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Bird Monitoring at Arkansas Post National Memorial, Arkansas: 2007 Status Report

Natural Resource Technical Report NPS/HTLN/NRTR—2008/099

ON THE COVER
Great egret (*Casmerodius albus*).
Photo taken by Jennifer L. Haack, NPS

Bird Monitoring at Arkansas Post National Memorial, Arkansas: 2007 Status Report

Natural Resource Technical Report NPS/HTLN/NRTR—2008/099

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May 2008

U.S. Department of the Interior
National Park Service
Natural Resource Program Center
Fort Collins, Colorado

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Please cite this publication as:

Peitz, D.G. 2008. Bird Monitoring at Arkansas Post National Memorial, Arkansas: 2007 Status Report. Natural Resource Technical Report NPS/HTLN/NRTR—2008/099. National Park Service, Fort Collins, Colorado.

NPS D-46, May 2008

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Executive Summary

During 2007, the Heartland I&M Network and Prairie Cluster Prototype Monitoring Program (HTLN) initiated breeding bird surveys on 36 plots at Arkansas Post National Memorial, Arkansas (ARPO) to address two objectives. The first is to monitor change in bird community composition and abundance. The second is to monitor the response of bird communities to change in habitat structure and other habitat variables related to management activities. This report provides baseline information on populations and breeding habitat of birds at ARPO, as well as population information and habitat conditions that should help in managing and interpreting natural resources of the park.

Forty-one of the forty-two bird species recorded during the breeding bird surveys are permanent or summer residents. The diverse mix of habitat found positively influenced the number of species observed. Partners in Flight, a coalition of agencies and individuals whose mission is to conserve North America's declining bird populations, classify eleven species as species of continental importance. Although the diverse mix of habitat provides potentially satisfactory habitat for all the birds of continental importance recorded and most other bird species, some of this habitat is relatively rare. Baseline data suggests that the Bachman's sparrow, Eastern towhee, Kentucky warbler, Prothonotary warbler, and White-eyed vireo may occur so infrequently that it will be difficult to assess the influence of habitat management actions on their numbers.

The Northern cardinal was the most common breeding species. The Dickcissel, a grassland obligate, was the most abundant species on plots, occupying field/prairie habitat. Management decisions aimed at influencing bird populations should focus on those identified as species of local or continental importance with consideration given to the more common species such as the Northern cardinal and Dickcissel. In planning management actions that aim to improve habitat for birds, one should refer to areas where species richness and the richness of species of continental importance are greatest. Based on these areas, the likelihood of success in improving habitat for birds elsewhere at ARPO is increased. Overall, average species richness (5.5 individuals) is what one would expect of a diverse habitat.

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 for 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.

At the time of European settlement, bottomland hardwood forest covered the Mississippi Alluvial Valley with small isolated pockets of prairie found at higher elevations (Twedt et al. 1999). However, 80% of this forested land and most, if not all, the prairie land has been cleared for agricultural purposes. This drastically altered the hydrology of the land, further inhibiting many aspects of the ecosystem's integrity. The remaining forest is in small fragments, further reducing the capacity of the landscape to support bird populations. In recent years, however, forest clearing has essentially stopped and restoration of bottomland hardwood forest is increasing total forest coverage (Smith et al. 2004).

Data collected during the U.S. Geological Survey's annual North American Breeding Bird Surveys (BBS) between 1966 and 2006 indicate that a number of bird species in the woodlands of Arkansas show evidence of population declines (Sauer et al. 2007). Woodland species such as the Eastern wood-peewee (*Contopus virens*), Prothonotary warbler (*Protonotaria citrea*), Red-headed woodpecker (*Melanerpes erythrocephalus*) and Worm-eating warbler (*Helmitheros vermivorus*) have declined at alarming rates. The destruction and fragmentation of bottomland hardwood forest, as well as structural degradation of remaining habitats, have contributed to these declines. The Dickcissel (*Spiza americana*), a grassland species, is declining across their range as well.

We use trends in the composition and abundance of bird populations as long-term indicators of ecosystem integrity in the prairie and bottomland hardwood forests of Arkansas Post National Memorial, Arkansas (ARPO). 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 habitat 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 the bird community in the prairie and woodlands of ARPO may reflect management's effectiveness at restoring these communities. Bird monitoring, initiated in 2007, will aid in assessing the success of restoration efforts. Long-term trends in community composition and abundance of breeding bird populations provide one measure for assessing the ecological integrity and sustainability of these systems.

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 the bird communities that occur at ARPO during the breeding season.
- Improve our understanding of breeding birds – habitat relationships and the effects of management actions such as 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).

This report summarizes survey results for the first year of monitoring.

Methods

Site Selection

Permanent monitoring locations or 'plots' were selected by overlaying a systematic grid of 200 x 200 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 36 permanent plots. Twenty-one are located on the main unit of ARPO and fifteen are on the Osotouy unit (Fig. 1).

During bird surveys, monitoring plots were located using navigation waypoints (Table 1) in a GPS unit and temporarily marked with 36-inch pin flags to aid in re-locating plots for habitat assessment, eliminating the need for permanent plot markers. We collected pin flags from each plot once the habitat work was completed. Monitoring plots will be re-located each year we conduct a bird survey.

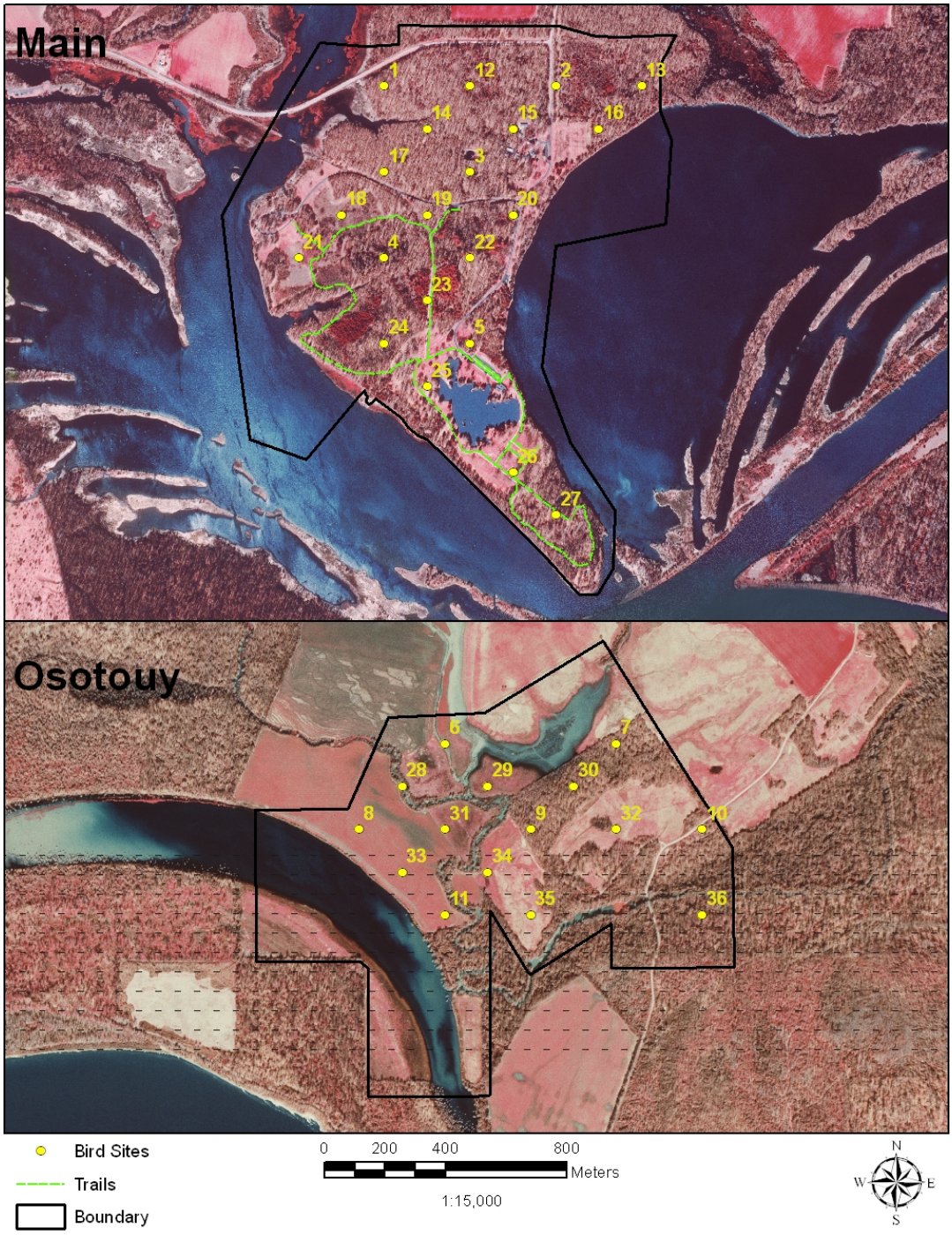

Figure 1. Bird plot locations on Arkansas Post National Memorial, Arkansas.

Table 1. Plot I.D. and habitat type for each breeding bird survey plot at Arkansas Post National Memorial, Arkansas. Also given are x and y UTM coordinates for each plot, UTM Zone 15 North Datum 1983 (Conus).

Plot I.D	Habitat Type	X Coordinate (Easting)	Y Coordinate (Northing)
ARPOTweety1	Woodland	652413.656	3766221.835
ARPOTweety2	Woodland / Edge	652979.342	3766221.835
ARPOTweety3	Woodland	652696.499	3765938.992
ARPOTweety4	Woodland	652413.656	3765656.149
ARPOTweety5	Woodland / Edge	652696.499	3765373.307
ARPOTweety6	Old Field	660050.410	3761979.194
ARPOTweety7	Woodland / Edge	660616.095	3761979.194
ARPOTweety8	Old Field	659767.567	3761696.351
ARPOTweety9	Woodland / Edge	660333.252	3761696.351
ARPOTweety10	Woodland / Edge	660898.938	3761696.351
ARPOTweety11	Old Field	660050.410	3761413.508
ARPOTweety12	Woodland	652696.499	3766221.835
ARPOTweety13	Woodland	653262.184	3766221.835
ARPOTweety14	Woodland	652555.078	3766080.413
ARPOTweety15	Woodland / Edge	652837.920	3766080.413
ARPOTweety16	Woodland	653120.763	3766080.413
ARPOTweety17	Woodland / Edge	652413.656	3765938.992
ARPOTweety18	Woodland / Edge	652272.235	3765797.571
ARPOTweety19	Woodland / Edge	652555.078	3765797.571
ARPOTweety20	Woodland / Edge	652837.920	3765797.571
ARPOTweety21	Old Field	652130.814	3765656.149
ARPOTweety22	Woodland	652696.499	3765656.149
ARPOTweety23	Woodland / Edge	652555.078	3765514.728
ARPOTweety24	Woodland	652413.656	3765373.307
ARPOTweety25	Lawn	652555.078	3765231.885
ARPOTweety26	Lawn	652837.920	3764949.042
ARPOTweety27	Woodland /Edge	652979.342	3764807.621
ARPOTweety28	Riparian	659908.988	3761837.773
ARPOTweety29	Old Field	660191.831	3761837.773
ARPOTweety30	Woodland	660474.674	3761837.773
ARPOTweety31	Old Field	660050.410	3761696.351
ARPOTweety32	Woodland / Edge	660616.095	3761696.351
ARPOTweety33	Old Field	659908.988	3761554.930
ARPOTweety34	Old Field	660191.831	3761554.930
ARPOTweety35	Old Field	660333.252	3761413.509
ARPOTweety36	Riparian	660898.938	3761413.509

Bird Surveys

Bird surveys followed methods outlined in the bird monitoring protocol by Peitz et al. (2003) 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 counted 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 future 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 will be 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 travelling 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 identify species missed during timed surveys. We sampled 36 plots between June 5 and June 7, 2007. We sampled birds during a period when it was light enough to observe birds to four hours after sunrise, approximately 14 hours over the three days of surveys.

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 counts were started as soon as the observer reached plot center. Doing this, our method took into account the fact that birds close to the observer have a higher probability of being detected (if they were not flushed) than birds far from the observer and that different species have different detection functions (i.e., the probability of detecting a bird at different distances from the observer). An important assumption of the method is that a bird exactly at the center of the plot has a probability of $p = 1$ of being detected, and that there is a high probability of detecting birds within the first 5-10 meters of plot center. The most important birds to detect are those very close to the observer (within the first 5-10 meters), and it is highly desirable that estimated distances, or those taken with a rangefinder, be within 1-2 meters of actual distances for any bird within 20 meters of the observer. However, we recorded all birds seen or heard along with distance from the observer when possible. For this report, all birds seen or heard during the full 5-min are included.

Bird Habitat

The collection of habitat data followed methods outlined in the bird monitoring protocol by Peitz et al. (2003) with one exception: only the center 5.0-m radius subplot was sampled. A summary of the sampling methods follows: Habitat data collection started after the first variable circular plot count was completed. Observers visited plots for habitat measures in the same order they were surveyed (for birds) to avoid disturbing birds on a plot prior to a survey. Once the habitat crew arrived at a plot, they set up the center subplot and completed all habitat measures for this subplot and the 50-m radius plot.

We characterized habitat available for each bird species on a number of different scales. Slope, slope variability, aspect, aspect variability, and topographic position of each 50-m radius plot were determined and recorded first. Measurements were recorded during the first year of

monitoring, but will not be re-measured in subsequent years. The amount of various vegetation types and the amount of road and water cover on each plot were recorded. As each plot was sampled, horizontal vegetation cover was estimated in 0.25-m intervals from 0.0 to 2.0 meters above ground surface using a 0.5-m cover board. Area of the cover board obscured by vegetation was estimated at 5- and 15-m distances from plot center. Using a graduated measuring rod, vertical vegetation structure was measured in 1-m increments up to 7.5 meters in height at four locations around the perimeter of the subplot. Locations were in the four cardinal directions. Vertical structure was recorded for deciduous, coniferous, and herbaceous vegetation. Trees were tallied by species and 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 the subplot. Lastly, at the subplot, ground and foliar cover were recorded in a 1.78-m radius nested sample plot. Ground cover included deciduous and grass litter, bare soil, rock, woody debris (>2.50 cm DBH), and un-vegetated. Foliar cover was estimated for six plant guilds, including warm- and cool-season grasses, forbs, moss and lichens, shrubs and vines, tree seedlings, and total foliar cover (<1.50 m tall).

Data Analysis

Prior to summary analysis, the residency status (permanent resident, summer resident, migrant) of each bird species recorded was determined. Identifying the residency of each species helps to exclude migrants from analysis of breeding birds within ARPO. The frequency and abundance of bird species were reported in four ways. 1) For each species, the number of individuals encountered per plot visit (individuals / plot visit) was averaged over all plots. 2) The proportion of plots occupied by each species was determined (total number of plots occupied by a species/36). 3) Restricting the area of inference to a 100-m radius (3.14 ha) around each plot center, we determined each species density (individuals / 3.14 ha) and averaged these values across all plots (average density $\pm$ std dev). 4) To examine local density, density was calculated using data from only plots where a species was encountered. Distance software, which accounts for un-detected individuals, will be used in future species density estimates once there are enough observations (~60) to do so accurately (Buckland et al. 1993, Buckland et al. 2001). Appendix 1 lists the number of resident individuals recorded on each plot, by species. A map was created showing species richness and the richness of species of continental importance, as determined by Partners in Flight (Rich et al. 2004), by plot.

Annual bird diversity, richness, and distribution evenness were calculated for permanent and summer resident males, by plot, and park-wide averages ($\pm$ std dev) were determined. Flyover males where included in each calculation. Bird diversity values for each plot were calculated using the Shannon Diversity Index:

$$H' = -\Sigma(n_1/N)\ln(n_1/N)$$

where n_1/N is the proportion of the total number of individuals in a population consisting of the ith species (Shannon, 1949). Species richness is the total number of bird taxa recorded per plot. Species distribution evenness was calculated for each plot using Pielou (J):

$$J' = H' / Hmax$$

where H' is the Shannon Diversity Index and Hmax is the maximum possible diversity for a given number of species if all species are present in equal numbers ((ln(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).

Location and permanent abiotic measures on each plot and habitat subplot were reported. Annual averages (± std dev) for semi-permanent plot data, including road and water cover were calculated from plot estimates. Using calculated plot averages or values, averages (± std dev) for horizontal vegetation cover between 0 - 0.5, 0.25 - 0.75, 0.5 - 1.0, 0.75 - 1.25, 1.0 - 1.5, 1.25 - 1.75, and 1.5 - 2.0 meters were calculated for both 5- and 15-m distances. Average (± std dev) annual vertical structure diversity was estimated and reported. Vertical structure diversity values were determined for each plot by summing the percents of possible touches (12) from vegetation within each 1-m height increment, actually touched; dividing this value by the number of height increments measured (8); adding the resulting value to the percent of increments occupied; multiplying this value by 100; and then dividing it by two. Vertical structure diversity values were weighted to equally 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 (>2.50 cm DBH), and unvegetated were averaged (± std dev) across plots. Foliar cover, by guild of warm- and cool-season grasses, forbs, mosses and lichens, shrubs and vines, tree seedlings, and total foliar cover (<1.50 m tall) were averaged across plots with, averages (± std dev). Appendix 2 lists habitat parameter values recorded for each plot.

Results

Bird Surveys

Forty-two bird species were recorded during the breeding bird surveys at ARPO in 2007 (Table 2). Seventeen of the 42 species recorded are classified as permanent residents (Stokes and Stokes 1996). One species, the House wren (*Troglodytes aedon*) is classified as a late migrant. The remaining twenty-four species are classified as summer residents. Two of the 42 species observed, the Anhinga (*Anhinga anhinga*) and Ruby-throated hummingbird (*Archilochus colubris*), were recorded as flyovers or outside the 5-min survey periods. Eleven species--Acadian flycatcher (*Empidonax virescens*), Bachman's sparrow (*Aimophila aestivalis*), Carolina wren (*Thryothorus ludovicianus*), Dickcissel (*Spiza americana*), Eastern towhee (*Pipilo erythrophthalmus*), Indigo bunting (*Passerina cyanea*), Kentucky warbler (*Oporornis formosus*), Prothonotary warbler (*Protonotaria citrea*), Red-bellied woodpecker (*Melanerpes carolinus*), White-eyed vireo (*Vireo griseus*), and Yellow-throated vireo (*Vireo flavifrons*)--are considered species of continental importance (Rich et al. 2004).

The Northern cardinal (*Cardinalis cardinalis*) was the most commonly occurring species during the breeding season based on the mean number of individuals per plot visit and the proportion of plots occupied (Tables 3 and 4, also see Appendix 1). Acadian flycatcher, Blue-gray gnatcatcher (*Polioptila caerulea*), Eastern wood-peewee (*Contopus virens*), Indigo bunting, Northern mockingbird (*Mimus polyglottos*), Red-bellied woodpecker and Yellow-billed cuckoo (*Coccyzus*

americanus) were moderately abundant. Nine species, American redstart (*Setophaga ruticilla*), Bachman's sparrow, Black-crowned night-heron (*Nycticorax nycticorax*), Common yellowthroat (*Geothlypis trichas*), Eastern meadowlark (*Sturnella magna*), Hairy woodpecker (*Picoides villosus*), Orchard oriole (*Icterus spurius*) and Red-eyed vireo (*Vireo olivaceus*) were represented by observation(s) on single plots. Average density of each bird species during the breeding season of 2007 is listed in Table 5. Average density of each species for plots occupied is listed in Table 6. The Northern cardinal had the highest density of any species. The Dickcissel, however, had the highest density of any species for plots occupied. Species richness and the richness of species of continental importance by plot are illustrated in Figure 2. Average (± std dev) species richness, diversity, and species distribution evenness values across plots are given in Figure 3.

Table 2. Bird species recorded during breeding bird surveys at Arkansas Post National Memorial, Arkansas in 2007. The American Ornithologists' Union Code (AOU code) and residency status of each species is given.

Common name	Species name	AOU code	Residency[1]
Acadian flycatcher	***Empidonax virescens***	**ACFL**	**SR**
American crow	*Corvus brachyrhynchos*	AMCR	R
American redstart	*Setophaga ruticilla*	AMRE	SR
Anhinga*	*Anhinga anhinga*	ANHI	SR
Bachman's sparrow	***Aimophila aestivalis***	**BACS**	**R**
Black-crowned night-heron	*Nycticorax nycticorax*	BCNH	SR
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	SR
Blue jay	*Cyanocitta cristata*	BLJA	R
Brown-headed cowbird	*Molothrus ater*	BHCO	R
Carolina chickadee	*Parus carolinensis*	CACH	R
Carolina wren	***Thryothorus ludovicianus***	**CARW**	**R**
Common moorhen	*Gallinula chloropus*	COMO	SR
Common yellowthroat	*Geothlypis trichas*	COYE	SR
Dickcissel	***Spiza americana***	**DICK**	**SR**
Eastern bluebird	*Sialia sialis*	EABL	R
Eastern kingbird	*Tyrannus tyrannus*	EAKI	SR
Eastern meadowlark	*Sturnella magna*	EAME	R
Eastern towhee	***Pipilo erythrophthalmus***	**EATO**	**R**
Eastern wood-pewee	*Contopus virens*	EAWP	SR
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	R
Great crested flycatcher	*Myiarchus crinitus*	GCFL	SR
Great egret	*Ardea alba*	GREG	SR
Hairy woodpecker	*Picoides villosus*	HAWO	R
House wren	*Troglodytes aedon*	HOWR	M
Indigo bunting	***Passerina cyanea***	**INBU**	**SR**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**SR**
Mourning dove	*Zenaida macroura*	MODO	R
Northern cardinal	*Cardinalis cardinalis*	NOCA	R
Northern mockingbird	*Mimus polyglottos*	NOMO	R
Northern parula	*Parula americana*	NOPA	SR

Table 2. continued

Common name	Species name	AOU code	Residency
Orchard oriole	*Icterus spurius*	OROR	SR
Pileated woodpecker	*Dryocopus pileatus*	PIWO	R
Prothonotary warbler	***Protonotaria citrea***	**PROW**	**SR**
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	**R**
Red-eyed vireo	*Vireo olivaceus*	REVI	SR
Ruby-throated hummingbird*	*Archilochus colubris*	RTHU	SR
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	R
Summer tanager	*Piranga rubra*	SUTA	SR
White-eyed vireo	***Vireo griseus***	**WEVI**	**SR**
Yellow-breasted chat	*Icteria virens*	YBCH	SR
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	SR
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**SR**

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

[1] Residency status: SR = summer resident; R = year around resident; M = late season migrant. According to Stokes and Stokes (1996).

Species names are valid and verified names taken from ITIS (Integrated Taxonomic Information System). http://www.itis.usda.gov/.

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 3. Number of individuals encountered per plot visit, averaged over all 36 plots, for bird species recorded at Arkansas Post National Memorial, Arkansas during the 2007 breeding bird surveys. Number of individuals encountered per plot visit includes all individuals recorded on plots during a 5-min survey, including flyovers.

Common name	Species name	AOU code	Individual / plot visit
Acadian flycatcher	***Empidonax virescens***	**ACFL**	**0.36**
American crow	*Corvus brachyrhynchos*	AMCR	0.06
American redstart	*Setophaga ruticilla*	AMRE	0.03
Bachman's sparrow	***Aimophila aestivalis***	**BACS**	**0.03**
Black-crowned night-heron	*Nycticorax nycticorax*	BCNH	0.03
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	0.36
Blue jay	*Cyanocitta cristata*	BLJA	0.11
Brown-headed cowbird	*Molothrus ater*	BHCO	0.14
Carolina chickadee	*Parus carolinensis*	CACH	0.17
Carolina wren	***Thryothorus ludovicianus***	**CARW**	**0.11**
Common moorhen	*Gallinula chloropus*	COMO	0.06
Common yellowthroat	*Geothlypis trichas*	COYE	0.03
Dickcissel	***Spiza americana***	**DICK**	**0.28**
Eastern bluebird	*Sialia sialis*	EABL	0.06
Eastern kingbird	*Tyrannus tyrannus*	EAKI	0.08
Eastern meadowlark	*Sturnella magna*	EAME	0.06
Eastern towhee	***Pipilo erythrophthalmus***	**EATO**	**0.06**
Eastern wood-pewee	*Contopus virens*	EAWP	0.36
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	0.25
Great crested flycatcher	*Myiarchus crinitus*	GCFL	0.08
Great egret	*Ardea alba*	GREG	0.06
Hairy woodpecker	*Picoides villosus*	HAWO	0.06
Indigo bunting	***Passerina cyanea***	**INBU**	**0.44**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**0.06**
Mourning dove	*Zenaida macroura*	MODO	0.25
Northern cardinal	*Cardinalis cardinalis*	NOCA	0.89
Northern mockingbird	*Mimus polyglottos*	NOMO	0.36
Northern parula	*Parula americana*	NOPA	0.19
Orchard oriole	*Icterus spurius*	OROR	0.03
Pileated woodpecker	*Dryocopus pileatus*	PIWO	0.06
Prothonotary warbler	***Protonotaria citrea***	**PROW**	**0.08**
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	**0.36**
Red-eyed vireo	*Vireo olivaceus*	REVI	0.03
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	0.31
Summer tanager	*Piranga rubra*	SUTA	0.33
White-eyed vireo	***Vireo griseus***	**WEVI**	**0.06**
Yellow-breasted chat	*Icteria virens*	YBCH	0.19
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0.36
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**0.17**

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 4. Proportion of plots (out of 36) occupied by bird species (including flyovers) at Arkansas Post National Memorial, Arkansas during the 2007 breeding bird surveys.

Common name	Species name	AOU code	Proportion of plots occupied
Acadian flycatcher	***Empidonax virescens***	**ACFL**	**0.33**
American crow	*Corvus brachyrhynchos*	AMCR	0.06
American redstart	*Setophaga ruticilla*	AMRE	0.03
Bachman's sparrow	***Aimophila aestivalis***	**BACS**	**0.03**
Black-crowned night-heron	*Nycticorax nycticorax*	BCNH	0.03
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	0.28
Blue jay	*Cyanocitta cristata*	BLJA	0.11
Brown-headed cowbird	*Molothrus ater*	BHCO	0.08
Carolina chickadee	*Parus carolinensis*	CACH	0.17
Carolina wren	***Thryothorus ludovicianus***	**CARW**	**0.11**
Common moorhen	*Gallinula chloropus*	COMO	0.06
Common yellowthroat	*Geothlypis trichas*	COYE	0.03
Dickcissel	***Spiza americana***	**DICK**	**0.14**
Eastern bluebird	*Sialia sialis*	EABL	0.06
Eastern kingbird	*Tyrannus tyrannus*	EAKI	0.06
Eastern meadowlark	*Sturnella magna*	EAME	0.03
Eastern towhee	***Pipilo erythrophthalmus***	**EATO**	**0.06**
Eastern wood-pewee	*Contopus virens*	EAWP	0.33
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	0.22
Great crested flycatcher	*Myiarchus crinitus*	GCFL	0.08
Great egret	*Ardea alba*	GREG	0.06
Hairy woodpecker	*Picoides villosus*	HAWO	0.03
Indigo bunting	***Passerina cyanea***	**INBU**	**0.28**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**0.06**
Mourning dove	*Zenaida macroura*	MODO	0.17
Northern cardinal	*Cardinalis cardinalis*	NOCA	**0.61**
Northern mockingbird	*Mimus polyglottos*	NOMO	0.31
Northern parula	*Parula americana*	NOPA	0.19
Orchard oriole	*Icterus spurius*	OROR	0.03
Pileated woodpecker	*Dryocopus pileatus*	PIWO	0.06
Prothonotary warbler	***Protonotaria citrea***	**PROW**	**0.08**
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	**0.33**
Red-eyed vireo	*Vireo olivaceus*	REVI	0.03
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	0.17
Summer tanager	*Piranga rubra*	SUTA	0.28
White-eyed vireo	***Vireo griseus***	**WEVI**	**0.06**
Yellow-breasted chat	*Icteria virens*	YBCH	0.19
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0.33
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**0.17**

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 5. Average density (± std. dev.) of bird species at Arkansas Post National Memorial, Arkansas during the 2007 breeding bird surveys. Species densities are for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers.

Common name	Species name	AOU code	Individuals / ha
Acadian flycatcher	***Empidonax virescens***	**ACFL**	**0.11 (0.17)**
American crow	*Corvus brachyrhynchos*	AMCR	0.01 (0.05)
American redstart	*Setophaga ruticilla*	AMRE	0.01 (0.05)
Bachman's sparrow	***Aimophila aestivalis***	**BACS**	**0.01 (0.05)**
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	0.11 (0.20)
Blue jay	*Cyanocitta cristata*	BLJA	0.02 (0.07)
Brown-headed cowbird	*Molothrus ater*	BHCO	0.03 (0.12)
Carolina chickadee	***Parus carolinensis***	**CACH**	**0.05 (0.12)**
Carolina wren	*Thryothorus ludovicianus*	CARW	0.03 (0.09)
Common yellowthroat	*Geothlypis trichas*	COYE	0.01 (0.05)
Dickcissel	***Spiza americana***	**DICK**	**0.07 (0.22)**
Eastern bluebird	*Sialia sialis*	EABL	0.02 (0.07)
Eastern meadowlark	*Sturnella magna*	EAME	0.02 (0.11)
Eastern towhee	*Pipilo erythrophthalmus*	EATO	0.02 (0.07)
Eastern wood-pewee	*Contopus virens*	EAWP	0.10 (0.17)
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	0.06 (0.15)
Great crested flycatcher	*Myiarchus crinitus*	GCFL	0.03 (0.09)
Hairy woodpecker	*Picoides villosus*	HAWO	0.02 (0.11)
Indigo bunting	***Passerina cyanea***	**INBU**	**0.14 (0.26)**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**0.02 (0.07)**
Mourning dove	*Zenaida macroura*	MODO	0.03 (0.12)
Northern cardinal	*Cardinalis cardinalis*	NOCA	0.25 (0.29)
Northern mockingbird	*Mimus polyglottos*	NOMO	0.06 (0.15)
Northern parula	*Parula americana*	NOPA	0.05 (0.12)
Pileated woodpecker	*Dryocopus pileatus*	PIWO	0.01 (0.05)
Prothonotary warbler	***Protonotaria citrea***	**PROW**	**0.03 (0.09)**
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	**0.10 (0.17)**
Red-eyed vireo	*Vireo olivaceus*	REVI	0.01 (0.05)
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	0.07 (0.20)
Summer tanager	*Piranga rubra*	SUTA	0.11 (0.19)
White-eyed vireo	***Vireo griseus***	**WEVI**	**0.02 (0.07)**
Yellow-breasted chat	*Icteria virens*	YBCH	0.05 (0.12)
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0.07 (0.15)
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**0.05 (0.12)**

Bolded species names are those species considered of continental importance (Rich et al. 2004).

Table 6. Average bird density (± std. dev.) for plots occupied by species at Arkansas Post National Memorial, Arkansas during the 2007 breeding bird surveys. Species densities are for individuals recorded within 100-m of plot center during a 5-min survey, excluding flyovers. A standard deviation of 0.00, indicate the species occurred on two or more plots with equal density. When a species occurs on only one plot, standard deviation could not be calculated.

Common name	Species name	AOU code	Individuals / ha
Acadian flycatcher	***Empidonax virescens***	**ACFL**	**0.34 (0.09)**
American crow	*Corvus brachyrhynchos*	AMCR	0.32
American redstart	*Setophaga ruticilla*	AMRE	0.32
Bachman's sparrow	***Aimophila aestivalis***	**BACS**	**0.32**
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	0.41 (0.15)
Blue jay	*Cyanocitta cristata*	BLJA	0.32 (0.00)
Brown-headed cowbird	*Molothrus ater*	BHCO	0.48 (0.23)
Carolina chickadee	*Parus carolinensis*	CACH	0.32 (0.00)
Carolina wren	***Thryothorus ludovicianus***	**CARW**	0.32 (0.00)
Common yellowthroat	*Geothlypis trichas*	COYE	0.32
Dickcissel	***Spiza americana***	**DICK**	**0.64 (0.26)**
Eastern bluebird	*Sialia sialis*	EABL	0.32 (0.00)
Eastern meadowlark	*Sturnella magna*	EAME	0.64
Eastern towhee	***Pipilo erythrophthalmus***	**EATO**	**0.32 (0.00)**
Eastern wood-pewee	*Contopus virens*	EAWP	0.35 (0.10)
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	0.37 (0.13)
Great crested flycatcher	*Myiarchus crinitus*	GCFL	0.32 (0.00)
Hairy woodpecker	*Picoides villosus*	HAWO	0.64
Indigo bunting	***Passerina cyanea***	**INBU**	**0.51 (0.22)**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**0.32 (0.00)**
Mourning dove	*Zenaida macroura*	MODO	0.48 (0.23)
Northern cardinal	*Cardinalis cardinalis*	NOCA	0.47 (0.22)
Northern mockingbird	*Mimus polyglottos*	NOMO	0.37 (0.13)
Northern parula	*Parula americana*	NOPA	0.32 (0.00)
Pileated woodpecker	*Dryocopus pileatus*	PIWO	0.32
Prothonotary warbler	***Protonotaria citrea***	**PROW**	**0.32 (0.00)**
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	**0.35 (0.10)**
Red-eyed vireo	*Vireo olivaceus*	REVI	0.32
Red-winged blackbird	*Agelaius phoeniceus*	RWBL	0.51 (0.28
Summer tanager	*Piranga rubra*	SUTA	0.38 (0.13)
White-eyed vireo	***Vireo griseus***	**WEVI**	**0.32 (0.00)**
Yellow-breasted chat	*Icteria virens*	YBCH	0.32 (0.00)
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0.36 (0.12)
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**0.32 (0.00)**

Bolded species names are those species considered of continental importance (Rich et al. 2004).

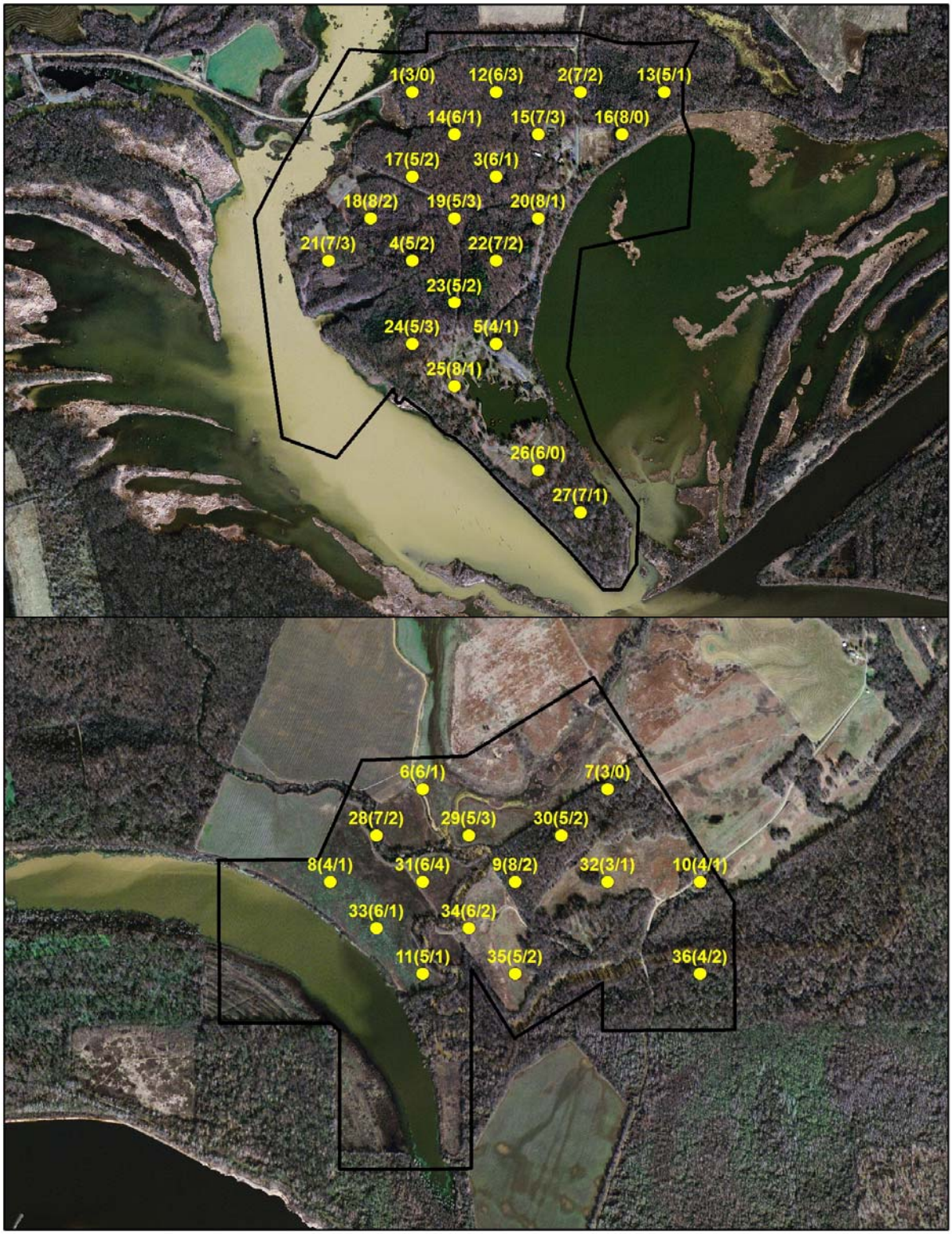

Figure 2. Bird species richness and the richness of species of continental importance for each plot on Arkansas Post National Memorial, Arkansas, in 2007.

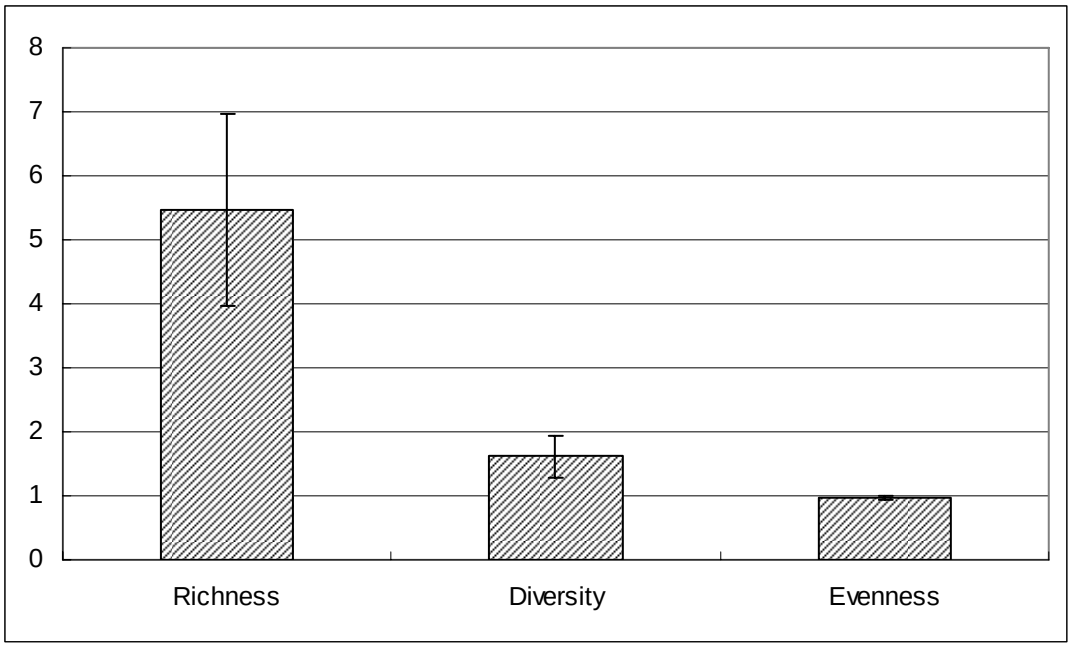

Figure 3. Average (± std dev) species richness, diversity, and species distribution evenness values across plots for the bird community at Arkansas Post National Memorial, Arkansas during the breeding season of 2007.

Bird Habitat

Abiotic features of plots sampled for breeding birds and habitat composition are given in Table 7. Slope and aspect variability were low for the majority of plots sampled. Plots were generally located on level topographic positions, with only four plots located in shallow draws. Slope across all survey plots was low, 4° or less, with one exception.

Bird survey plots average over 52% woodland habitat type and 20% field / prairie habitat type, with smaller amounts of several other habitat types present (Table 8, also see Appendix 2). Canopy cover averaged over 63%, with most being from hardwood trees. Basal area from hardwood trees averaged almost 13 m^2/ha. Hardwood tree species from eleven different families contributed to the canopy cover and basal area (Table 9). Tree species from the family *Cupressaceae* account for the limited amount of conifer canopy cover and basal area recorded.

The highest horizontal vegetation cover observed occurred in the 0.00 – 0.50 through 0.75 – 1.25 meter profile classes when read from both 5- and 15-m distances (Table 8). However, vegetation cover averaged 34% or better for all profile classes when read from a distance of 15-m. In spite of good horizontal vegetation cover, the average vertical structure diversity estimate of 22% appears to be low.

Deciduous litter was the most prominent litter type, with lesser amounts of grass litter (Table 8). Ground cover was mostly unvegetated and bare soil. Forbs, cool-season grasses, and woody shrubs and vines provided the greatest amount of live foliar cover. Total foliar coverage averaged 35% across plots.

Table 7. Abiotic features of 50-m radius plots sampled for breeding birds at Arkansas Post National Memorial, Arkansas.

Plot number	Slope (^{O})	Slope variability	Aspect (^{O})	Aspect variability	Topographic position	Habitat type
ARPOTweety1	2.5	Low	246	Low	Level	Woodland
ARPOTweety2	0.5	Low	176	Low	Level	Woodland / Edge
ARPOTweety3	1.0	Low	168	Low	Level	Woodland
ARPOTweety4	1.5	Low	209	Medium	Level	Woodland
ARPOTweety5	1.0	Medium	51	Medium	Draw	Woodland / Edge
ARPOTweety6	1.5	Low	129	Low	Level	Old Field
ARPOTweety7	3.0	Low	228	Low	Level	Woodland / Edge
ARPOTweety8	0.0	Low	--	Low	Level	Old Field
ARPOTweety9	2.0	Low	267	Low	Level	Woodland / Edge
ARPOTweety10	1.0	Low	120	Medium	Level	Woodland / Edge
ARPOTweety11	1.0	Low	118	Low	Level	Old Field
ARPOTweety12	0.0	Low	--	Low	Level	Woodland
ARPOTweety13	0.0	Low	--	Low	Level	Woodland
ARPOTweety14	0.5	Low	12	Low	Level	Woodland
ARPOTweety15	0.0	Low	--	Low	Level	Woodland / Edge
ARPOTweety16	0.0	Low	--	Low	Level	Woodland
ARPOTweety17	0.0	Low	--	Low	Level	Woodland / Edge
ARPOTweety18	2.0	Low	244	Low	Level	Woodland / Edge
ARPOTweety19	0.5	Low	208	Low	Level	Woodland / Edge
ARPOTweety20	0.0	Low	--	Low	Level	Woodland / Edge
ARPOTweety21	0.0	Low	--	Low	Level	Old Field
ARPOTweety22	1.0	Low	314	Low	Level	Woodland
ARPOTweety23	4.0	Low	123	Low	Level	Woodland / Edge
ARPOTweety24	0.0	Low	--	Low	Level	Woodland
ARPOTweety25	4.0	Low	30	Low	Level	Lawn
ARPOTweety26	0.0	Low	--	Low	Level	Lawn
ARPOTweety27	1.0	Low	90	Low	Level	Woodland /Edge
ARPOTweety28	9.0	Low	75.0	Low	Draw	Riparian
ARPOTweety29	0.0	Low	--	Low	Level	Old Field
ARPOTweety30	3.0	Low	324	Low	Draw	Woodland
ARPOTweety31	1.5	Low	190	Low	Level	Old Field
ARPOTweety32	1.5	Low	226	Low	Level	Woodland / Edge
ARPOTweety33	0.5	Low	120	Low	Level	Old Field
ARPOTweety34	3.0	Low	266	Low	Level	Old Field
ARPOTweety35	1.0	Low	82	Low	Level	Old Field
ARPOTweety36	0.0	Low	--	Low	Draw	Riparian

Table 8. Averages (± std dev) for habitat parameters at Arkansas Post National Memorial, Arkansas during the 2007 bird breeding season. Within the scale in which habitat parameters are collected, 50-m plot, 5-m subplot, and 1.78-m sample plot, percentages of coverage 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	Mean	Std dev
50 meter plot coverage		
Woodland (%)	51.94	43.61
Woodland Swamp (%)	4.44	19.05
Shrubland (%)	2.71	16.25
Field / Prairie (%)	20.11	37.52
Lawn (%)	4.22	17.32
Road / Trails (%)	1.00	2.64
Pond / Stream (%)	0.19	0.70
5 meter subplot		
Canopy cover		
Hardwood (%)	61.84	43.51
Conifer (%)	1.48	7.07
Total cover (%)	63.32	43.78
Canopy Height		
Hardwood (m)	13.07	11.17
Conifer (m)	1.51	4.58
Basal Area		
Hardwood (m^2/ha)	12.76	11.56
Conifer (m^2/ha)	0.51	1.66
Horizontal vegetation profile at 5-m		
0.0 – 0.5 m (%)	56.82	39.03
0.25 – 0.75 m (%)	43.63	41.61
0.5 – 1.0 m (%)	31.83	36.59
0.75 – 1.25 m (%)	20.85	29.65
1.0 – 1.5 m (%)	18.63	30.58
1.25 – 1.75 m (%)	18.07	30.37
1.5 – 2.0 m (%)	19.67	30.95
Horizontal vegetation profile at 15-m		
0.0 – 0.5 m (%)	73.33	35.17
0.25 – 0.75 m (%)	65.44	41.20
0.5 – 1.0 m (%)	50.18	41.60
0.75 – 1.25 m (%)	40.74	40.24
1.0 – 1.5 m (%)	39.31	39.34
1.25 – 1.75 m (%)	37.11	40.31
1.5 – 2.0 m (%)	33.90	40.06
Vertical structure diversity (%)	22.29	13.07
1.78 meter sample plot coverage		
Deciduous litter (%)	40.15	32.71
Conifer litter (%)	0.08	0.50
Grass litter (%)	8.83	13.92
Bare soil (%)	17.14	18.36
Rock (%)	0.17	0.70
Woody debris (%)	0.53	0.92
Unvegetated (%)	86.88	8.09
Warm-season grass (%)	0.46	0.94

Table 8. continued

Habitat Parameter	Mean	Std dev
Cool-season grass (%)	6.76	12.35
Forb (%)	7.00	10.61
Moss and lichen (%)	0.17	0.70
Woody shrub and vine (%)	6.75	10.99
Tree seedling (%)	0.69	2.46
Total foliar (%)	35.43	20.10

Table 9. Stems per hectare of trees by size class found on Arkansas Post National Memorial, Arkansas during the 2007 bird-breeding season. Stems per hectare of trees are reported by family.

Family	<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 cm	>38.0 cm
Aceraceae	0.00	0.00	0.00	0.00	3.54	0.00	0.00
Cupressaceae	0.00	0.00	3.54	21.22	14.15	10.61	3.54
Ebenaceae	0.00	14.15	14.15	0.00	7.07	3.54	0.00
Fabaceae	31.83	21.22	10.61	3.54	7.07	0.00	0.00
Fagaceae	35.37	0.00	0.00	10.61	7.07	7.07	14.15
Hamamelidaceae	0.00	0.00	24.76	24.76	3.54	3.54	0.00
Juglandaceae	0.00	10.61	14.15	3.54	0.00	0.00	7.07
Oleacea	0.00	10.61	21.22	7.07	0.00	3.54	3.54
Platanaceae	0.00	0.00	3.54	3.54	0.00	0.00	0.00
Rhamnaceae	0.00	3.54	7.07	3.54	0.00	0.00	0.00
Rosaceae	35.37	67.20	24.76	0.00	0.00	0.00	7.07
Ulmaceae	42.44	49.51	63.66	38.90	24.76	17.68	0.00
Total stems	**145.01**	**176.84**	**187.46**	**116.72**	**67.2**	**45.98**	**35.37**
Snags	0.00	3.54	10.61	7.07	3.54	3.54	0.00

Discussion

Bird surveys and habitat assessment work was initiated at Arkansas Post National Memorial, Arkansas in 2007, to assist the park in assessing the integrity of their prairie and bottomland hardwood habitats through time. Forty-one of the 42 bird species recorded during the breeding bird surveys are permanent or summer residents to the area (Stokes and Stokes 1996). Therefore, most species have some value in characterizing the breeding bird communities of ARPO, the only exception being the migrant House wren. Changes in the numbers of the most common and widely distributed species, however--Acadian flycatcher, Blue-gray gnatcatcher, Eastern wood-peewee, Indigo bunting, Northern Cardinal, Northern mockingbird, Red-bellied woodpecker, and Yellow-billed cuckoo--will serve as the better indicators for changing habitat conditions. For example, species like the Dickcissel, common in grassland habitat, have improved reproductive success when grass cover is dense, forb presence is heavy, and litter cover is thick (Johnson et al. 1998, Winter 1998). Therefore, a decline in Dickcissel numbers could very well indicate changes in any one or all three of these grassland measures. Less common and widely distributed species will likely occur so infrequently that strong species-habitat relationships may not be established.

The diverse mix of woodland, field/prairie, lawn, riparian, and woodland edge habitat positively influenced the number of species observed. Habitat diversity is especially important to high

priority species as their microhabitat requirements vary (Pashley and Barrow 1993). For example, the Prothonotary and Kentucky warblers prefer ravines and wet bottomland hardwood habitats, while the Bachman's sparrow, Eastern towhee, and White-eyed vireo require thick shrubby habitat (Stokes and Stokes 1996). Woodland swamp and pond/stream habitat made up nearly 5% of the habitat on plots sampled, and shrubland habitat nearly 3%. Almost 52% of the habitat is woodland dominated by hardwoods, which favor most species observed. Another 20% is field/prairie habitat preferred by grassland bird species such as the Dickcissel. A total of eleven species (Acadian flycatcher, Bachman's sparrow, Carolina wren, Dickcissel, Eastern towhee, Indigo bunting, Kentucky warbler, Prothonotary warbler, Red-bellied woodpecker, White-eyed vireo, and Yellow-throated vireo) are species of continental importance and deserve extra scrutiny each time a survey is completed. Although the diverse mix of habitats provides potentially satisfactory habitat for all the birds of continental importance and most other species, some of this habitat is relatively rare. Our baseline data suggests that five (i.e. Bachman's sparrow, Eastern towhee, Kentucky warbler, Prothonotary warbler, and White-eyed vireo) of the eleven species of continental importance may occur infrequently or rarely enough that it will be difficult to assess the influence of habitat management actions on their numbers. Similar to the habitat requirements listed above for the Dickcissel, the habitat requirement of the five remaining species of continental importance can be identified--Acadian flycatcher, mature hardwood forest generally near water; Carolina wren, forest understory and shrubby habitat; Indigo bunting, brush and low trees of overgrown fields; Red-bellied woodpecker, woodlands and urban / suburban forest; and Yellow-throated vireo, mature forest (Stokes and Stokes 1996).

The Northern cardinal, the most common species, has shown moderate increase in numbers throughout Arkansas and the Mississippi Alluvial Valley but only a slight increase or even decline in other areas of North America (Sauer et al. 2007). Therefore, the importance of the park to conservation of even its most common species cannot be underestimated. The Dickcissel, the most abundant species on plots they occupied (field/prairie) have shown significant decline across their range (Sauer et al. 2007). Management decisions aimed at influencing bird populations should center on those identified as local or continental species of importance. Species common to the park, however, such as the Northern cardinal and Dickcissel, need consideration in a broader context of bird conservation when making management decisions. An interesting finding from this initial bird survey is that even moderately abundant species such as the Acadian flycatcher, Indigo Bunting, and Red-bellied woodpecker are species of continental importance.

In planning management actions that aim to improve habitat for birds, one should refer to Figure 2 and Appendix 1. Figure 2 identifies areas where species richness and the number of species of continental importance are greatest, allowing managers to prioritize areas for habitat improvement. Appendix 2 describes in detail each habitat parameter found on a plot. Managers may choose to manipulate a particular habitat element to benefit a particular species. Management actions aimed at improving habitat for a single species, however, may come at a cost to other species, unless the selected species is a keystone species for the habitat desired (i.e., Dickcissel in grassland habitat).

Species richness, diversity, and evenness values are generally greater for bird communities in woodland and mixed habitats (Kelsey 2001) than grasslands (Cody 1966, Knopf 1997, Wiens

1973, Wiens 1974, Zimmerman 1992). Kelsey (2001) reported species richness for breeding birds on 271 transects (0.5 ha) to be between 5.3 and 6.5 individuals in woodland habitats. Using spot mapping techniques on 4.0 – 10.6 ha plots, Cody (1966) reported species richness across seasons in grasslands as generally less than 10 and Wiens (1973) reported breeding species richness much less than this, 2 - 6. Therefore, species richness, diversity, and distribution evenness values for the breeding bird community in the mixed habitat types at ARPO appear to be quite normal. Average species richness on plots surveyed is nearly 5.5 individuals. Our distribution evenness values suggest that a number of breeding species contributed significantly to diversity measures. Though hard to discern now, the real value of richness, diversity, and evenness values will be realized when we examine changes in the bird community through time-- 20, 30 or more years--and these changes can be linked to management activity rather than innate variability of the habitats present.

Acknowledgements

We would like to thank the staff of Arkansas Post National Memorial, Arkansas for allowing us access during our site visits. We would especially like to thank Leo A. Acosta and Joseph M. Byers for their assistance with monitoring and support of our program.

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Appendix 1. Bird species counts by plot for Arkansas Post National Memorial, Arkansas in 2007. Data includes all resident species recorded from a plot during a 5 min. survey. A species may have been recorded as a flyover only. No species recorded outside a 5 min. survey were included.

	Species code																																								
PLOT	**ACFL**	AMCR	AMRE	**BACS**	BCNH	BGGN	BHCO	BLJA	CACH	**CARW**	COMO	COYE	**DICK**	EABL	EAKI	EAME	**EATO**	EAWP	ETTI	GCFL	GREG	HAWO	**INBU**	**KEWA**	MODO	NOCA	NOMO	NOPA	ORORO	PIWO	**PROW**	**RBWO**	REVI	RWBL	SUTA	**WEVI**	YBCH	YBCU	**YTVI**	**SPP**	**SCI**
1	**0**	0	0	**0**	0	2	0	0	0	**0**	1	0	**0**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	0	1	0	0	0	0	**0**	**0**	0	0	0	**0**	0	0	**0**	**3**	**0**
2	**1**	0	0	**0**	0	0	0	0	1	**0**	0	0	**0**	0	0	0	**0**	1	0	0	0	0	**0**	**0**	0	1	0	1	0	0	**0**	**1**	1	0	0	**0**	0	0	**0**	**7**	**2**
3	**1**	0	0	**0**	0	1	0	0	0	**0**	0	0	**0**	0	0	0	**0**	1	1	0	0	0	**0**	**0**	0	1	0	0	0	1	**0**	**0**	0	0	0	**0**	0	0	**0**	**6**	**1**
4	**1**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	1	2	0	0	0	**0**	**0**	0	0	0	0	0	0	**0**	**1**	0	0	0	**0**	0	1	**0**	**5**	**2**
5	**0**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	1	1	2	0	0	0	**1**	**0**	0	0	0	**0**	0	0	**0**	**4**	**1**
6	**0**	0	0	**0**	1	0	0	0	0	**0**	0	0	**3**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	0	1	0	0	1	0	**0**	**0**	0	2	0	**0**	1	0	**0**	**6**	**1**
7	**0**	0	1	**0**	0	1	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	**0**	**0**	0	0	1	**0**	0	0	**0**	**3**	**0**
8	**0**	0	0	**0**	0	0	0	1	0	**0**	0	0	**2**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	0	0	0	0	0	0	**0**	**0**	0	4	0	**0**	1	0	**0**	**4**	**1**
9	**1**	0	0	**0**	0	1	0	0	0	**0**	0	0	**0**	0	0	0	**0**	1	1	0	0	0	**1**	**0**	0	1	0	0	0	0	**0**	**0**	0	0	1	**0**	0	1	**0**	**8**	**2**
10	**0**	0	0	**0**	0	0	0	0	1	**0**	0	0	**0**	0	0	0	**0**	0	0	1	0	0	**2**	**0**	0	0	1	0	0	0	**0**	**0**	0	0	0	**0**	0	0	**0**	**4**	**1**
11	**0**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	1	1	0	**0**	0	0	0	0	0	**2**	**0**	0	0	2	0	0	0	**0**	**0**	0	0	0	**0**	1	0	**0**	**5**	**1**
12	**1**	0	0	**0**	0	1	0	0	0	**1**	0	0	**0**	0	0	0	**0**	1	0	0	0	0	**0**	**1**	0	0	0	0	0	0	**0**	**0**	0	0	0	**0**	0	1	**0**	**6**	**3**
13	**0**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	1	0	0	0	**0**	**0**	0	3	0	0	0	0	**0**	**0**	0	0	1	**0**	0	1	**1**	**5**	**1**
14	**0**	0	0	**0**	0	1	0	0	0	**0**	0	0	**0**	0	0	0	**0**	2	0	1	0	0	**0**	**0**	0	2	0	0	0	0	**0**	**1**	0	0	1	**0**	0	0	**0**	**6**	**1**
15	**1**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**1**	1	0	0	0	0	**0**	**0**	0	1	1	0	0	0	**0**	**1**	0	0	2	**0**	0	0	**0**	**7**	**3**
16	**0**	0	0	**0**	0	0	0	0	1	**0**	0	0	**0**	0	0	0	**0**	0	0	1	0	0	**0**	**0**	2	1	1	0	0	1	**0**	**0**	0	1	0	**0**	0	2	**0**	**8**	**0**
17	**1**	0	0	**0**	0	2	0	0	0	**0**	0	0	**0**	0	0	0	**0**	1	0	0	0	0	**0**	**0**	0	3	0	0	0	0	**0**	**1**	0	0	0	**0**	0	0	**0**	**5**	**2**
18	**0**	0	0	**1**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**1**	1	0	0	0	0	**0**	**0**	1	1	1	0	0	0	**0**	**0**	0	0	0	**0**	1	1	**0**	**8**	**2**
19	**1**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**1**	**0**	0	1	0	0	0	0	**0**	**0**	0	0	0	**0**	0	1	**1**	**5**	**3**
20	**1**	0	0	**0**	0	0	0	0	1	**0**	0	0	**0**	0	0	0	**0**	0	1	0	0	2	**0**	**0**	1	1	0	0	0	0	**0**	**0**	0	0	2	**0**	0	1	**0**	**8**	**1**
21	**0**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	1	0	**1**	**0**	0	2	1	0	0	0	**0**	**1**	0	0	0	**1**	0	1	**0**	**7**	**3**
22	**0**	0	0	**0**	0	1	0	1	1	**0**	0	0	**0**	0	0	0	**0**	1	0	0	0	0	**0**	**0**	0	0	0	1	0	0	**1**	**0**	0	0	0	**0**	0	0	**1**	**7**	**2**
23	**0**	0	0	**0**	0	0	0	0	1	**1**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	0	1	0	1	0	0	**0**	**1**	0	0	0	**0**	0	0	**0**	**5**	**2**
24	**1**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	1	0	0	0	**0**	**0**	0	2	0	0	0	0	**0**	**1**	0	0	0	**0**	0	0	**1**	**5**	**3**
25	**0**	0	0	**0**	0	2	2	1	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	2	0	1	0	0	0	**0**	**2**	0	1	0	**0**	0	1	**0**	**8**	**1**
26	**0**	0	0	**0**	0	0	0	0	0	**0**	1	0	**0**	1	0	0	**0**	0	1	0	0	0	**0**	**0**	0	1	1	0	0	0	**0**	**0**	0	0	1	**0**	0	0	**0**	**6**	**0**
27	**0**	1	0	**0**	0	0	1	1	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	0	2	0	1	0	0	**0**	**1**	0	0	1	**0**	0	0	**0**	**7**	**1**
28	**1**	0	0	**0**	0	1	0	0	0	**1**	0	1	**0**	0	0	0	**0**	1	0	0	0	0	**0**	**0**	0	1	0	0	0	0	**0**	**0**	0	0	1	**0**	0	0	**0**	**7**	**2**
29	**0**	0	0	**0**	0	0	0	0	0	**0**	0	0	**2**	0	0	0	**0**	0	0	0	0	0	**1**	**1**	0	0	0	1	0	0	**0**	**0**	0	0	0	**0**	1	0	**0**	**5**	**3**
30	**2**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	1	0	0	0	0	**0**	**0**	0	3	0	0	0	0	**0**	**1**	0	0	0	**0**	0	1	**0**	**5**	**2**
31	**0**	0	0	**0**	0	0	0	0	0	**1**	0	0	**1**	0	0	0	**0**	0	0	0	0	0	**1**	**0**	0	0	0	0	0	0	**1**	**0**	0	1	0	**0**	1	0	**0**	**6**	**4**
32	**0**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	1	0	0	0	**2**	**0**	0	0	1	0	0	0	**0**	**0**	0	0	0	**0**	0	0	**0**	**3**	**1**

Appendix 1. continued

	Species Code																																								
PLOT	**ACFL**	AMCR	AMRE	**BACS**	BCNH	BGGN	BHCO	BLJA	CACH	**CARW**	COMO	COYE	**DICK**	EABL	EAKI	EAME	**EATO**	EAWP	ETTI	GCFL	GREG	HAWO	**INBU**	**KEWA**	MODO	NOCA	NOMO	NOPA	OROR	PIWO	**PROW**	**RBWO**	REVI	RWBL	SUTA	**WEVI**	YBCH	YBCU	**YTVI**	**SPP**	**SCI**
33	**0**	0	0	**0**	0	0	0	0	0	**0**	0	0	**2**	0	1	2	**0**	0	0	0	1	0	**0**	**0**	0	0	0	0	0	0	**0**	**0**	0	2	0	**0**	1	0	**0**	**6**	**1**
34	**0**	1	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**2**	**0**	0	1	1	0	0	0	**0**	**0**	0	0	0	**1**	0	1	**0**	**6**	**2**
35	**0**	0	0	**0**	0	0	1	0	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**3**	**0**	1	0	0	1	0	0	**0**	**0**	0	0	0	**0**	0	0	**1**	**5**	**2**
36	**0**	0	0	**0**	0	0	0	0	0	**0**	0	0	**0**	0	0	0	**0**	0	0	0	0	0	**0**	**0**	0	0	0	1	0	0	**0**	**1**	0	0	1	**0**	0	0	**1**	**4**	**2**

SPP = Species Richness

SCI = The Species Richness for a plot of “Species of Continental Importance”

Appendix 2. Averages (± std dev) for habitat parameters at Arkansas Post National Memorial, Arkansas during the 2007 bird breeding season. Within the scale in which habitat parameters are collected, 50-m plot, 5-m subplot and 1.78-m sample plot, percentages of coverage 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%).

	Plot														
Habitat Parameter	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
50 meter plot coverage															
Woodland (%)	97.5	62.5	97.5	97.5	37.5	0	85.0	0	85.0	85.0	0	97.5	97.5	97.5	85.0
Woodland Swamp (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shrubland (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Field / Prairie (%)	0	0	0	0	0	85.0	0.5	97.5	0.5	0	15.0	0	0	0	0
Lawn (%)	0	0	0	0	3.0	0	0	0	0	0	0	0	0	0	0.5
Road (%)	0	15.0	0	0	3.0	0	0	0	0	3.0	3.0	0	0	0	0.5
Path/ Trail/ Sidewalk (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pond/ Stream (%)	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0
5 meter subplot															
Canopy cover															
Hardwood (%)	98.0	99.3	95.2	99.8	99.8	0	98.0	0	98.5	95.2	0	97.8	92.0	98.0	80.3
Conifer (%)	0	2.08	0	0	0	0	0	0	0	0	0	0	0	0	0
Total cover (%)	98.0	99.8	95.2	99.8	99.8	0	98.0	0	98.5	95.2	0	97.8	92.0	98.0	80.3
Canopy Height															
Hardwood (m)	23.0	21.0	0	0	0	0	0	0	0	5.0	0	8.0	32.5	28.0	4.0
Conifer (m)	0	15.0	0	0	0	0	0	0	0	0	0	0	0	0	0
Basal Area															
Hardwood (m^2/ha)	22.5	15.0	27.5	5.0	20.0	0	35.0	0	22.5	5.0	0	17.5	17.5	25.0	7.5
Conifer (m^2/ha)	0	7.5	0	0	0	0	0	0	0	0	0	0	0	0	0
Horizontal vegetation profile at 5-m															
0.0 – 0.5 m (%)	97.5	3.0	97.5	0	37.5	62.5	62.5	97.5	15.0	97.5	97.5	15.0	37.5	97.5	0
0.25 – 0.75 m (%)	85.0	37.5	85.5	0	3.0	15.0	0.5	85.0	0	85.0	97.5	15.0	3.0	85.0	0
0.5 – 1.0 m (%)	37.5	37.5	62.5	97.5	0	0	0	3.0	0	85.0	62.5	3.0	0.5	85.0	0
0.75 – 1.25 m (%)	37.5	15.0	0	97.5	0	0	0	0	0	37.5	15.0	37.5	37.5	85.0	0
1.0 – 1.5 m (%)	62.5	0	0	97.5	0	0	0	0	0	15.0	0	37.5	62.5	37.5	0
1.25 – 1.75 m (%)	37.5	37.5	0	97.5	0	0	0	0	0	15.0	0	0	37.5	37.5	15.0
1.5 – 2.0 m (%)	15.0	37.5	0	97.5	37.5	0	0	0	0	15.0	0	0	37.5	37.5	37.5
Horizontal vegetation profile at 15-m															
0.0 – 0.5 m (%)	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5	62.5	97.5	97.5	15.0	37.5	97.5	0
0.25 – 0.75 m (%)	97.5	85.0	97.5	97.5	85.0	97.5	15.0	97.5	0.5	97.5	97.5	37.5	62.5	97.5	0

Appendix 2. continued

Habitat Parameter	Plot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0.5 – 1.0 m (%)	85.0	85.0	85.0	97.5	3.0	97.5	0.5	85.0	3.0	85.0	97.5	37.5	3.0	97.5	0
0.75 – 1.25 m (%)	97.5	62.5	85.0	97.5	0	62.5	0	0.5	3.0	37.5	97.5	37.5	37.5	97.5	0
1.0 – 1.5 m (%)	97.5	62.5	85.0	97.5	0	97.5	15.0	0	37.5	62.5	85.0	3.0	37.5	62.5	0
1.25 – 1.75 m (%)	62.5	85.0	62.5	97.5	15.0	0.5	37.5	0	97.5	97.5	15.0	0	62.5	37.5	3.0
1.5 – 2.0 m (%)	15.0	97.5	15.0	97.5	37.5	62.5	37.5	0	85.0	85.0	0	15.0	85.0	37.5	37.5
Vertical Profile: Deciduous															
0.0 – 1.0 m (%)	25.0	25.0	100.0	50.0	0	0	0	0	25.0	25.0	0	50.0	0	100.0	0
1.0 – 2.0 m (%)	0	0	25.0	50.0	0	0	0	0	0	50.0	0	25.0	25.0	0	0
2.0 – 3.0 m (%)	0	25.0	0	25.0	25.0	25.0	0	0	0	75.0	0	0	50.0	0	25.0
3.0 – 4.0 m (%)	0	25.0	0	0	25.0	0	25.0	0	25.0	75.0	0	0	25.0	0	0
4.0 – 5.0 m (%)	0	25.0	0	0	0	0	0	0	25.0	50.0	0	0	50.0	0	25.0
5.0 – 6.0 m (%)	0	25.0	0	0	25.0	0	0	0	0	50.0	0	0	25.0	0	25.0
6.0 – 7.0 m (%)	0	25.0	0	25.0	50.0	0	0	0	0	25.0	0	25.0	50.0	0	25.0
7.0 – 7.5 m (%)	0	25.0	0	0	0	0	0	0	25.0	0	0	25.0	0	0	25.0
Vertical Profile: Conifer															
0.0 – 1.0 m (%)	0	25.0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.0 – 2.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0 – 3.0 m (%)	0	25.0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0 – 4.0 m (%)	0	25.0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.0 – 5.0 m (%)	0	25.0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.0 – 6.0 m (%)	0	25.0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0 – 7.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0 – 7.5 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertical Profile: Herbaceous															
0.0 – 1.0 m (%)	100.0	25.0	75.0	50.0	100.0	75.0	100.0	100.0	25.0	75.0	75.0	0	100.0	50.0	25.0
1.0 – 2.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0 – 3.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0 – 4.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.0 – 5.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.0 – 6.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0 – 7.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0 – 7.5 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.78 meter sample plot coverage															
Deciduous litter (%)	37.5	85.0	37.5	62.5	62.5	0.5	37.5	0	62.5	15.0	0.5	85.0	62.5	62.5	62.5
Conifer litter (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grass litter (%)	0.5	0	0.5	0.5	0.5	37.5	3.0	37.5	0.5	3.0	3.0	0.5	0.5	0.5	0

Appendix 2. continued

Habitat Parameter	Plot 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bare soil (%)	62.5	15.0	3.0	0	0.5	15.0	15.0	15.0	0	15.0	37.5	3.0	0	15.0	3.0
Rock (%)	0	0	0	3.0	0	0	0	0	3.0	0	0	0	0	0	0
Woody debris (%)	3.0	0.5	0.5	0	0	0	0.5	0	0.5	0.5	0	0	0.5	0.5	0
Unvegetated (%)	85.0	97.5	62.5	85.0	97.5	85.0	85.0	85.0	97.5	85.0	85.0	97.5	85.0	85.0	97.5
Warm-season grass (%)	0	0	0	0	0	3.0	0	0.5	0	0.5	0.5	0	0	0	0
Cool-season grass (%)	3.0	0	0.5	3.0	0.5	3.0	3.0	15.0	0.5	15.0	3.0	0.5	3.0	0.5	0
Forb (%)	15.0	0.5	0.5	3.0	0.5	15.0	15.0	15.0	3.0	3.0	15.0	0.5	0	3.0	0
Moss and lichen (%)	0	0	0	0	3.0	0	0	0	0	0	0	0	0	0	0
Woody shrub and vine (%)	37.5	3.0	37.5	15.0	0	0	3.0	0	0.5	3.0	0.5	3.0	15.0	15.0	0
Tree seedling (%)	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0.5	0	0.5	0	0.5	0.5	0
Total foliar (%)	62.5	15.0	37.5	37.5	15.0	37.5	37.5	62.5	15.0	37.5	37.5	15.0	37.5	37.5	0

Appendix 2. Averages (± std dev) for habitat parameters at Arkansas Post National Memorial, Arkansas during the 2007 bird breeding season. Within the scale in which habitat parameters are collected, 50-m plot, 5-m subplot and 1.78-m sample plot, percentages of coverage 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	Plot 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
50 meter plot coverage															
Woodland (%)	97.5	85.0	85.0	85.0	37.5	0	97.5	62.5	97.5	0	0	85.0	0	0	97.5
Woodland Swamp (%)	0	0	0	0	0	0	0	0	0	0	0	0	62.5	0	0
Shrubland (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Field / Prairie (%)	0	0	0.5	0	0	97.5	0	0	0	0	0	0	0	97.5	0
Lawn (%)	0	0	0	0	0.5	0	0	0.5	0	62.5	85.0	0	0	0	0
Road (%)	0	0.5	0	0.5	3.0	0	0	0	0	0	0	0	0	0	0
Path/ Trail/ Sidewalk (%)	0	0	0	0	0	0	0	3.0	0	0.5	0	0.5	0	0	0
Pond / Stream (%)	0	0	0	0	0	0	0	0	0	3.0	0.5	0	3.0	0	0
5 meter subplot															
Canopy cover															
Hardwood (%)	99.1	99.6	88.4	79.0	99.8	10.4	99.6	76.4	99.3	34.7	23.2	97.5	39.0	0	97.2
Conifer (%)	0	0	0	10.4	0	0	0	8.3	0	0	0	0	0	0	0
Total cover (%)	99.1	99.6	88.4	81.6	99.8	10.4	99.6	84.8	99.3	34.7	23.2	97.5	39.0	0	97.2

Appendix 2. continued

Habitat Parameter	Plot 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Canopy Height															
Hardwood (m)	32.0	30.0	14.0	17.0	5.0	3.0	30.0	12.5	14.0	22.0	32.0	28.0	7.0	0	12.0
Conifer (m)	0	0	0	9.0	0	0	0	10.5	0	0	0	0	0	0	0
Basal Area															
Hardwood (m^2/ha)	40.0	22.5	2.5	27.5	12.5	0	20.0	20.0	15.0	7.5	7.5	27.5	17.5	0	27.5
Conifer (m^2/ha)	0	0	0	2.5	0	0	0	7.5	0	0	0	0	0	0	0
Horizontal vegetation profile at 5-m															
0.0 – 0.5 m (%)	0.5	62.5	62.5	15.0	97.5	97.5	37.5	0	97.5	3.0	15.0	62.5	15.0	97.5	3.0
0.25 – 0.75 m (%)	0	37.5	3.0	37.5	97.5	62.5	0	0	97.5	0	0	15.0	15.0	97.5	0
0.5 – 1.0 m (%)	0	37.5	0.5	3.0	97.5	15.0	0	0	97.5	0	0	0	15.0	85.0	0
0.75 – 1.25 m (%)	0	85.0	37.5	3.0	97.5	0	0	0	62.5	0	0	3.0	15.0	0.5	0
1.0 – 1.5 m (%)	0	85.0	37.5	0	97.5	0	0	0	37.5	0	0	62.5	37.5	0	0
1.25 – 1.75 m (%)	0	97.5	62.5	0	97.5	0	0	0	37.5	0	0	15.0	62.5	0	0.5
1.5 – 2.0 m (%)	0	85.0	37.5	0	97.5	0	0	0	37.5	0	0	37.5	97.5	0	0.5
Horizontal vegetation profile at 15-m															
0.0 – 0.5 m (%)	15.0	97.5	62.5	62.5	97.5	97.5	37.5	0	97.5	15.0	37.5	97.5	97.5	97.5	15.0
0.25 – 0.75 m (%)	3.0	97.5	15.0	37.5	97.5	97.5	37.5	0	97.5	0	0	97.5	97.5	97.5	0.5
0.5 – 1.0 m (%)	0	97.5	0	37.5	97.5	37.5	0.5	0	97.5	0	0	97.5	37.5	97.5	0.5
0.75 – 1.25 m (%)	0.5	97.5	15.0	37.5	97.5	37.5	0	0	97.5	0	0	97.5	15.0	97.5	15.0
1.0 – 1.5 m (%)	62.5	97.5	62.5	15.0	97.5	0	0	0	97.5	0	0	97.5	37.5	62.5	15.0
1.25 – 1.75 m (%)	37.5	85.0	85.0	0.5	97.5	0	0	0	97.5	0	0	37.5	97.5	97.5	3.0
1.5 – 2.0 m (%)	0	85.0	37.5	0	97.5	0	0	0	97.5	0	0	0	97.5	97.5	0.5
Vertical Profile: Deciduous															
0.0 – 1.0 m (%)	0	50.0	25.0	25.0	50.0	0	0	0	25.0	0	0	0	50.0	0	25.0
1.0 – 2.0 m (%)	0	25.0	25.0	0	75.0	0	0	0	0	0	0	25.0	0	0	0
2.0 – 3.0 m (%)	0	0	0	0	50.0	0	0	25.0	50.0	0	0	0	0	0	0
3.0 – 4.0 m (%)	25.0	0	0	0	0	0	25.0	0	25.0	25.0	0	0	25.0	0	25.0
4.0 – 5.0 m (%)	25.0	0	50.0	0	0	0	25.0	0	0	0	0	0	25.0	0	0
5.0 – 6.0 m (%)	0	0	25.0	0	25.0	0	0	0	25.0	25.0	0	0	25.0	0	25.0
6.0 – 7.0 m (%)	25.0	0	25.0	25.0	0	0	0	0	0	25.0	0	0	0	0	0
7.0 – 7.5 m (%)	25.0	0	100.0	25.0	0	0	0	25.0	0	0	0	0	0	0	0
Vertical Profile: Conifer															
0.0 – 1.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.0 – 2.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0 – 3.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0 – 4.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.0 – 5.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 2. continued

Habitat Parameter	Plot 16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
5.0 – 6.0 m (%)	0	0	0	0	0	0	0	50.0	0	0	0	0	0	0	0
6.0 – 7.0 m (%)	0	0	0	0	0	0	0	25.0	0	0	0	0	0	0	0
7.0 – 7.5 m (%)	0	0	0	25.0	0	0	0	0	0	0	0	0	0	0	0
Vertical Profile: Herbaceous															
0.0 – 1.0 m (%)	50.0	50.0	50.0	0	25.0	100.0	25.0	0	75.0	100.0	100.0	100.0	25.0	100.0	100.0
1.0 – 2.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2.0 – 3.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3.0 – 4.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4.0 – 5.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.0 – 6.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0 – 7.0 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0 – 7.5 m (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.78 meter sample plot coverage															
Deciduous litter (%)	85.0	62.5	62.5	85.0	85.0	0.5	62.5	62.5	62.5	0.5	0.5	62.5	15.0	0	62.5
Conifer litter (%)	0	0	0	0	0	0	0	3.0	0	0	0	0	0	0	0
Grass litter (%)	0.5	0.5	0.5	0.5	0.5	37.5	0.5	0.5	0.5	15.0	15.0	0.5	0	37.5	0.5
Bare soil (%)	0.5	3.0	3.0	3.0	3.0	15.0	0.5	3.0	3.0	37.5	37.5	3.0	37.5	37.5	15.0
Rock (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Woody debris (%)	0.5	0	0	0.5	0.5	0	3.0	0.5	0.5	0	0	0	3.0	0	0.5
Unvegetated (%)	97.5	85.0	85.0	85.0	85.0	85.0	85.0	85.0	97.5	85.0	62.5	85.0	97.5	85.0	97.5
Warm-season grass (%)	0	0	0	0	0	0.5	0	0	0	3.0	0	0.5	0	3.0	0
Cool-season grass (%)	0	0.5	3.0	0.5	3.0	37.5	0.5	0.5	0.5	15.0	62.5	15.0	0	3.0	0.5
Forb (%)	0.5	3.0	3.0	3.0	0	3.0	3.0	0.5	0.5	37.5	3.0	3.0	0.5	37.5	3.0
Moss and lichen (%)	0	0	0	0	0	0	0	3.0	0	0	0	0	0	0	0
Woody shrub and vine (%)	3.0	37.5	0.5	3.0	3.0	0	15.0	0	0	0	0	0	0	0	3.0
Tree seedling (%)	0.5	0.5	0.5	0	0	0	0.5	0.5	0.5	0	0	15.0	0.5	0	0.5
Total foliar (%)	15.0	62.5	37.5	15.0	37.5	62.5	37.5	15.0	15.0	37.5	85.0	62.5	3.0	37.5	15.0

Appendix 2. Averages (± std dev) for habitat parameters at Arkansas Post National Memorial, Arkansas during the 2007 bird breeding season. Within the scale in which habitat parameters are collected, 50-m plot, 5-m subplot, and 1.78-m sample plot, percentages of coverage 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%).

	Plot					
Habitat Parameter	31	32	33	34	35	36
50 meter plot coverage						
Woodland (%)	0	15.0	0	0	0	0
Woodland Swamp (%)	0	0	0	0	0	97.5
Shrubland (%)	0	0	0	0	0	0
Field / Prairie (%)	85.0	62.5	97.5	85.0	97.5	0
Lawn (%)	0	0	0	0	0	0
Road (%)	0.5	0	0	3.0	0	0
Path/ Trail/ Sidewalk (%)	0	0	0	0	0	0
Pond / Stream (%)	0	0	0	0	0	0
5 meter subplot						
Canopy cover						
Hardwood (%)	0	17.7	0	0	0	46.3
Conifer (%)	0	0	0	0	0	41.9
Total cover (%)	0	17.7	0	0	0	88.1
Canopy Height						
Hardwood (m)	0	0	0	0	0	18.0
Conifer (m)	0	0	0	0	0	20.0
Basal Area						
Hardwood (m^2/ha)	0	0	0	0	0	40.0
Conifer (m^2/ha)	0	0	0	0	0	2.5
Horizontal vegetation profile at 5-m						
0.0 – 0.5 m (%)	97.5	97.5	97.5	97.5	97.5	37.5
0.25 – 0.75 m (%)	97.5	97.5	97.5	97.5	85.0	0
0.5 – 1.0 m (%)	37.5	62.5	85.0	85.0	3.0	0
0.75 – 1.25 m (%)	0	3.0	15.0	15.0	3.0	0
1.0 – 1.5 m (%)	0	0.5	0	0	0	0
1.25 – 1.75 m (%)	0	0	0	0	0	0
1.5 – 2.0 m (%)	0	0	0	0	0	0

Appendix 2. continued

Habitat Parameter	Plot 31	32	33	34	35	36
Horizontal vegetation profile at 15-m						
0.0 – 0.5 m (%)	97.5	97.5	97.5	97.5	97.5	37.5
0.25 – 0.75 m (%)	97.5	97.5	97.5	97.5	97.5	15.0
0.5 – 1.0 m (%)	37.5	97.5	97.5	97.5	37.5	0
0.75 – 1.25 m (%)	0.5	3.0	85.0	3.0	3.0	0
1.0 – 1.5 m (%)	0	0	3.0	0	0	0
1.25 – 1.75 m (%)	0	0	0	0	0	0
1.5 – 2.0 m (%)	0	0	0	0	0	0
Vertical Profile: Deciduous						
0.0 – 1.0 m (%)	0	50.0	0	75.0	0	75.0
1.0 – 2.0 m (%)	0	0	0	0	0	0
2.0 – 3.0 m (%)	0	0	0	0	0	0
3.0 – 4.0 m (%)	0	0	0	0	0	25.0
4.0 – 5.0 m (%)	0	0	0	0	0	0
5.0 – 6.0 m (%)	0	0	0	0	0	0
6.0 – 7.0 m (%)	0	0	0	0	0	25.0
7.0 – 7.5 m (%)	0	0	0	0	0	0
Vertical Profile: Conifer						
0.0 – 1.0 m (%)	0	0	0	0	0	0
1.0 – 2.0 m (%)	0	0	0	0	0	0
2.0 – 3.0 m (%)	0	0	0	0	0	0
3.0 – 4.0 m (%)	0	0	0	0	0	0
4.0 – 5.0 m (%)	0	0	0	0	0	0
5.0 – 6.0 m (%)	0	0	0	0	0	0
6.0 – 7.0 m (%)	0	0	0	0	0	0
7.0 – 7.5 m (%)	0	0	0	0	0	0
Vertical Profile: Herbaceous						
0.0 – 1.0 m (%)	100.0	75.0	100.0	100.0	100.0	25.0
1.0 – 2.0 m (%)	0	0	50.0	0	0	0
2.0 – 3.0 m (%)	0	0	0	0	0	0
3.0 – 4.0 m (%)	0	0	0	0	0	0
4.0 – 5.0 m (%)	0	0	0	0	0	0
5.0 – 6.0 m (%)	0	0	0	0	0	0
6.0 – 7.0 m (%)	0	0	0	0	0	0
7.0 – 7.5 m (%)	0	0	0	0	0	0

Appendix 2. continued

Habitat Parameter	Plot 31	32	33	34	35	36
1.78 meter sample plot coverage						
Deciduous litter (%)	0	0	0	0.5	0	62.5
Conifer litter (%)	0	0	0	0	0	0
Grass litter (%)	15.0	37.5	15.0	15.0	37.5	0
Bare soil (%)	37.5	37.5	37.5	37.5	62.5	3.0
Rock (%)	0	0	0	0	0	0
Woody debris (%)	0	0	0	0.5	0	3.0
Unvegetated (%)	85.0	85.0	85.0	85.0	85.0	85.0
Warm-season grass (%)	0.5	3.0	0.5	0.5	0.5	0
Cool-season grass (%)	3.0	15.0	15.0	15.0	3.0	0
Forb (%)	15.0	0.5	37.5	3.0	3.0	3.0
Moss and lichen (%)	0	0	0	0	0	0
Woody shrub and vine (%)	0	15.0	0	15.0	0	15.0
Tree seedling (%)	0	0	0	0.5	0	0.5
Total foliar (%)	37.5	62.5	62.5	37.5	37.5	15.0

The NPS has organized its parks with significant natural resources into 32 networks linked by geography and shared natural resource characteristics. HTLN is composed of 15 National Park Service (NPS) units in eight Midwestern states. These parks contain a wide variety of natural and cultural resources including sites focused on commemorating civil war battlefields, Native American heritage, westward expansion, and our U.S. Presidents. The Network is charged with creating inventories of its species and natural features as well as monitoring trends and issues in order to make sound management decisions. Critical inventories help park managers understand the natural resources in their care while monitoring programs help them understand meaningful change in natural systems and to respond accordingly. The Heartland Network helps to link natural and cultural resources by protecting the habitat of our history.

The I&M program bridges the gap between science and management with a third of its efforts aimed at making information accessible. Each network of parks, such as Heartland, has its own multi-disciplinary team of scientists, support personnel, and seasonal field technicians whose system of online databases and reports make information and research results available to all. Greater efficiency is achieved through shared staff and funding as these core groups of professionals augment work done by individual park staff. Through this type of integration and partnership, network parks are able to accomplish more than a single park could on its own.

The mission of the Heartland Network is to collaboratively develop and conduct scientifically credible inventories and long-term monitoring of park "vital signs" and to distribute this information for use by park staff, partners, and the public, thus enhancing understanding which leads to sound decision making in the preservation of natural resources and cultural history held in trust by the National Park Service.

www.nature.nps.gov/im/units/htln/

Heartland Network

Natural Resource Monitoring

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 D-46, May 2008

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