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Bird Monitoring at Lincoln Boyhood National Memorial, Indiana: 2007 Status Report

Natural Resource Technical Report NPS/HTLN/NRTR—2008/100

ON THE COVER
Sign at entrance to Lincoln Boyhood National Memorial.
Photo from Heartland Network Files

Bird Monitoring at Lincoln Boyhood National Memorial, Indiana: 2007 Status Report

Natural Resource Technical Report NPS/HTLN/NRTR—2008/100

David G. Peitz
National Park Service, The Heartland I&M Network and Prairie Cluster Prototype Monitoring Program
Wilson's Creek National Battlefield, 6424 West Farm Road 182, Republic, MO 65738

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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 Lincoln Boyhood National Memorial, Indiana (LIBO) to address two objectives. The first is to monitor changes in bird community composition and abundance. The second is to monitor the responses of bird communities to changes in habitat structure and other habitat variables related to management activities. This report provides plot specific and park-wide baseline data on populations and breeding habitat of birds at LIBO. Thirty-five species of birds were recorded during site visits in June. The most common and widely distributed species was the Northern cardinal (*Cardinalis cardinalis*). The American crow (*Corvus brachyrhynchos*), Indigo bunting (*Passerina cyanea*), and Eastern Tufted titmouse (*Parus bicolor*) occurred frequently as well. Partners in Flight, a coalition of agencies and individuals whose mission is to conserve North America's declining bird populations, classify eleven species found at LIBO as species of continental importance. Species richness of birds was found to be low when compared to other woodlands. Deciduous woodlands dominated the habitat; other habitats were rare. Bird surveys were not conducted in the small pasture and garden areas of LIBO. The mixed structural composition of the woodlands positively influenced the bird diversity observed.

Plot specific population information and habitat conditions during the breeding season of 2007 will aid natural resource staff in planning management actions that may affect various bird populations. With this report, park staff will be able to better plan management objectives, and future monitoring will aid in assessing their effectiveness. Monitoring data also provides park staff with additional information used in interpreting their natural resources.

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.

The topography of the Interior Low Plateaus of Illinois, Indiana, Ohio, Kentucky, Tennessee, and Alabama is hilly and rolling, but includes swampy alluvial valleys, established rivers and streams, and karst plains. This landscape contains a rich and diverse plant community, with species from both the mid-western and eastern United States. Over 150 bird species nest in the Interior Low Plateaus, reflecting this area's diversity of habitats (Ford et al. 2000). Wide spread habitat loss to agriculture, as well as urban and industrial development, threaten the integrity of this physiographic area for birds.

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 Indiana show evidence of population declines (Sauer et al. 2007). Woodland species such as the Black-billed cuckoo (*Coccyzus erythropthalmus*), Red-headed woodpecker (*Melanerpes erythrocephalus*) and Northern flicker (*Colaptes auratus*) have declined at alarming rates. Grassland species such as the Field sparrow (*Spizella pusilla*), Grasshopper sparrow (*Ammodramus savannarum*), and Bobolink (*Dolichonyx oryzivorus*) have declined across the region as well.

We use trends in the composition and abundance of bird populations as long-term indicators of ecosystem integrity in the woodlands of Lincoln Boyhood National Memorial, Indiana (LIBO). 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 bird communities in woodlands may reflect the effectiveness of management in restoring and maintaining this community at LIBO. Bird monitoring, initiated in 2007, will aid in assessing the success of management efforts. Long-term trends in community composition and abundance of breeding bird populations provide one measure for assessing the ecological integrity and sustainability of this system.

Objectives

There are two primary objectives for monitoring breeding birds at Lincoln Boyhood National Memorial:

- Identify significant temporal changes in the species composition and abundance of bird communities that occur at LIBO during the breeding season.
- Improve our understanding of breeding bird – habitat relationships and the effects of management actions such as stand thinning or prescribed fire on bird populations, by correlating changes in bird community composition and abundance with changes in specific habitat variables (e.g., vegetation structure, ground cover).

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 100 x 100 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. Our sampling grid also matches an established grid used to assess plant communities. We established 41 permanent plots. However, due to the location of six plots in the pasture and garden areas of the memorial, monitoring only occurs on 35 of the plots (Fig. 1).

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

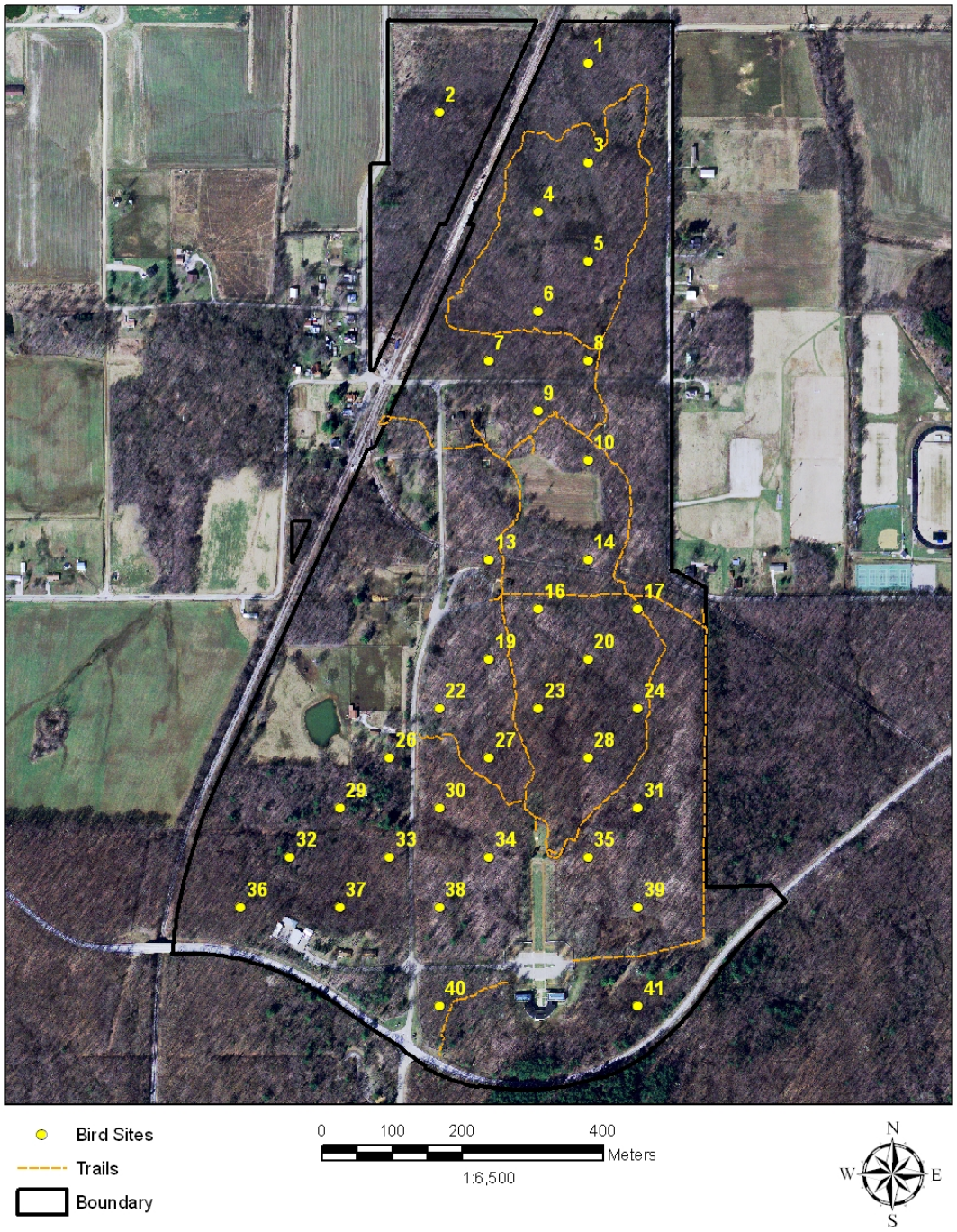

Figure 1. Bird plot locations on Lincoln Boyhood National Memorial, Indiana.

Table 1. Plot I.D. and habitat type for each breeding bird survey plot at Lincoln Boyhood National Memorial, Indiana. Also given are x and y UTM coordinates for each plot. UTM Zone 16 North, Datum 1983 (Conus).

Plot I.D.	Habitat Type	X Coordinate (Easting)	Y Coordinate (Northing)
LIBOTweety1	Woodland / Edge	500432.278	4219695.381
LIBOTweety2	Woodland	500220.146	4219624.671
LIBOTweety3	Woodland	500432.278	4219553.960
LIBOTweety4	Woodland	500361.567	4219483.249
LIBOTweety5	Woodland	500432.278	4219412.539
LIBOTweety6	Woodland	500361.567	4219341.828
LIBOTweety7	Woodland / Edge	500290.856	4219271.117
LIBOTweety8	Woodland / Edge	500432.278	4219271.117
LIBOTweety9	Woodland	500361.567	4219200.407
LIBOTweety10	Woodland	500432.278	4219129.696
LIBOTweety13	Woodland / Edge	500290.856	4218988.275
LIBOTweety14	Woodland / Edge	500432.278	4218988.275
LIBOTweety16	Woodland	500361.567	4218917.564
LIBOTweety17	Woodland	500502.988	4218917.564
LIBOTweety19	Woodland	500290.856	4218846.853
LIBOTweety20	Woodland	500432.278	4218846.853
LIBOTweety22	Woodland / Edge	500220.146	4218776.143
LIBOTweety23	Woodland	500361.567	4218776.143
LIBOTweety24	Woodland	500502.988	4218776.143
LIBOTweety26	Woodland / Edge	500149.435	4218705.432
LIBOTweety27	Woodland	500290.856	4218705.432
LIBOTweety28	Woodland	500432.278	4218705.432
LIBOTweety29	Woodland	500078.724	4218634.721
LIBOTweety30	Woodland / Edge	500220.146	4218634.721
LIBOTweety31	Woodland	500502.988	4218634.721
LIBOTweety32	Woodland / Edge	500008.014	4218564.010
LIBOTweety33	Woodland /Edge	500149.435	4218564.010
LIBOTweety34	Woodland	500290.856	4218564.010
LIBOTweety35	Woodland	500432.278	4218564.010
LIBOTweety36	Woodland / Edge	499937.303	4218493.300
LIBOTweety37	Woodland	500078.724	4218493.300
LIBOTweety38	Woodland / Edge	500220.146	4218493.300
LIBOTweety39	Woodland	500502.988	4218493.300
LIBOTweety40	Woodland	500220.146	4218351.878
LIBOTweety41	Woodland / Edge	500502.988	4218351.878

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 identifying species missed during timed surveys. We sampled all 35 plots between June 9 and June 10, 2007. We sampled birds during a period when it was light enough to observe birds to four hours after sunrise, approximately nine hours over the two 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 the 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 birds exactly at the center of the plot have 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 the 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 method's 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 the 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 plots were sampled, horizontal vegetation cover was estimated in 0.25-m intervals from 0.0 to 2.0 meters above ground surface using a 0.5-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 LIBO. 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/35). 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). 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 i^{th} species (Shannon, 1949). Species richness is the total number of bird taxa recorded per plot. Species distribution evenness is 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 than dividing it by two. 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 (>2.50 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 (± std dev). Appendix 2 lists habitat parameter values recorded for each plot.

Results

Bird Surveys

Thirty-five bird species were recorded during the breeding bird surveys at LIBO in 2007 (Table 2). Seventeen of the 35 species recorded are classified as permanent residents (Stokes and Stokes 1996). The remaining 18 species are classified as summer residents. One species, the Wild turkey (*Meleagris gallopavo*), was only observed outside the 5-min survey periods. Eleven species--Acadian flycatcher (Empidonax virescens), Carolina wren (*Thryothorus ludovicianus*), Eastern towhee (*Pipilo erythrophthalmus*), Indigo bunting (*Passerina cyanea*), Kentucky warbler (*Oporornis formosus*), Prothonotary warbler (*Protonotaria citrea*), Red-bellied woodpecker (*Melanerpes carolinus*), Red-headed woodpecker (*Melanerpes erythrocephalus*), Wood thrush (*Hylocichla mustelina*), Yellow-throated vireo (*Vireo flavifrons*), and Yellow-throated warbler (*Dendroica dominica*)--are considered species of continental importance (Rich et al. 2004).

The Northern cardinal (*Cardinalis cardinalis*) is the most commonly occurring species during the breeding season based on the mean number of individuals per plot and the proportion of plots occupied (Tables 3 and 4, also see Appendix 1). The American crow (*Corvus brachyrhynchos*), Blue-gray gnatcatcher (*Polioptila caerulea*), Carolina wren (*Thryothorus ludovicianus*), Eastern wood-peewee (*Contopus virens*), (Eastern) Tufted titmouse (*Parus bicolor*), Indigo bunting (*Passerina cyanea*), Red-bellied woodpecker (*Melanerpes carolinus*), and Yellow-billed cuckoo (*Coccyzus americanus*) are moderately abundant. Twelve species--American woodcock

(*Scolopax minor*), Chimney swift (*Chaetura pelagica*), Common grackle (*Quiscalus quiscula*), Eastern towhee (*Pipilo erythrophthalmus*), Kentucky warbler (*Oporornis formosus*), Northern bobwhite (*Colinus virginianus*), Ovenbird (*Seiurus aurocapillus*), Prothonotary warbler (*Protonotaria citrea*), Sharp-shinned hawk (*Accipiter striatus*), Summer tanager (*Piranga rubra*), Yellow-throated warbler (*Dendroica dominica*), and Yellow warbler (*Dendroica petechia*--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 densities of any species. However, the Pileated woodpecker (*Dryocopus pileatus*) and American crow (*Corvus brachyrhynchos*) had the highest densities of any species for plots occupied. Species richness and the richness of species of continental importance by plot are illustrated in Figure 2. Average ($\pm$ std dev) species richness, diversity, and species distribution evenness values for the bird community is given in Figure 3.

Table 2. Bird species recorded during breeding bird surveys at Lincoln Boyhood National Memorial, Indiana 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 robin	*Turdus migratorius*	AMRO	R
American woodcock	*Scolopax minor*	AMWO	R
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	SR
Blue jay	*Cyanocitta cristata*	BLJA	R
Carolina chickadee	*Parus carolinensis*	CACH	R
Carolina wren	***Thryothorus ludovicianus***	**CARW**	**R**
Chimney swift	*Chaetura pelagica*	CHSW	SR
Common grackle	*Quiscalus quiscula*	COGR	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
Gray catbird	*Dumetella carolinensis*	GRCA	SR
Indigo bunting	***Passerina cyanea***	**INBU**	**SR**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**SR**
Northern bobwhite	*Colinus virginianus*	NOBO	R
Northern cardinal	*Cardinalis cardinalis*	NOCA	R
Northern parula	*Parula Americana*	NOPA	SR
Ovenbird	*Seiurus aurocapillus*	OVEN	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
Red-headed woodpecker	***Melanerpes erythrocephalus***	**RHWO**	**R**
Sharp-shinned hawk	*Accipiter striatus*	SSHA	R
Summer tanager	*Piranga rubra*	SUTA	SR
White-breasted nuthatch	*Sitta carolinensis*	WBNU	R
Wild turkey*	*Meleagris gallopavo*	WITU	R
Wood thrush	***Hylocichla mustelina***	**WOTH**	**SR**
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	SR
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**SR**
Yellow-throated warbler	***Dendroica dominica***	**YTWA**	**SR**
Yellow warbler	*Dendroica petechia*	YWAR	SR

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

[1] Residency: SR = summer resident; R = year around resident; 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 35 plots, for bird species recorded at Lincoln Boyhood National Memorial, Indiana during the 2007 breeding bird surveys. Number of individuals per plot 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**	**0.06**
American crow	*Corvus brachyrhynchos*	AMCR	0.31
American robin	*Turdus migratorius*	AMRO	0.06
American woodcock	*Scolopax minor*	AMWO	0.03
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	0.23
Blue jay	*Cyanocitta cristata*	BLJA	0.09
Carolina chickadee	*Parus carolinensis*	CACH	0.09
Carolina wren	***Thryothorus ludovicianus***	**CARW**	**0.23**
Chimney swift	*Chaetura pelagica*	CHSW	0.06
Common grackle	*Quiscalus quiscula*	COGR	0.03
Eastern towhee	***Pipilo erythrophthalmus***	**EATO**	**0.03**
Eastern wood-pewee	*Contopus virens*	EAWP	0.26
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	0.40
Great crested flycatcher	*Myiarchus crinitus*	GCFL	0.11
Gray catbird	*Dumetella carolinensis*	GRCA	0.06
Indigo bunting	***Passerina cyanea***	**INBU**	**0.29**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**0.03**
Northern bobwhite	*Colinus virginianus*	NOBO	0.03
Northern cardinal	*Cardinalis cardinalis*	NOCA	0.69
Northern parula	*Parula Americana*	NOPA	0.09
Ovenbird	*Seiurus aurocapillus*	OVEN	0.03
Pileated woodpecker	*Dryocopus pileatus*	PIWO	0.09
Prothonotary warbler	***Protonotaria citrea***	**PROW**	**0.03**
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	**0.20**
Red-eyed vireo	*Vireo olivaceus*	REVI	0.11
Red-headed woodpecker	***Melanerpes erythrocephalus***	**RHWO**	0.06
Sharp-shinned hawk	*Accipiter striatus*	SSHA	0.03
Summer tanager	*Piranga rubra*	SUTA	0.03
White-breasted nuthatch	*Sitta carolinensis*	WBNU	0.17
Wood thrush	***Hylocichla mustelina***	**WOTH**	**0.11**
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0.26
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**0.11**
Yellow-throated warbler	***Dendroica dominica***	**YTWA**	**0.03**
Yellow warbler	*Dendroica petechia*	YWAR	0.03

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

Table 4. Proportion of plots (out of 35) occupied by bird species (including flyovers) at Lincoln Boyhood National Memorial, Indiana during the 2007 breeding bird surveys.

Common name	Species name	AOU code	Proportion of plots occupied
Acadian flycatcher	***Empidonax virescens***	**ACFL**	0.06
American crow	*Corvus brachyrhynchos*	AMCR	0.23
American robin	*Turdus migratorius*	AMRO	0.06
American woodcock	*Scolopax minor*	AMWO	0.03
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	0.23
Blue jay	*Cyanocitta cristata*	BLJA	0.09
Carolina chickadee	*Parus carolinensis*	CACH	0.09
Carolina wren	***Thryothorus ludovicianus***	**CARW**	0.23
Chimney swift	*Chaetura pelagica*	CHSW	0.03
Common grackle	*Quiscalus quiscula*	COGR	0.03
Eastern towhee	***Pipilo erythrophthalmus***	**EATO**	0.03
Eastern wood-pewee	*Contopus virens*	EAWP	0.20
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	0.31
Great crested flycatcher	*Myiarchus crinitus*	GCFL	0.11
Gray catbird	*Dumetella carolinensis*	GRCA	0.06
Indigo bunting	***Passerina cyanea***	**INBU**	0.26
Kentucky warbler	***Oporornis formosus***	**KEWA**	0.03
Northern bobwhite	*Colinus virginianus*	NOBO	0.03
Northern cardinal	*Cardinalis cardinalis*	NOCA	0.54
Northern parula	*Parula Americana*	NOPA	0.09
Ovenbird	*Seiurus aurocapillus*	OVEN	0.03
Pileated woodpecker	*Dryocopus pileatus*	PIWO	0.06
Prothonotary warbler	***Protonotaria citrea***	**PROW**	0.03
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	0.20
Red-eyed vireo	*Vireo olivaceus*	REVI	0.09
Red-headed woodpecker	***Melanerpes erythrocephalus***	**RHWO**	0.06
Sharp-shinned hawk	*Accipiter striatus*	SSHA	0.03
Summer tanager	*Piranga rubra*	SUTA	0.03
White-breasted nuthatch	*Sitta carolinensis*	WBNU	0.17
Wood thrush	***Hylocichla mustelina***	**WOTH**	0.11
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0.23
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	0.11
Yellow-throated warbler	***Dendroica dominica***	**YTWA**	0.03
Yellow warbler	*Dendroica petechia*	YWAR	0.03

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

Table 5. Average density (± std. dev.) of bird species at Lincoln Boyhood National Memorial, Indiana 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	2007 Individuals / ha
Acadian flycatcher	***Empidonax virescens***	**ACFL**	**0.02 (0.07)**
American crow	*Corvus brachyrhynchos*	AMCR	0.06 (0.19)
American robin	*Turdus migratorius*	AMRO	0.02 (0.07)
American woodcock	*Scolopax minor*	AMWO	0.01 (0.05)
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	0.07 (0.14)
Blue jay	*Cyanocitta cristata*	BLJA	0.01 (0.05)
Carolina chickadee	*Parus carolinensis*	CACH	0.02 (0.07)
Carolina wren	***Thryothorus ludovicianus***	**CARW**	**0.07 (0.14)**
Common grackle	*Quiscalus quiscula*	COGR	0.01 (0.05)
Eastern towhee	***Pipilo erythrophthalmus***	**EATO**	**0.01 (0.05)**
Eastern wood-pewee	*Contopus virens*	EAWP	0.07 (0.17)
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	0.10 (0.20)
Great crested flycatcher	*Myiarchus crinitus*	GCFL	0.04 (0.10)
Gray catbird	*Dumetella carolinensis*	GRCA	0.02 (0.07)
Indigo bunting	***Passerina cyanea***	**INBU**	**0.09 (0.17)**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**0.01 (0.05)**
Northern cardinal	*Cardinalis cardinalis*	NOCA	0.19 (0.22)
Northern parula	*Parula Americana*	NOPA	0.03 (0.09)
Ovenbird	*Seiurus aurocapillus*	OVEN	0.01 (0.05)
Pileated woodpecker	*Dryocopus pileatus*	PIWO	0.02 (0.11)
Prothonotary warbler	***Protonotaria citrea***	**PROW**	**0.01 (0.05)**
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	**0.05 (0.12)**
Red-eyed vireo	*Vireo olivaceus*	REVI	0.04 (0.13)
Red-headed woodpecker	***Melanerpes erythrocephalus***	**RHWO**	**0.02 (0.07)**
Sharp-shinned hawk	*Accipiter striatus*	SSHA	0.01 (0.05)
Summer tanager	*Piranga rubra*	SUTA	0.01 (0.05)
White-breasted nuthatch	*Sitta carolinensis*	WBNU	0.05 (0.12)
Wood thrush	***Hylocichla mustelina***	**WOTH**	**0.03 (0.09)**
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0.05 (0.14)
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**0.04 (0.10)**
Yellow-throated warbler	***Dendroica dominica***	**YTWA**	**0.01 (0.05)**
Yellow warbler	*Dendroica petechia*	YWAR	0.01 (0.05)

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 Lincoln Boyhood National Memorial, Indiana 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**	**0.32 (0.00)**
American crow	*Corvus brachyrhynchos*	AMCR	0.56 (0.16)
American robin	*Turdus migratorius*	AMRO	0.32 (0.00)
American woodcock	*Scolopax minor*	AMWO	0.32
Blue-gray gnatcatcher	*Polioptila caerulea*	BGGN	0.32 (0.00)
Blue jay	*Cyanocitta cristata*	BLJA	0.32
Carolina chickadee	*Parus carolinensis*	CACH	0.32 (0.00)
Carolina wren	***Thryothorus ludovicianus***	**CARW**	**0.32 (0.00)**
Common grackle	*Quiscalus quiscula*	COGR	0.32
Eastern towhee	***Pipilo erythrophthalmus***	**EATO**	**0.32**
Eastern wood-pewee	*Contopus virens*	EAWP	0.42 (0.16)
(Eastern) Tufted titmouse	*Parus bicolor*	ETTI	0.39 (0.21)
Great crested flycatcher	*Myiarchus crinitus*	GCFL	0.32 (0.00)
Gray catbird	*Dumetella carolinensis*	GRCA	0.32 (0.00)
Indigo bunting	***Passerina cyanea***	**INBU**	**0.35 (0.11)**
Kentucky warbler	***Oporornis formosus***	**KEWA**	**0.32**
Northern cardinal	*Cardinalis cardinalis*	NOCA	0.39 (0.14)
Northern parula	*Parula Americana*	NOPA	0.32 (0.00)
Ovenbird	*Seiurus aurocapillus*	OVEN	0.32
Pileated woodpecker	*Dryocopus pileatus*	PIWO	0.64
Prothonotary warbler	***Protonotaria citrea***	**PROW**	**0.32**
Red-bellied woodpecker	***Melanerpes carolinus***	**RBWO**	**0.32 (0.00)**
Red-eyed vireo	*Vireo olivaceus*	REVI	0.42 (0.18)
Red-headed woodpecker	***Melanerpes erythrocephalus***	**RHWO**	**0.32 (0.00)**
Sharp-shinned hawk	*Accipiter striatus*	SSHA	0.32
Summer tanager	*Piranga rubra*	SUTA	0.32
White-breasted nuthatch	*Sitta carolinensis*	WBNU	0.32 (0.00)
Wood thrush	***Hylocichla mustelina***	**WOTH**	**0.32 (0.00)**
Yellow-billed cuckoo	*Coccyzus americanus*	YBCU	0.40 (0.16)
Yellow-throated vireo	***Vireo flavifrons***	**YTVI**	**0.32 (0.00)**
Yellow-throated warbler	***Dendroica dominica***	**YTWA**	**0.32**
Yellow warbler	*Dendroica petechia*	YWAR	0.32

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

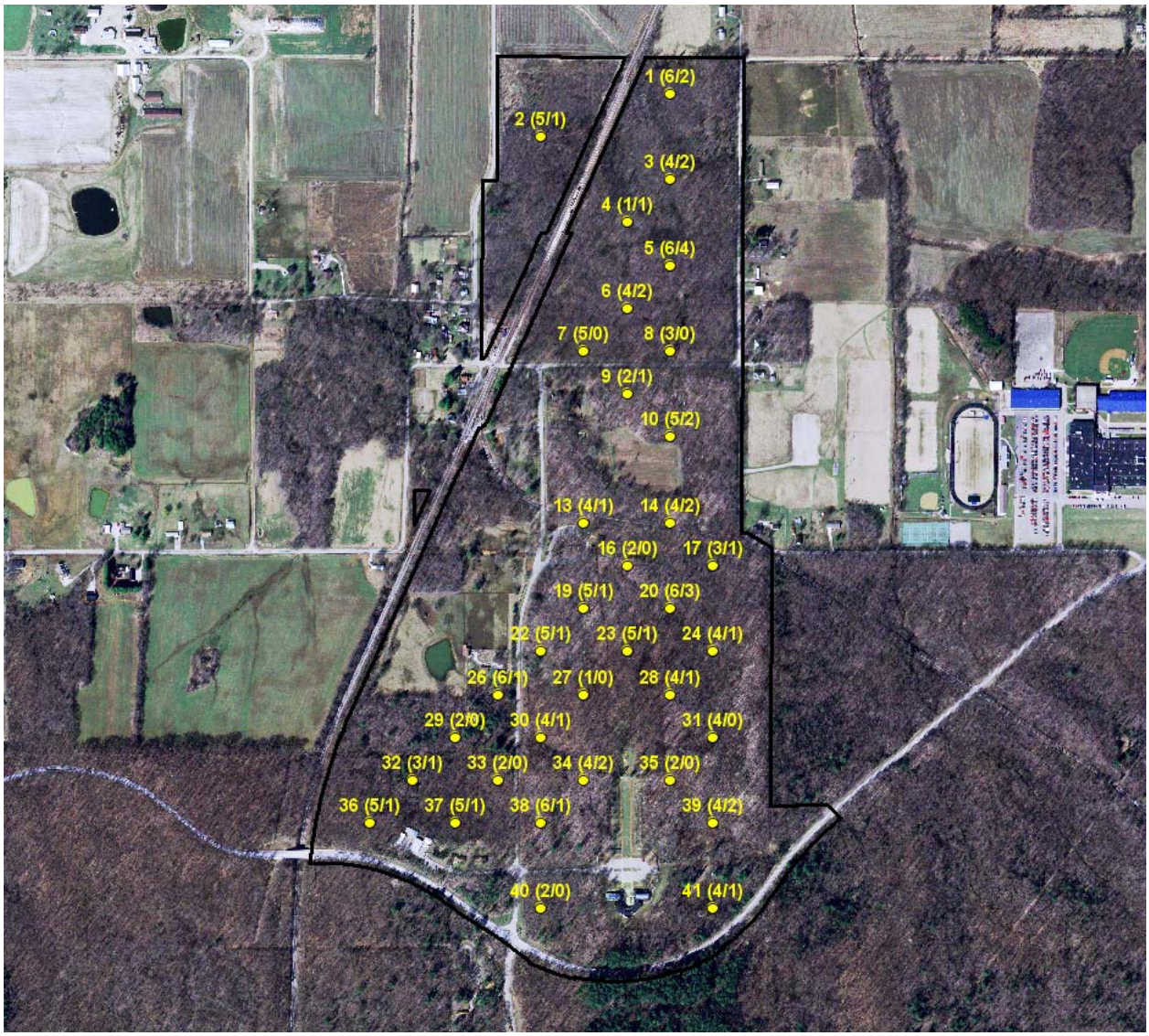

Figure 2. Bird species richness and the richness of species of continental importance for each plot on Lincoln Boyhood National Memorial, Indiana, in 2007

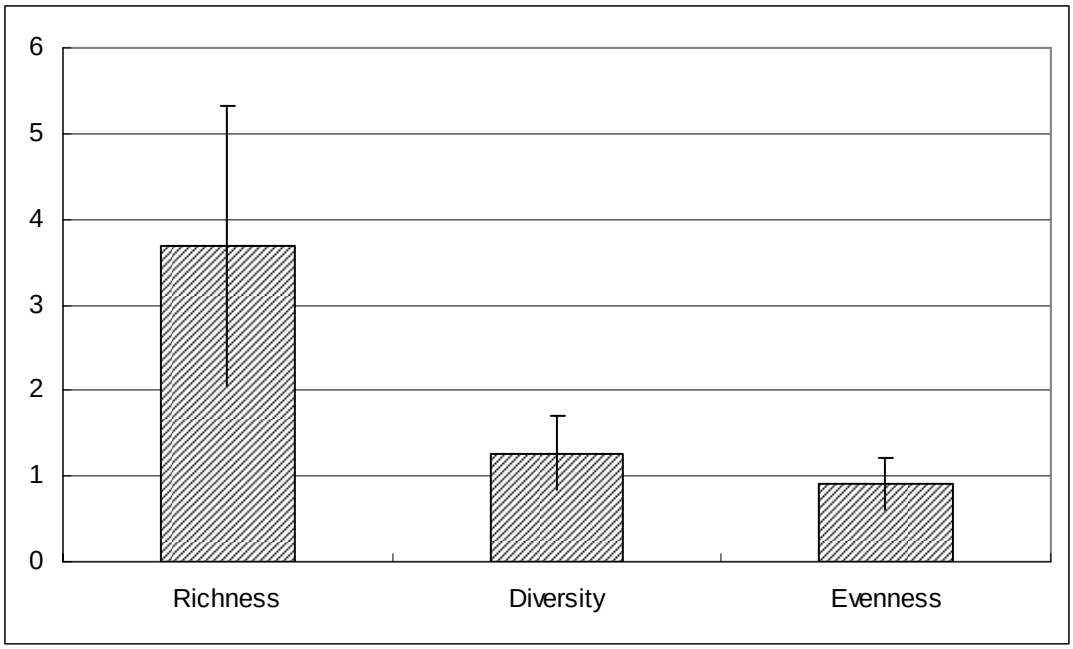

Figure 3. Average (± std dev) species richness, diversity, and species distribution evenness values for the bird community at Lincoln Boyhood National Memorial, Indiana during the breeding seasons of 2007.

Bird Habitat

Abiotic features of plots sampled for breeding birds and habitat composition are given in Table 7. Slope and aspect variability are low to medium for plots sampled. All plots are located on level topographic positions. Slope across all survey plots is $\leq 13^{o}$.

Bird survey plots average almost 79% woodland habitat type and 2% roads / trails, with smaller amounts of other habitat types present (Table 8). Canopy cover averaged almost 93%, with most being from hardwood trees. Basal area from hardwood trees averaged almost 18 m^2/ha. Hardwood tree species from fourteen different families contributed to the canopy cover and basal area (Table 9). Tree species from the *Cupressaceae* and *Pinaceae* families account for the limited amount of conifer canopy cover and basal area.

The highest horizontal vegetation cover observed occurred in profile classes below 1.0 meter when read from both 5- and 15-m distances (Table 8, also see Appendix 2). However, vegetation cover averaged 15% 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, 23%, appears to be low.

Deciduous litter was the most prominent litter type recorded (Table 8). Ground cover was mostly unvegetated and bare soil. Forbs, tree seedlings, and woody shrubs and vines provided the greatest amount of live foliar cover. Total foliar coverage averaged 29% across plots.

Table 7. Abiotic features of 50-m radius plots sampled for breeding birds at Lincoln Boyhood National Memorial, Indiana.

Plot number	Slope (^{O})	Slope variability	Aspect (^{O})	Aspect variability	Topographic position	Habitat type
LIBOTweety1	4.0	Low	232	Low	Level	Woodland / Edge
LIBOTweety2	5.0	Low	273	Low	Level	Woodland
LIBOTweety3	1.0	Low	52	Low	Level	Woodland
LIBOTweety4	4.0	Low	220	Low	Level	Woodland
LIBOTweety5	2.0	Low	13	Low	Level	Woodland
LIBOTweety6	5.0	Low	290	Low	Level	Woodland
LIBOTweety7	7.0	Low	310	Low	Level	Woodland / Edge
LIBOTweety8	4.0	Low	278	Low	Level	Woodland / Edge
LIBOTweety9	10.0	Low	28	Low	Level	Woodland
LIBOTweety10	10.0	Low	51	Low	Level	Woodland
LIBOTweety13	6.0	Medium	280	Medium	Level	Woodland / Edge
LIBOTweety14	5.0	Low	252	Low	Level	Woodland / Edge
LIBOTweety16	8.0	Low	128	Low	Level	Woodland
LIBOTweety17	2.0	Low	282	Low	Level	Woodland
LIBOTweety19	5.0	Low	292	Low	Level	Woodland
LIBOTweety20	6.0	Low	291	Low	Level	Woodland
LIBOTweety22	5.0	Low	30	Low	Level	Woodland / Edge
LIBOTweety23	11.0	Low	318	Low	Level	Woodland
LIBOTweety24	4.0	Medium	299	Low	Level	Woodland
LIBOTweety26	13.0	Low	264	Low	Level	Woodland / Edge
LIBOTweety27	12.0	Low	33	Low	Level	Woodland
LIBOTweety28	10.0	Low	299	Low	Level	Woodland
LIBOTweety29	10.0	Medium	245	Low	Level	Woodland
LIBOTweety30	10.0	Low	223	Low	Level	Woodland / Edge
LIBOTweety31	10.0	Medium	40	Low	Level	Woodland
LIBOTweety32	8.0	Low	7	Low	Level	Woodland / Edge
LIBOTweety33	7.0	Medium	328	Low	Level	Woodland /Edge
LIBOTweety34	8.0	Low	303	Low	Level	Woodland
LIBOTweety35	11.0	Low	185	Low	Level	Woodland
LIBOTweety36	4.0	Low	305	Low	Level	Woodland / Edge
LIBOTweety37	4.0	Medium	272	Low	Level	Woodland
LIBOTweety38	6.0	Low	100	Low	Level	Woodland / Edge
LIBOTweety39	10.0	Low	298	Low	Level	Woodland
LIBOTweety40	5.0	Low	225	Low	Level	Woodland
LIBOTweety41	5.0	Low	164	Low	Level	Woodland / Edge

Table 8. Averages (± std dev) for habitat parameters at Lincoln Boyhood National Memorial, Indiana during the bird breeding season, 2007. 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 (%)	78.64	19.40
Disturbed Floodplain (%)	0.09	0.51
Lawn (%)	0.09	0.51
Roads / Trails (%)	1.64	2.78
Railroad Tracks (%)	0.53	2.57
5 meter subplot		
Canopy cover		
Hardwood (%)	92.66	7.00
Conifer (%)	0.41	2.07
Total cover (%)	92.73	7.05
Canopy Height		
Hardwood (m)	22.31	7.26
Conifer (m)	0.93	3.29
Basal Area		
Hardwood (m^2/ha)	17.84	6.13
Conifer (m^2/ha)	0.33	0.99
Horizontal vegetation profile at 5-m		
0.0 – 0.5 m (%)	67.23	30.12
0.25 – 0.75 m (%)	31.11	32.01
0.5 – 1.0 m (%)	15.27	25.29
0.75 – 1.25 m (%)	9.81	20.34
1.0 – 1.5 m (%)	8.53	17.48
1.25 – 1.75 m (%)	5.59	12.16
1.5 – 2.0 m (%)	6.36	16.00
Horizontal vegetation profile at 15-m		
0.0 – 0.5 m (%)	88.36	20.94
0.25 – 0.75 m (%)	70.09	31.98
0.5 – 1.0 m (%)	49.37	33.06
0.75 – 1.25 m (%)	27.33	30.61
1.0 – 1.5 m (%)	20.13	27.64
1.25 – 1.75 m (%)	17.67	26.08
1.5 – 2.0 m (%)	14.67	21.53
Vertical structure diversity (%)	22.51	12.61
1.78 meter sample plot coverage		
Deciduous litter (%)	38.66	20.08
Conifer litter (%)	0.09	0.51
Grass litter (%)	0.43	0.50
Bare soil (%)	6.57	7.50
Rock (%)	0.10	0.51
Woody debris (%)	5.80	12.30
Unvegetated (%)	87.14	4.78
Warm-season grass (%)	0.00	0.00
Cool-season grass (%)	0.63	0.89
Forb (%)	6.23	7.71

Tables 8. continued

Habitat Parameter	Mean	std dev
Moss and lichen (%)	0.06	0.16
Woody shrub and vine (%)	1.91	4.21
Tree seedling (%)	3.49	5.40
Total foliar (%)	28.97	13.26

Table 9. Stems per hectare of trees by size class found on Lincoln Boyhood National Memorial, Indiana 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	80.03	163.70	152.79	61.84	40.02	43.65	21.83
Betulaceae	0.00	76.39	0.00	0.00	0.00	0.00	0.00
Cornaceae	0.00	14.55	32.74	7.28	0.00	0.00	0.00
Cupressaceae	0.00	0.00	0.00	3.64	0.00	0.00	0.00
Fabaceae	0.00	3.64	7.28	0.00	0.00	0.00	3.64
Fagaceae	0.00	0.00	10.91	3.64	0.00	0.00	3.64
Hamamelidaceae	7.28	7.28	10.91	10.91	10.91	32.74	25.46
Juglandaceae	14.55	83.67	47.29	14.55	14.55	21.83	7.28
Lauraceae	58.21	123.69	25.46	10.91	3.64	3.64	0.00
Magnoliaceae	87.31	14.55	32.74	21.83	3.64	3.64	14.55
Nyssaceae	0.00	69.12	0.00	3.64	3.64	0.00	0.00
Oleacea	116.41	94.58	36.38	0.00	0.00	0.00	0.00
Pinaceae	0.00	0.00	0.00	0.00	3.64	0.00	0.00
Platanaceae	0.00	0.00	0.00	0.00	0.00	0.00	10.91
Rosaceae	0.00	0.00	0.00	0.00	0.00	3.64	0.00
Ulmaceae	0.00	14.55	36.38	18.19	3.64	0.00	0.00
Total stems	**363.78**	**665.72**	**392.89**	**156.43**	**83.67**	**109.13**	**87.31**
Snags	0.00	138.24	72.76	21.83	10.91	7.28	0.00

Discussion

Bird surveys and habitat assessment work was initiated at Lincoln Boyhood National Memorial, Indiana in 2007, to assist the park in assessing the integrity of their woodlands through time. All thirty-five bird species recorded during the breeding bird surveys are permanent or summer residents to the area (Stokes and Stokes 1996). Therefore, all 35 species have some value in characterizing the breeding bird community of LIBO. Changes in the number of the most common and widely distributed species in the park--American crow, Indigo bunting, Northern cardinal, and Tufted titmouse--will serve as better measures for assessing changing woodland conditions. For example, species like the Northern cardinal and Indigo bunting have improved reproductive success when shrub cover is dense and mid-canopy trees are present (Stokes and Stokes 1996). Therefore, a decline in either species' numbers could very well indicate changes in the understory and mid-story of the woodlands. Less common and widely distributed species will likely occur so infrequently that strong species-habitat relationship may not be established.

Deciduous woodlands dominated the habitat (> 78%). However, the woodlands were of mixed structural composition, which positively influenced the number of species observed. Habitat diversity (structural composition) is especially important to high priority species, as their microhabitat requirements vary (Pashley and Barrow 1992). For example, Acadian flycatcher,

Wood thrush, and Yellow-throated vireo prefer mature deciduous habitat, while most other species of continental importance observed require thick shrubby habitat or open park-like woodlands (Stokes and Stokes 1996). Mowed lawn around the visitor center made up most of the grassland habitat in the park that was surveyed. Bird surveys were not conducted in the small pasture and garden areas. The eleven species of continental importance deserve extra scrutiny each time a survey is completed. Although the diverse mix of woodland habitats provides potentially satisfactory habitat for all the birds of continental importance as well as most other bird species, this habitat is easily altered if trees are thinned, insect infestations occur, or the understory or mid-story is cleared. Our baseline data suggests that three of the eleven species of continental importance (i.e., Carolina wren, Indigo bunting, and Red-bellied woodpecker) occur frequently enough at LIBO to aid significantly in assessing the influence of habitat management actions on their numbers. Similar to the habitat requirements listed above for the Acadian flycatcher, Wood thrush, and Yellow-throated vireo, the habitat requirement of these three species can be identified--Carolina wren, forest understory and shrubby habitat; Indigo bunting, brush and low trees of overgrown fields; and Red-bellied woodpecker, woodlands and urban / suburban forest (Stokes and Stokes 1996).

The Northern cardinal, the most common species, has remained relatively stable throughout Indiana and the Interior Low Plateaus, but declined 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. Management decisions aimed at influencing bird populations should center on those identified as species of local or continental importance. Species common to the park, however, such as the Northern cardinal, 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 widespread species, such as the Carolina wren, 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 richness 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 price to other species, unless that species is a keystone species for the desired habitat conditions (i.e., Ovenbird in mature woodlands).

Species richness, diversity, and evenness values are generally greater for bird communities in woodland and mixed habitats (Kelsey 2001) than open or grassland habitats (Cody 1966, Knopf 1997, Wiens 1973, Wiens 1974, Zimmerman 1992). Species richness values for the breeding bird community at Lincoln Boyhood National Memorial, however, appears to be low. 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. Average species richness on plots surveyed at LIBO was less than 3.7 individuals. Distribution evenness values suggest that a number of breeding bird 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.

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Appendix 1. Bird species counts by plot for Lincoln Boyhood National Memorial, Indiana in 2007. Data includes all 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	AMRO	AMWO	BGGN	BLJA	CACH	**CARW**	CHSW	COGR	**EATO**	EAWP	ETTI	GCFL	GRCA	**INBU**	**KEWA**	NOBO	NOCA	NOPA	OVEN	PIWO	**PROW**	**RBWO**	REVI	**RHWO**	SSHA	SUTA	WBNU	**WOTH**	YBCU	**YTVI**	**YTWA**	YWAR	**SPP**	**SCI**
1	**0**	2	0	0	1	0	0	**0**	0	0	**0**	0	1	0	0	**0**	**0**	0	0	0	1	0	**0**	**0**	0	**0**	0	0	0	**1**	0	**1**	**0**	0	**6**	**2**
2	**0**	2	0	0	0	0	1	**0**	0	0	**0**	0	1	0	0	**2**	**0**	0	0	0	0	0	**0**	**0**	0	**0**	0	0	1	**0**	0	**0**	**0**	0	**5**	**1**
3	**0**	2	0	0	0	0	0	**1**	0	0	**0**	0	0	0	0	**0**	**0**	1	0	0	0	0	**0**	**0**	0	**0**	0	0	0	**0**	0	**1**	**0**	0	**4**	**2**
4	**0**	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	**0**	0	**0**	**0**	0	**1**	**1**
5	**1**	0	0	0	0	0	0	**1**	0	0	**0**	0	0	0	0	**1**	**0**	0	0	0	0	0	**0**	**0**	0	**0**	1	0	0	**0**	1	**1**	**0**	0	**6**	**4**
6	**0**	0	0	0	1	0	0	**0**	0	0	**0**	0	0	0	0	**1**	**0**	0	1	0	0	0	**0**	**0**	0	**0**	0	0	0	**1**	0	**0**	**0**	0	**4**	**2**
7	**0**	1	0	0	1	0	0	**0**	0	0	**0**	0	1	0	0	**0**	**0**	0	2	0	0	0	**0**	**0**	2	**0**	0	0	0	**0**	0	**0**	**0**	0	**5**	**0**
8	**0**	0	0	0	0	1	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**	**0**	0	**3**	**0**
9	**0**	0	1	0	0	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	**2**	**1**
10	**1**	0	0	0	0	0	0	**0**	0	0	**0**	0	1	0	0	**0**	**0**	0	0	0	0	0	**0**	**1**	0	**0**	0	0	1	**0**	1	**0**	**0**	0	**5**	**2**
13	**0**	1	0	0	1	0	0	**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**	**0**	0	**4**	**1**
14	**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	**0**	**1**	0	**4**	**2**
16	**0**	0	0	0	0	0	0	**0**	0	0	**0**	0	0	0	0	**0**	**0**	0	2	1	0	0	**0**	**0**	0	**0**	0	0	0	**0**	0	**0**	**0**	0	**2**	**0**
17	**0**	0	0	0	0	0	0	**0**	0	0	**0**	1	2	0	0	**0**	**0**	0	0	0	0	0	**0**	**1**	0	**0**	0	0	0	**0**	0	**0**	**0**	0	**3**	**1**
19	**0**	0	0	0	0	0	0	**0**	0	0	**0**	0	0	0	0	**0**	**0**	0	1	1	0	1	**0**	**1**	0	**0**	0	0	0	**0**	1	**0**	**0**	0	**5**	**1**
20	**0**	0	0	0	0	0	0	**1**	0	0	**0**	0	0	0	0	**0**	**0**	0	1	1	0	0	**1**	**1**	0	**0**	0	0	0	**0**	2	**0**	**0**	0	**6**	**3**
22	**0**	0	0	0	0	0	0	**0**	0	0	**0**	0	0	1	1	**1**	**0**	0	1	0	0	0	**0**	**0**	0	**0**	0	0	1	**0**	0	**0**	**0**	0	**5**	**1**
23	**0**	0	0	0	0	1	0	**0**	0	0	**0**	2	0	1	0	**0**	**0**	0	2	0	0	0	**0**	**1**	0	**0**	0	0	0	**0**	0	**0**	**0**	0	**5**	**1**
24	**0**	0	0	0	0	0	0	**0**	0	0	**0**	1	0	1	0	**0**	**1**	0	0	0	0	0	**0**	**0**	0	**0**	0	0	0	**0**	0	**0**	**0**	1	**4**	**1**
26	**0**	0	0	0	1	0	0	**0**	0	1	**0**	0	1	0	0	**0**	**0**	0	1	0	0	0	**0**	**0**	0	**0**	0	0	1	**1**	0	**0**	**0**	0	**6**	**1**
27	**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	**0**	0	0	0	**0**	0	**0**	**0**	0	**1**	**0**
28	**0**	0	0	0	0	0	0	**1**	0	0	**0**	0	0	0	0	**0**	**0**	0	0	0	0	2	**0**	**0**	0	**1**	0	1	0	**0**	0	**0**	**0**	0	**4**	**1**
29	**0**	0	1	0	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**	**0**	0	**2**	**0**
30	**0**	1	0	0	0	0	0	**0**	0	0	**0**	1	0	0	0	**0**	**0**	0	1	0	0	0	**0**	**1**	0	**0**	0	0	0	**0**	0	**0**	**0**	0	**4**	**1**
31	**0**	0	0	1	0	0	0	**0**	0	0	**0**	0	0	0	0	**0**	**0**	0	1	0	0	0	**0**	**0**	1	**0**	0	0	0	**0**	1	**0**	**0**	0	**4**	**0**
32	**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	1	**0**	0	**0**	**0**	0	**3**	**1**
33	**0**	0	0	0	0	0	0	**0**	0	0	**0**	0	1	0	1	**0**	**0**	0	0	0	0	0	**0**	**0**	0	**0**	0	0	0	**0**	0	**0**	**0**	0	**2**	**0**
34	**0**	0	0	0	1	0	0	**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**	**0**	0	**4**	**2**
35	**0**	0	0	0	0	0	0	**0**	0	0	**0**	1	0	0	0	**0**	**0**	0	2	0	0	0	**0**	**0**	0	**0**	0	0	0	**0**	0	**0**	**0**	0	**2**	**0**
36	**0**	0	0	0	0	0	1	**0**	0	0	**0**	1	3	0	0	**0**	**0**	0	0	0	0	0	**0**	**0**	0	**0**	0	0	1	**1**	0	**0**	**0**	0	**5**	**1**
37	**0**	0	0	0	1	0	1	**0**	0	0	**0**	2	0	0	0	**0**	**0**	0	1	0	0	0	**0**	**0**	0	**0**	0	0	0	**0**	0	**1**	**0**	0	**5**	**1**

Appendix 1. continued

	Species Code																																			
P	**A**	A	A	A	B	B	C	**C**	C	C	**E**	E	E	G	G	**I**	**K**	N	N	N	O	P	**P**	**R**	R	**R**	S	S	W	**W**	Y	**Y**	**Y**	Y		
L	**C**	M	M	M	G	L	A	**A**	H	O	**A**	A	T	C	R	**N**	**E**	O	O	O	V	I	**R**	**B**	E	**H**	S	U	B	**O**	B	**T**	**T**	W	**S**	**S**
O	**F**	C	R	W	G	J	C	**R**	S	G	**T**	W	T	F	C	**B**	**W**	B	C	P	E	W	**O**	**W**	V	**W**	H	T	N	**T**	C	**V**	**W**	A	**P**	**C**
T	**L**	R	O	O	N	A	H	**W**	W	R	**O**	P	I	L	A	**U**	**A**	O	A	A	N	O	**W**	**O**	I	**O**	A	A	U	**H**	U	**I**	**A**	R	**P**	**I**
38	**0**	1	0	0	0	1	0	**1**	0	0	**0**	0	1	0	0	**0**	**0**	0	1	0	0	0	**0**	**0**	0	**0**	0	0	0	**0**	1	**0**	**0**	0	**6**	**1**
39	**0**	1	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	**0**	**0**	0	**4**	**2**
40	**0**	0	0	0	1	0	0	**0**	0	0	**0**	0	0	0	0	**0**	**0**	0	2	0	0	0	**0**	**0**	0	**0**	0	0	0	**0**	0	**0**	**0**	0	**2**	**0**
41	**0**	0	0	0	0	0	0	**0**	1	0	**0**	0	1	0	0	**1**	**0**	0	0	0	0	0	**0**	**0**	0	**0**	0	0	0	**0**	1	**0**	**0**	0	**4**	**1**

SPP = Species Richness

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

Appendix 2. Averages (± std dev) for habitat parameters at Lincoln Boyhood National Memorial, Indiana 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 (%)	85.0	97.5	85.0	97.5	97.5	85.0	62.5	37.5	85.0	85.0	0	0	15.0	62.5	0
Woodland Swamp (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Railroad (%)	0.5	0	0	0	0	0	0	0	0	0	0	0	3.0	15.0	0
Field / Prairie (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lawn (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Road (%)	0	0	0	0	0	0	3.0	3.0	0	0	0	0	0.5	0	0
Path/ Trail/ Sidewalk (%)	0	0	0.5	0	0	0.5	0	3.0	0.5	0.5	0	0	3.0	0	0
Pond / Stream (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 meter subplot															
Canopy cover															
Hardwood (%)	86.8	74.9	87.4	90.5	99.8	93.6	71.5	95.7	93.6	99.3	0	0	92.0	90.2	0
Conifer (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total cover (%)	86.8	74.9	87.4	90.5	99.8	93.6	71.5	95.7	93.6	99.3	0	0	92.0	90.2	0
Canopy Height															
Hardwood (m)	22.0	24.0	21.0	15.0	14.0	24.0	24.0	13.0	10.0	27.0	0	0	31.0	18.5	0
Conifer (m)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Basal Area															
Hardwood (m^2/ha)	25.0	15.0	17.5	20.0	10.0	15.0	15.0	15.0	17.5	10.0	0	0	22.5	15.0	0
Conifer (m^2/ha)	0	0	0	0	0	0	0	2.5	0	0	0	0	0	0	0
Horizontal vegetation profile at 5-m															
0.0 – 0.5 m (%)	15.0	97.5	62.5	37.5	85.0	37.5	97.5	97.5	97.5	97.5	0	0	37.5	37.5	0
0.25 – 0.75 m (%)	3.0	37.5	37.5	0.5	37.5	3.0	62.5	0.5	85.0	37.5	0	0	3.0	37.5	0
0.5 – 1.0 m (%)	0.5	0.5	15.0	0.5	0.5	0	37.5	0	0.5	37.5	0	0	0	37.5	0
0.75 – 1.25 m (%)	0	0	0	0	0	0	15.0	0	37.5	0.5	0	0	0	0	0
1.0 – 1.5 m (%)	0	0	0	0	0	0	15.0	0	37.5	0	0	0	0	0.5	0
1.25 – 1.75 m (%)	0	3.0	0	0	0	0	3.0	0	3.0	0.5	0	0	3.0	0	0
1.5 – 2.0 m (%)	0	37.5	0	0	0	0	0	0	0	15.0	0	0	15.0	0	0
Horizontal vegetation profile at 15-m															
0.0 – 0.5 m (%)	37.5	97.5	97.5	62.5	97.5	62.5	97.5	97.5	97.5	97.5	0	0	97.5	97.5	0
0.25 – 0.75 m (%)	15.0	97.5	85.0	0	62.5	15.0	97.5	85.0	62.5	97.5	0	0	62.5	97.5	0
0.5 – 1.0 m (%)	3.0	85.0	62.5	0	62.5	0	97.5	0	15.0	62.5	0	0	62.5	85.0	0

Appendix 2. continued

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

Appendix 2. continued

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

Appendix 2. Averages (± std dev) for habitat parameters at Lincoln Boyhood National Memorial, Indiana 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	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
50 meter plot coverage															
Woodland (%)	85.0	62.5	0	62.5	97.5	0	85.0	85.0	85.0	0	37.5	85.0	97.5	85.0	85.0
Woodland Swamp (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disturbed Floodplain (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	3.0	0
Field / Prairie (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lawn (%)	0	0	0	0	0	0	0	0	0	0	3.0	0	0	0	0
Road (%)	0	0	0	0	0	0	0.5	0	0	0	3.0	0	0	0	0.5
Path/ Trails/ Sidewalk (%)	0.5	3.0	0	3.0	0	0	0	3.0	0.5	0	0	0.5	0	0	0
Pond / Stream (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5 meter subplot															
Canopy cover															
Hardwood (%)	95.2	98.3	0	99.8	95.7	0	96.7	84.8	85.8	0	95.4	97.8	90.5	98.0	90.5
Conifer (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	12.2	2.1
Total cover (%)	95.2	98.3	0	99.8	95.7	0	96.7	84.8	85.8	0	95.4	97.8	90.5	99.3	90.5
Canopy Height															
Hardwood (m)	28.0	36.0	0	36.0	28.0	0	24.0	30.0	26.0	0	24.0	20.0	13.0	11.0	9.5
Conifer (m)	0	0	0	0	0	0	0	0	0	0	0	0	0	12.0	5.5

Appendix 2. continued

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

Appendix 2. continued

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

Appendix 2. Averages (± std dev) for habitat parameters at Lincoln Boyhood National Memorial, Indiana 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	37	38	39	40	41
50 meter plot coverage											
Woodland (%)	97.5	62.5	62.5	85.0	85.0	85.0	97.5	85.0	97.5	85.0	62.5
Woodland Swamp (%)	0	0	0	0	0	0	0	0	0	0	0
Shrubland (%)	0	0	0	0	0	0	0	0	0	0	0
Field / Prairie (%)	0	0	0	0	0	0	0	0	0	0	0
Lawn (%)	0	0	0	0	0	0	0	0	0	0	0
Road (%)	0	15.0	3.0	0	0	0.5	0	3.0	0	0	3.0
Path/ Trail/ Sidewalk (%)	0	0	0	0.5	0.5	0	0	0	0	3.0	0
Pond / Stream (%)	0	0	0	0	0	0	0	0	0	0	0
5 meter subplot											
Canopy cover											
Hardwood (%)	93.1	95.2	95.9	99.6	78.0	99.1	99.3	94.1	90.7	94.6	99.8
Conifer (%)	2.1	2.1	0	0	0	0	0	0	0	0	0
Total cover (%)	93.1	96.2	95.9	99.6	78.0	99.1	99.3	94.1	90.7	94.6	99.8
Canopy Height											
Hardwood (m)	30.0	20.0	26.0	26.0	18.0	30.0	12.0	25.0	28.0	24.0	13.0
Conifer (m)	15.0	0	0	0	0	0	0	0	0	0	0
Basal Area											
Hardwood (m^2/ha)	25.0	10.0	15.0	27.5	20.0	20.0	5.0	35.0	25.0	15.0	15.0
Conifer (m^2/ha)	2.5	0	0	0	0	0	0	0	0	0	0
Horizontal vegetation profile at 5-m											
0.0 – 0.5 m (%)	97.5	97.5	37.5	62.5	97.5	62.5	97.5	37.5	37.5	85.0	97.5
0.25 – 0.75 m (%)	85.0	62.5	0	15.0	85.0	3.0	37.5	0	15.0	62.5	62.5
0.5 – 1.0 m (%)	62.5	37.5	0	0.5	62.5	0	0	0	0	37.5	0
0.75 – 1.25 m (%)	37.5	37.5	0	0	85.0	0	0	0	0	0.5	0
1.0 – 1.5 m (%)	62.5	0	15.0	0	62.5	0	0	0	0	0	0.5
1.25 – 1.75 m (%)	37.5	0	37.5	0	15.0	0	0	0	0	0	37.5
1.5 – 2.0 m (%)	62.5	0	0	0	0	0	0	0	0	0	62.5
Horizontal vegetation profile at 15-m											
0.0 – 0.5 m (%)	97.5	97.5	15.0	97.5	97.5	97.5	97.5	97.5	97.5	97.5	97.5
0.25 – 0.75 m (%)	97.5	97.5	15.0	85.0	97.5	85.0	97.5	62.5	97.5	97.5	62.5
0.5 – 1.0 m (%)	97.5	37.5	37.5	62.5	97.5	37.5	62.5	97.5	62.5	97.5	37.5

Appendix 2. continued

	Plot										
Habitat Parameter	31	32	33	34	35	36	37	38	39	40	41
0.75 – 1.25 m (%)	37.5	62.5	15.0	85.0	97.5	0	37.5	15.0	37.5	62.5	0
1.0 – 1.5 m (%)	85.0	0.5	0	37.5	62.5	15.0	0.5	0	15.0	37.5	37.5
1.25 – 1.75 m (%)	62.5	0	3.0	15.0	37.5	0	37.5	0	3.0	0.5	62.5
1.5 – 2.0 m (%)	37.5	0	0	15.0	0	0	37.5	15.0	3.0	0	62.5
Vertical Profile: Deciduous											
0.0 – 1.0 m (%)	50.0	25.0	100.0	50.0	50.0	75.0	100.0	25.0	75.0	50.0	50.0
1.0 – 2.0 m (%)	50.0	0	0	0	25.0	25.0	75.0	0	25.0	25.0	0
2.0 – 3.0 m (%)	25.0	0	0	0	0	50.0	50.0	0	0	0	0
3.0 – 4.0 m (%)	0	0	25.0	25.0	0	0	0	0	0	0	50.0
4.0 – 5.0 m (%)	0	25.0	0	25.0	0	25.0	0	0	0	25.0	25.0
5.0 – 6.0 m (%)	0	25.0	25.0	0	0	25.0	0	25.0	25.0	0	0
6.0 – 7.0 m (%)	0	50.0	0	0	0	0	0	0	0	25.0	25.0
7.0 – 7.5 m (%)	0	25.0	0	0	0	0	0	0	25.0	0	0
Vertical Profile: Conifer											
0.0 – 1.0 m (%)	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
2.0 – 3.0 m (%)	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
4.0 – 5.0 m (%)	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
6.0 – 7.0 m (%)	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
Vertical Profile: Herbaceous											
0.0 – 1.0 m (%)	50.0	75.0	0	0	75.0	25.0	0	25.0	75.0	75.0	50.0
1.0 – 2.0 m (%)	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
3.0 – 4.0 m (%)	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
5.0 – 6.0 m (%)	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
7.0 – 7.5 m (%)	0	0	0	0	0	0	0	0	0	0	0
1.78 meter sample plot coverage											
Deciduous litter (%)	15.0	62.5	62.5	62.5	37.5	62.5	62.5	62.5	37.5	62.5	37.5
Conifer litter (%)	0	0	0	0	0	0	0	0	0	0	0
Grass litter (%)	0	0.5	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bare soil (%)	15.0	3.0	3.0	3.0	3.0	3.0	0	3.0	3.0	0.5	3.0

Appendix 2. continued

	Plot										
Habitat Parameter	31	32	33	34	35	36	37	38	39	40	41
Rock (%)	0	0	0	0	0	0	0	0	0	0	0
Woody debris (%)	15.0	3.0	0.5	3.0	3.0	0	3.0	0.5	0.5	3.0	0.5
Unvegetated (%)	85.0	85.0	85.0	85.0	85.0	85.0	85.0	97.5	85.0	85.0	85.0
Warm-season grass (%)	0	0	0	0	0	0	0	0	0	0	0
Cool-season grass (%)	0.5	0.5	0.5	0.5	0.5	0	0.5	3.0	0.5	0.5	0.5
Forb (%)	3.0	15.0	3.0	0.5	0.5	3.0	3.0	3.0	15.0	3.0	15.0
Moss and lichen (%)	0.5	0	0	0	0	0	0	0	0	0	0
Woody shrub and vine (%)	0.5	0.5	0	0	0	0	0	0	0	3.0	0
Tree seedling (%)	15.0	3.0	0.5	3.0	15.0	3.0	15.0	0.5	0.5	0.5	0.5
Total foliar (%)	37.5	37.5	15.0	15.0	37.5	15.0	37.5	15.0	37.5	37.5	37.5

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

National Park Service
U.S. Department of the Interior

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nps.gov