height	Hardwood (m)	13.07 ($\pm$ 11.17)	20.67 ($\pm$ 8.53)	24.50 ($\pm$ 13.73)	18.11 ($\pm$ 11.75)
	Conifer (m)	1.51 ($\pm$ 4.58)	1.49 ($\pm$ 3.78)	0.83 ($\pm$ 5.00)	1.37 ($\pm$ 5.08)
Basal area	Hardwood (m ² /ha)	14.10 ($\pm$ 12.41)	21.85 ($\pm$ 12.47)	10.56 ($\pm$ 8.35)	19.44 ($\pm$ 9.79)
	Conifer (m ² /ha)	0.56 ($\pm$ 1.80)	1.76 ($\pm$ 4.03)	0.49 ($\pm$ 1.77)	0.83 ($\pm$ 3.02)
	Total (m ² /ha)	14.65 ($\pm$ 12.88)	23.61 ($\pm$ 12.21)	11.04 ($\pm$ 8.27)	20.28 ($\pm$ 9.74)
Horizontal vegetation profile—measured at 15 m north of plot center (percent cover at different height increments)	0.00–0.25 m (%)	–	68.41 ($\pm$ 37.84)	64.53 ($\pm$ 40.31)	76.31 ($\pm$ 26.45)
	0.00–0.50 m (%)	75.43 ($\pm$ 33.32)	–	–	–
	0.25–0.50 m (%)	–	50.24 ($\pm$ 42.92)	43.11 ($\pm$ 43.43)	52.96 ($\pm$ 39.25)
	0.25–0.75 m (%)	66.97 ($\pm$ 40.73)	–	–	–
	0.50–0.75 m (%)	–	29.50 ($\pm$ 38.61)	29.50 ($\pm$ 38.19)	34.56 ($\pm$ 33.70)
	0.50–1.00 m (%)	50.59 ($\pm$ 42.39)	–	–	–
	0.75–1.00 m (%)	–	26.24 ($\pm$ 36.35)	25.19 ($\pm$ 35.50)	25.63 ($\pm$ 32.10)
	0.75–1.25 m (%)	40.53 ($\pm$ 41.33)	–	–	–
	1.00–1.25 m (%)	–	30.04 ($\pm$ 39.95)	21.86 ($\pm$ 33.76)	27.80 ($\pm$ 34.26)
	1.00–1.50 m (%)	39.74 ($\pm$ 39.86)	–	–	–
	1.25–1.50 m (%)	–	30.22 ($\pm$ 39.21)	30.46 ($\pm$ 37.63)	35.13 ($\pm$ 34.49)
	1.25–1.75 m (%)	37.49 ($\pm$ 40.89)	–	–	–
	1.50–1.75 m (%)	–	35.37 ($\pm$ 39.54)	20.78 ($\pm$ 35.22)	30.46 ($\pm$ 37.42)
	1.50–2.00 m (%)	34.87 ($\pm$ 40.22)	–	–	–
	1.75–2.00 m (%)	–	39.13 ($\pm$ 41.57)	19.40 ($\pm$ 36.07)	37.26 ($\pm$ 38.10)
Vertical structure diversity (%)	n/a	23.98 ($\pm$ 13.73)	19.91 ($\pm$ 9.83)	28.99 ($\pm$ 16.47)	34.14 ($\pm$ 15.33)

Table F3. Average ($\pm$ std dev) percent of soil substrate cover and plant guild cover in 1.78-m-radius sample plots in habitat at Arkansas Post National Memorial, Arkansas, during the bird breeding seasons in 2007, 2011, 2015, and 2019. 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	2007	2011	2015	2019
Deciduous litter (%)	40.15 ($\pm$ 32.71)	54.07 ($\pm$ 34.37)	42.93 ($\pm$ 39.54)	58.74 ($\pm$ 30.91)
Conifer litter (%)	0.08 (0.50)	1.48 (7.20)	4.11 (17.34)	3.19 (16.35)
Grass litter (%)	8.83 ($\pm$ 13.92)	9.06 ($\pm$ 20.24)	3.86 ($\pm$ 6.10)	10.30 ($\pm$ 22.37)
Bare soil (%)	17.14 ($\pm$ 18.36)	3.80 ($\pm$ 8.18)	9.17 ($\pm$ 17.82)	17.93 ($\pm$ 23.59)
Rock (%)	0.17 ($\pm$ 0.70)	0	1.74 ($\pm$ 10.42)	0
Woody debris (%)	0.53 ($\pm$ 0.92)	9.48 ($\pm$ 11.56)	8.32 ($\pm$ 9.74)	4.61 ($\pm$ 5.17)
Unvegetated (%)	86.88 ($\pm$ 8.09)	78.80 ($\pm$ 16.75)	73.07 ($\pm$ 29.62)	85.93 ($\pm$ 15.55)
Warm-season grass (%)	0.47 ($\pm$ 0.95)	6.96 ($\pm$ 20.01)	1.56 ($\pm$ 6.66)	2.32 ($\pm$ 12.03)
Cool-season grass (%)	6.96 ($\pm$ 12.48)	3.50 ($\pm$ 8.25)	13.99 ($\pm$ 18.25)	17.52 ($\pm$ 24.40)
Forb (%)	7.20 ($\pm$ 10.70)	1.78 ($\pm$ 3.94)	5.93 ($\pm$ 10.63)	5.56 ($\pm$ 10.58)
Moss and lichen (%)	0.17 ($\pm$ 0.71)	0.82 ($\pm$ 2.90)	0.97 ($\pm$ 2.61)	0.56 ($\pm$ 0.91)
Woody shrub and vine (%)	6.94 ($\pm$ 11.09)	12.22 ($\pm$ 18.59)	7.78 ($\pm$ 14.11)	11.78 ($\pm$ 15.50)
Tree seedling (%)	0.71 ($\pm$ 2.50)	0.94 ($\pm$ 1.14)	0.22 ($\pm$ 0.25)	2.87 ($\pm$ 5.22)
Total foliar (%)	36.44 ($\pm$ 19.44)	28.61 ($\pm$ 26.30)	28.85 ($\pm$ 26.58)	38.94 ($\pm$ 33.07)

Appendix G. Trees Found on Arkansas Post National Memorial

Table G1. Stems per hectare of trees found on Arkansas Post National Memorial, Arkansas, by size class in the 2007, 2011, 2015, and 2019 bird breeding seasons. Stems per hectare of trees are reported by family.

Stem Size Class (cm diameter)	Family	2007	2011	2015	2019
<1.0 cm	Aceraceae	0	0	14	0
	Annonaceae	0	0	0	5
	Aquifoliaceae	0	0	28	0
	Cornaceae	0	9	0	9
	Cupressaceae	0	0	0	5
	Ebenaceae	0	9	4	24
	Fabaceae	32	0	0	0
	Fagaceae	35	0	18	28
	Hippocastanaceae	0	5	0	5
	Juglandaceae	0	0	64	0
	Rosaceae	35	0	0	19
	Rutaceae	0	660	0	0
	Snag	0	0	7	5
	Ulmaceae	42	19	88	160
	Verbenaceae	0	307	57	0
1.1–2.5 cm	Aceraceae	0	0	95	0
	Aquifoliaceae	0	0	4	9
	Araliaceae	0	0	0	5
	Cornaceae	0	9	7	14
	Cupressaceae	0	0	4	0
	Ebenaceae	14	19	53	0
	Fabaceae	21	9	4	0
	Fagaceae	0	14	21	14
	Hamamelidaceae	0	5	0	5
	Hippocastanaceae	0	0	0	0
	Juglandaceae	11	0	35	0
	Lauraceae	0	0	4	0
	Oleaceae	11	0	7	0
	Rhamnaceae	4	0	0	0
	Rosaceae	67	0	7	9
	Snag	4	5	0	14
	Ulmaceae	50	52	32	118
	Verbenaceae	0	0	50	0

Table G1 (continued). Stems per hectare of trees found on Arkansas Post National Memorial, Arkansas, by size class in the 2007, 2011, 2015, and 2019 bird breeding seasons. Stems per hectare of trees are reported by family.

Stem Size Class (cm diameter)	Family	2007	2011	2015	2019
2.6–8.0 cm	Aceraceae	0	0	78	0
	Aquifoliaceae	0	5	32	14
	Betulaceae	0	5	0	0
	Cornaceae	0	24	21	42
	Cupressaceae	4	9	0	0
	Ebenaceae	14	38	42	19
	Fabaceae	11	5	0	9
	Fagaceae	0	42	18	52
	Hamamelidaceae	25	24	35	9
	Juglandaceae	14	0	0	0
	Oleaceae	21	5	7	0
	Platanaceae	4	0	0	0
	Rhamnaceae	7	0	0	0
	Rosaceae	25	0	0	0
	Snag	11	38	25	42
	Ulmaceae	64	137	177	231
	Verbenaceae	0	5	0	0
8.1–15.0 cm	Cupressaceae	21	19	11	14
	Ebenaceae	0	14	21	0
	Fabaceae	4	5	4	9
	Fagaceae	11	9	25	28
	Hamamelidaceae	25	19	46	19
	Juglandaceae	4	0	0	0
	Oleaceae	7	0	0	0
	Platanaceae	4	0	0	0
	Rhamnaceae	4	0	4	0
	Rosaceae	0	0	4	0
	Snag	7	5	14	24
	Ulmaceae	39	85	50	71
15.1–23.0 cm	Aceraceae	4	0	0	0
	Cupressaceae	14	5	11	9
	Ebenaceae	7	0	0	0
	Fabaceae	7	9	0	9
	Fagaceae	7	14	7	19
	Hamamelidaceae	4	42	4	14
	Juglandaceae	0	5	0	0
	Snag	4	0	7	9
	Ulmaceae	25	52	21	52

Table G1 (continued). Stems per hectare of trees found on Arkansas Post National Memorial, Arkansas, by size class in the 2007, 2011, 2015, and 2019 bird breeding seasons. Stems per hectare of trees are reported by family.

Stem Size Class (cm diameter)	Family	2007	2011	2015	2019
23.1–38.0 cm	Cupressaceae	11	9	4	9
	Ebenaceae	4	5	4	0
	Fabaceae	0	5	4	5
	Fagaceae	7	9	7	19
	Hamamelidaceae	4	9	7	0
	Juglandaceae	0	0	4	5
	Oleaceae	4	0	0	0
	Pinaceae	0	5	0	0
	Snag	4	9	0	0
	Ulmaceae	18	24	14	9
>38.0 cm	Cupressaceae	4	0	4	0
	Ebenaceae	0	5	0	0
	Fagaceae	14	57	21	52
	Juglandaceae	7	5	0	0
	Oleaceae	4	0	0	0
	Pinaceae	0	0	4	5
	Rosaceae	7	0	0	0
	Snag	0	0	7	0
	Ulmaceae	0	5	7	0

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