

IDNR Wildlife Preservation Fund Final Report

A Multivariate Habitat Model for State Threatened Cerulean Warbler and Other
Neotropical Migrant Songbirds in Southwestern Illinois

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Project Objective: The objectives of the proposed study are to: (1) establish 140 permanent vegetation plots on the SIUE campus and adjacent Bohm Woods State Nature Reserve; (2) collect quantitative data on the composition and structure of the forest community (both woody and herbaceous plant species); (3) census bluff forest avifauna in order to generate baseline data for future sampling efforts aimed at monitoring population trends; and (4) generate a predictive model using vegetation and avian census data in order to identify suitable habitat for target species such as the Cerulean Warbler.

Project Accomplishments: We published a peer-reviewed paper based upon the results of this IDNR supported research entitled “A survey of bluff forest avifauna in southwestern Illinois” in *Transactions of the Illinois State Academy of Sciences*.

Richter, L. A., Essner, R. L. & Minchin, P.R. (2010). A survey of bluff forest avifauna in southwestern Illinois. *Transactions of the Illinois State Academy of Science*, 103: 39-48.

In addition, we presented results of this study at the 2009 Illinois State Academy of Science Meetings and at a 2009 National Great Rivers Research and Education Center Symposium. We will also be presenting additional data from spring/summer 2010 at the 2011 Illinois State Academy of Science Meetings. We have two additional papers in preparation, one on the results of the vegetation survey and another on habitat modeling. Highlights of this research include identification of 94 bird species among the three forest patches, including species of conservation concern in Illinois: Black-billed Cuckoo, Northern Harrier, and Cerulean Warbler. The results of this study also underscore the importance of Bohm Woods State Nature Preserve for forest interior birds and transient migrants. We found that Bohm Woods differed from the other forest patches in the study by supporting higher numbers of forest interior birds,

including two Neotropical migrants sensitive to fragmentation, Acadian Flycatcher and Wood Thrush (Richter et al., 2010).

As part of our study, we conducted vegetation surveys that included the following variables: Distance to edge, 3D ordination, total richness (native and exotic), total shrub density (native and exotic), total tree dominance, total groundlayer cover, total tree density, 90th percentile DBH, snag class, coarse woody debris class, canopy height, and canopy openness. We used non-metric multidimensional scaling (NMDS) ordination, to classify the forest patches into four forest types: Group 1: Sugar maple - White ash - Red oak – Basswood forest; Group 2: White Ash - White Oak – Hickory forest; Group 3: Box elder - Hackberry – Elm forest; Group 4: Black locust - Hackberry – Elm (Looft et al., in prep). We have created habitat models for a number of bird species (Richter et al., in prep). Figure 1 (Appendix) shows an example of a habitat model for the Wood Thrush (*Hylocichla mustelina*) in Bohm Woods State Nature Preserve. Additional appendix photos (2-7) present examples of habitat and species encountered as part of the study.

A Survey of Bluff Forest Avifauna in Southwestern Illinois

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ABSTRACT

The forested bluffs of southwestern Illinois attract large numbers of migrating songbirds due to their prime location near the confluence of the Mississippi, Missouri, and Illinois Rivers. Our objective was to assess avian populations in several forest patches in order to characterize existing habitat as well as to inform future land use decisions. Fixed-distance point-count surveys (25 m radius) were conducted from May-July, 2008 at 129 randomized plots in three forest patches in Madison County, Illinois. Density estimates, species richness, species diversity, and indicator species analysis were used to assess the avifauna. We identified a total of 90 species, including species of conservation concern. Of the three forest patches surveyed, Bohm Woods Nature Preserve exhibited the highest numbers of forest interior species. Efforts should be made to acquire or convert additional habitat to buffer sensitive species against the negative effects of forest fragmentation.

INTRODUCTION

The forested bluffs of southwestern Illinois attract large numbers of migrating songbirds due to their prime location near the confluence of the Mississippi, Missouri, and Illinois Rivers. These once extensive oak-hickory forests are now highly fragmented, initially due to agriculture and more recently due to increasing urbanization. As the St. Louis metropolitan area continues its rapid expansion eastward, protection and management of remaining forests is crucial. The campus of Southern Illinois University Edwardsville (SIUE) and adjacent Bohm Woods Nature Preserve include some of the largest remaining forest tracts in Madison County, Illinois.

Population declines have been noted for many neotropical migrants in Illinois (Robinson et al., 1995), and are hypothesized to be influenced by fragmentation of forests on breeding grounds (Gates and Evans, 1998; Robinson and Robinson, 2001), brood parasitism by Brown-

headed Cowbirds (Robinson et al, 1995), deforestation in the tropics (Bollinger and Linder, 1994), invasion of exotic plants and increasing populations of browsers (Elphick et al., 2001) and predators (Heske et al., 2001). Our objective was to assess avian populations in several forest patches in southwestern Illinois in order to characterize existing habitat as well as to inform future land use decisions in this rapidly developing area.

The three forest patches included in the survey occur on or adjacent to the SIUE campus in Madison County, Illinois (Fig. 1). All occur on loess bluffs at the edge of the Mississippi River floodplain known as the American Bottoms. Sweet William Woods is the largest forest patch covering 59.7 ha. The majority of this mesic/dry-mesic upland forest was formerly agricultural land that has experienced recent regrowth (<50 years). Portions of the forest that are along ravines have had trees present for over 100 years. Sweet William Woods includes an extensive network of trails and experiences the greatest amount of foot traffic. Bluebell Woods is a smaller mesic/dry-mesic upland forest that covers 30.3 ha and has a similar history of disturbance. However, it lacks trails and experiences little foot traffic. Bohm Woods Nature Preserve is largely mesic/dry-mesic upland forest, but also includes portions of wet bottomland forest. It covers 25.6 ha and has a more uniform distribution of mature trees than the other two forest patches. In addition, it has had little logging disturbance and receives intermediate levels of human traffic. All three forests have abundant deer populations due to adjoining agricultural land coupled with minimal hunting pressure.

MATERIALS AND METHODS

Fixed-distance point-count surveys (25 m radius) were conducted from May-July, 2008 at 129 randomized plots on the SIUE campus and adjacent Bohm Woods Nature Preserve (Bluebell, $n = 34$; Bohm, $n = 29$; Sweet William, $n = 66$). Surveys were conducted daily from

0600-1000 hours except when raining, foggy, or excessively windy. Each survey included a 1 minute warm-up period, followed by a 5 minute sampling period. Before the warm-up period a laser rangefinder (Bushnell Yardage Pro 500) was used to mark distance in the 4 cardinal directions (unless prevented by vegetation). All birds seen or heard during the sampling period were recorded, but only species within the 25 m radius were used in population density estimates (Bibby et al., 2000). During the sampling period a digital voice recorder (Olympus DS-40) was used to record songs and calls for subsequent identification in the lab. Sites were chosen each day to maximize distance between sampling locations, and the most direct routes to those sites were traveled in order to minimize disturbance (Bibby et al., 2000). Plots were visited 3 times each for a total sampling effort of 32.25 hours.

Density estimates for each bird species assumed there was one female for each singing male recorded. Densities were then calculated within plots and scaled up to one hectare. Overall densities for each forest patch were summed across all plots and average densities were estimated. In addition, species richness (S ; total number of species), Shannon's diversity index ($H' \log_e$; measure of diversity incorporating richness and evenness), and Hill's diversity index ($N1$; exponential of $H' \log_e$) were calculated for each forest patch using Primer 6 (Clarke and Gorley, 2008). Indicator species analysis (ISA) was used to identify bird species that best characterized each forest patch (Dufrene and Legendre, 1997). We used a liberal P-value of 0.2 for ISA since we intended it as an exploratory analysis rather than as an explicit test of hypotheses.

RESULTS

Species richness was highest for the largest forest patch, Sweet William Woods ($S = 63$), with Bluebell and Bohm Woods exhibiting identical richness ($S = 45$; Table 1). Species

diversity, as measured by Shannon's diversity index, was similar between Sweet William ($H'(\log_e) = 3.39$) and Bohm Woods ($H'(\log_e) = 3.38$), despite a large difference in area. Bluebell Woods (30.3 ha) had the lowest species diversity ($H'(\log_e) = 3.16$; Table 1).

Tables 2-5 list the densities for each species within each forest patch. Overall, warbler population densities were relatively low throughout the three forest patches (<1 individual/ha; Table 2). Exceptions, included Northern Parula, which was abundant (>2 /ha) at all three sites, and Magnolia, Yellow, and Black-throated Green Warblers, which were moderately abundant in Bohm Woods (1-2 individuals/ha). Among other migratory passerines, densities exceeded 1 individual/ha at all three sites for Eastern Wood-Pewee, Acadian Flycatcher, Wood Thrush, Great Crested Flycatcher, Indigo Bunting, Blue-gray Gnatcatcher, and Red-eyed Vireo (Table 3). In addition, Swainson's Thrush and White-throated Sparrow were abundant in Bohm Woods. Among resident passerines, Tufted Titmouse, Northern Cardinal, American Goldfinch, Brown-headed Cowbird, Eastern Towhee, Carolina Chickadee, White-breasted Nuthatch, Carolina Wren, and American Robin were abundant at all three sites. The Blue Jay was abundant at Bluebell and Sweet William Woods. (Table 4). Among nonpasserines, Red-bellied and Downy Woodpeckers were abundant at all three sites; whereas, Ruby-throated Hummingbird, Chimney Swift, Northern Flicker, and Hairy Woodpecker were abundant at Bohm Woods (Table 5).

Table 6 describes the results of the indicator species analysis (ISA). Seven species were identified whose relatively high indicator values acted to differentiate Bluebell Woods from the remaining forest patches. These included Northern Cardinal, American Goldfinch, Tufted Titmouse, Eastern Towhee, Blue-gray Gnatcatcher, Common Grackle, and Black-capped Chickadee. Three species differentiated Sweet William from the other forests: Carolina Chickadee, Carolina Wren, and Kentucky Warbler. Lastly, 12 species served as indicators for

Bohm Woods: Acadian Flycatcher, American Robin, Ruby-throated Hummingbird, Downy woodpecker, Wood Thrush, Hairy Woodpecker, Chimney Swift, Northern Flicker, Yellow Warbler, White-throated Sparrow, Black-throated Green Warbler, and Swainson's Thrush.

Table 7 lists additional species encountered during the sampling period outside of 25 m plots and not included in species richness or density estimates. Table 8 lists additional species encountered outside of the sampling period and not included in species richness or density.

DISCUSSION

We identified 90 species among three forest patches on and adjacent to the Southern Illinois University Edwardsville campus, including species of conservation concern such as the state threatened Black-billed Cuckoo (proposed) and the state endangered Northern Harrier. Bohm Woods appears to be particularly valuable from a conservation perspective. It is the only patch to feature migratory transients as indicator species, including Black-throated Green Warbler and Swainson's Thrush (Table 6). This suggests an important role as a migratory stopover site, despite its small size. Nevertheless, Bohm Woods is also comprised of relatively undisturbed mature forest which may make it more attractive than larger forest patches with greater levels of disturbance. In addition, Bohm Woods is also distinguished by supporting higher numbers of forest interior species, including two Neotropical migrants sensitive to fragmentation, Acadian Flycatcher and Wood Thrush (Roth et al., 1996; Whitehead and Taylor, 2002; Table 6).

The Acadian Flycatcher breeds near water in deciduous forests of the Midwest (Whitehead and Taylor, 2002). They have been found to exhibit low reproductive success within 600 m of a forest edge in southern Illinois due to cowbird parasitism and predation resulting from fragmentation (Hoover et al., 2006). None of the forest patches surveyed in the present

study include habitat greater than 600 m from an edge. This would seem to make the entire area a population sink for Acadian Flycatchers. However, another study in Illinois determined that Acadian Flycatchers may be less sensitive to fragmentation than other forest passerines in Illinois and may exhibit reproductive success in narrow riparian corridors (Chapa-Vargas and Robinson, 2007). The extensive network of ravines, transitioning to wet, bottomland forest in Bohm Woods may provide ideal conditions for Acadian Flycatchers, as evidenced by the high density estimates (6.79/ha; Table 6). The degree of reproductive success should be monitored to determine which of these two scenarios characterizes this population.

Wood Thrushes in Illinois also exhibit low nesting productivity due to the effects of forest fragmentation. Forest patches as large as 2200 ha have been found to be population sinks (Trine, 1998). Given the small size of the forest patches in the present study, local populations are likely to exhibit low recruitment. Nevertheless, Bohm Woods attracts relatively large numbers of Wood Thrush due to its mature trees. Despite its likely status as a population sink, it undoubtedly has value as a migratory stopover site.

Bohm Woods exhibited the lowest Brown-headed Cowbird density of the three forest patches (Table 4). Brown-headed Cowbirds are brood parasites that lay their eggs in the nests of many avian host species, providing no additional parental investment. The hosts may then incubate and rear cowbird offspring to the detriment of their own fitness (Brittingham and Temple, 1983). Cowbirds forage in agricultural areas and are typically more abundant at forest edge rather than forest interior (Lowther, 1993). Despite its small size and close proximity to agriculture, Bohm Woods may be less attractive to cowbirds than larger surrounding patches due to its mature trees and circular shape, which maximizes the amount of interior forest habitat.

Sweet William and Bluebell Woods are comprised of large areas of regrowth and are characterized by higher numbers of bird species associated with this habitat type (Table 6). However, they maintain core areas of mature trees, concentrated around ravines. These areas are important for forest interior bird species and should be protected from future disturbance. As the surrounding forest continues to mature, the value for interior species will increase.

Efforts should be made to acquire additional land and convert adjacent non-forested land to forest in order to benefit forest interior species. Although, young forest would be of little direct value to these species in terms of suitable foraging or nesting habitat, it would serve an important indirect role by providing a buffer to cowbirds and predators. This is critical for Bohm Woods which has higher numbers of sensitive species.

Bluff forest avifauna should continue to be observed over the long term in order to monitor population trends. This is especially important due to current and predicted changes in vegetation. Long-term monitoring may allow elucidation of the effects of rapid expansion of bush honeysuckle (*Lonicera maackii*), as well as the predicted loss of ash (*Fraxinus* sp.) from these forests. The plots used in this study are permanently marked and georeferenced and we intend to resample them regularly in the future to monitor changes in the vegetation and bird communities.

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1

2 Table 1. Species richness (S), Shannon (H' loge) and Hill (N1) diversity indices for 3 forest
3 patches in Madison County, Illinois.

Forest	S	H'(loge)	N1
Bluebell	45	3.16	23.6
Bohm	45	3.38	29.5
Sweet William	63	3.39	29.6

Table 2. Estimated population densities (individuals/ha) for warblers in 3 forest patches in Madison County, IL

Warblers				
Species	Common Name	Bluebell	Bohm	Sweet William
<i>Dendroica coronata</i>	Yellow-rumped Warbler	0.60	0.34	0.15
<i>Dendroica dominica</i>	Yellow-throated Warbler	0.00	0.34	0.15
<i>Dendroica fusca</i>	Blackburnian Warbler	0.30	0.00	0.15
<i>Dendroica magnolia</i>	Magnolia Warbler	0.30	1.02	0.23
<i>Dendroica pensylvanica</i>	Chestnut-sided Warbler	0.00	0.85	0.62
<i>Dendroica petechia</i>	Yellow Warbler	0.00	1.53	0.31
<i>Dendroica striata</i>	Blackpoll Warbler	0.00	0.00	0.46
<i>Dendroica virens</i>	Black-throated Green Warbler	0.00	1.02	0.15
<i>Geothlypis trichas</i>	Common Yellowthroat	0.60	0.00	0.15
<i>Mniotilta varia</i>	Black-and-white Warbler	0.00	0.00	0.15
<i>Oporornis formosus</i>	Kentucky Warbler	0.00	0.00	0.39
<i>Oporornis philadelphia</i>	Mourning Warbler	0.00	0.17	0.00
<i>Parula americana</i>	Northern Parula	4.19	2.55	3.70
<i>Seiurus aurocapilla</i>	Ovenbird	0.00	0.34	0.31
<i>Seiurus motacilla</i>	Louisiana Waterthrush	0.00	0.00	0.46
<i>Setophaga ruticilla</i>	American Redstart	0.30	0.51	0.39
<i>Vermivora peregrina</i>	Tennessee Warbler	0.30	0.34	0.31
<i>Vermivora ruficapilla</i>	Nashville Warbler	0.00	0.00	0.15
<i>Wilsonia citrina</i>	Hooded Warbler	0.00	0.34	0.00

Table 3. Estimated population densities (individuals/ha) for other (non-warbler) migratory passerines in 3 forest patches in Madison County, IL.

Other Migratory Passerines				
Species	Common Name	Bluebell	Bohm	Sweet William
<i>Catharus fuscescens</i>	Veery	0.00	0.00	0.15
<i>Catharus ustulatus</i>	Swainson's Thrush	0.60	1.53	0.08
<i>Contopus virens</i>	Eastern Wood-Pewee	2.10	1.36	2.39
<i>Dumetella carolinensis</i>	Gray Catbird	0.00	0.00	0.23
<i>Empidonax alnorum</i>	Alder Flycatcher	0.00	0.00	0.15
<i>Empidonax flaviventris</i>	Yellow-bellied Flycatcher	0.30	0.00	0.46
<i>Empidonax virescens</i>	Acadian Flycatcher	2.10	6.79	2.16
<i>Hylocichla mustelina</i>	Wood Thrush	1.95	4.07	2.08
<i>Icterus galbula</i>	Baltimore Oriole	0.00	0.34	0.08
<i>Myiarchus crinitus</i>	Great Crested Flycatcher	2.40	1.19	3.47
<i>Passerina cyanea</i>	Indigo Bunting	5.69	8.49	4.01
<i>Pheucticus ludovicianus</i>	Rose-breasted Grosbeak	0.15	0.34	0.00
<i>Piranga olivacea</i>	Scarlet Tanager	0.00	0.00	0.46
<i>Piranga rubra</i>	Summer Tanager	0.00	0.34	0.08
<i>Poliophtila caerulea</i>	Blue-gray Gnatcatcher	4.04	1.19	2.47
<i>Sayornis phoebe</i>	Eastern Phoebe	0.00	0.00	0.08
<i>Spizella passerine</i>	Chipping Sparrow	0.30	0.00	0.15
<i>Toxostoma rufum</i>	Brown Thrasher	0.30	0.00	0.15
<i>Troglodytes aedon</i>	House Wren	0.30	0.00	0.85
<i>Tyrannus tyrannus</i>	Eastern Kingbird	0.30	0.00	0.08
<i>Vireo flavifrons</i>	Yellow-throated Vireo	0.00	0.34	0.15
<i>Vireo gilvus</i>	Warbling Vireo	0.00	0.00	0.15
<i>Vireo griseus</i>	White-eyed Vireo	0.30	0.00	0.31
<i>Vireo olivaceus</i>	Red-eyed Vireo	6.89	5.09	5.63
<i>Vireo philadelphicus</i>	Philadelphia Vireo	0.00	0.34	0.31
<i>Zonotrichia albicollis</i>	White-throated Sparrow	0.15	1.02	0.00

Table 4. Estimated population densities (individuals/ha) for resident passerines in 3 forest patches in Madison County, IL.

Resident Passerines				
Species	Common Name	Bluebell	Bohm	Sweet William
<i>Agelaius phoeniceus</i>	Red-winged Blackbird	0.60	0.34	0.00
<i>Baeolophus bicolor</i>	Tufted Titmouse	7.79	5.77	5.09
<i>Cardinalis cardinalis</i>	Northern Cardinal	12.58	6.45	9.80
<i>Carduelis tristis</i>	American Goldfinch	11.38	4.24	4.48
<i>Corvus brachyrhynchos</i>	American Crow	0.75	0.00	0.77
<i>Cyanocitta cristata</i>	Blue Jay	1.50	0.68	1.62
<i>Mimus polyglottos</i>	Northern Mockingbird	0.00	0.00	0.31
<i>Molothrus ater</i>	Brown-headed Cowbird	5.09	2.89	4.63
<i>Pipilo erythrophthalmus</i>	Eastern Towhee	5.54	1.53	3.63
<i>Poecile atricapilla</i>	Black-capped Chickadee	1.05	0.00	0.00
<i>Poecile carolinensis</i>	Carolina Chickadee	5.69	2.89	7.18
<i>Quiscalus quiscula</i>	Common Grackle	1.80	0.00	0.62
<i>Sialia sialis</i>	Eastern Bluebird	0.00	0.00	0.15
<i>Sitta carolinensis</i>	White-breasted Nuthatch	0.75	2.21	2.24
<i>Sturnus vulgaris</i>	European Starling	0.30	0.00	0.00
<i>Thryothorus ludovicianus</i>	Carolina Wren	1.20	1.70	2.86
<i>Turdus migratorius</i>	American Robin	2.40	4.92	1.77

Table 5. Estimated population densities (individuals/ha) for nonpasserines in 3 forest patches in Madison County, IL.

Nonpasserines				
Species	Common Name	Bluebell	Bohm	Sweet William
<i>Archilochus colubris</i>	Ruby-throated Hummingbird	0.60	2.55	0.39
<i>Chaetura pelagica</i>	Chimney Swift	0.00	1.70	0.00
<i>Coccyzus americanus</i>	Yellow-billed Cuckoo	0.90	0.68	0.46
<i>Colaptes auratus</i>	Northern Flicker	0.45	1.36	0.15
<i>Dryocopus pileatus</i>	Pileated Woodpecker	0.30	0.85	0.46
<i>Melanerpes carolinus</i>	Red-bellied Woodpecker	1.35	2.55	2.16
<i>Meleagris gallopavo</i>	Wild Turkey	0.00	0.00	0.15
<i>Picoides pubescens</i>	Downy Woodpecker	3.15	3.90	2.08
<i>Picoides villosus</i>	Hairy Woodpecker	0.75	2.21	0.85

Table 6. Indicator species analysis for 3 forest patches in Madison County, IL. Tabulated indicator values are the product of fidelity and constancy. P values are based on 10,000 random permutations of group membership. Species with $P < 0.2$ are shown. A liberal P-value of 0.2 since was used since this was an exploratory analysis rather than an explicit test of hypotheses. Bold values indicate the group for which the species is a significant indicator.

Species	Common Name	Bluebell	Bohm	Sweet William	P
<i>Baeolophus bicolor</i>	Tufted Titmouse	26	14	12	0.1401
<i>Cardinalis cardinalis</i>	Northern Cardinal	35	16	28	0.1058
<i>Carduelis tristis</i>	American Goldfinch	32	8	8	0.0055
<i>Pipilo erythrophthalmus</i>	Eastern Towhee	20	3	12	0.1258
<i>Poecile atricapillus</i>	Black-capped Chickadee	6	0	0	0.1181
<i>Polioptila caerulea</i>	Blue-gray Gnatcatcher	19	3	9	0.1053
<i>Quiscalus quiscula</i>	Common Grackle	11	0	2	0.0385
<i>Archilochus colubris</i>	Ruby-throated Hummingbird	1	17	0	0.0051
<i>Catharus ustulatus</i>	Swainson's Thrush	1	9	0	0.037
<i>Chaetura pelagica</i>	Chimney Swift	0	13	0	0.0027
<i>Colaptes auratus</i>	Northern Flicker	1	12	0	0.0213
<i>Dendroica petechia</i>	Yellow Warbler	0	11	1	0.0149
<i>Dendroica virens</i>	Black-throated Green Warbler	0	9	0	0.0313
<i>Empidonax virescens</i>	Acadian Flycatcher	3	41	4	0.0001
<i>Hylocichla mustelina</i>	Wood Thrush	4	15	5	0.124
<i>Picoides pubescens</i>	Downy Woodpecker	10	17	4	0.125
<i>Picoides villosus</i>	Hairy Woodpecker	2	14	2	0.0559
<i>Turdus migratorius</i>	American Robin	6	20	4	0.0409
<i>Zonotrichia albicollis</i>	White-throated Sparrow	0	9	0	0.0155
<i>Oporornis formosus</i>	Kentucky Warbler	0	0	6	0.1546
<i>Poecile carolinensis</i>	Carolina Chickadee	18	7	25	0.1737
<i>Thryothorus ludovicianus</i>	Carolina Wren	2	7	17	0.1497

Table 7. Observations of additional species encountered during sampling period outside of 25 m plots and not included in species richness or density estimates.

Species	Common Name	Bluebell	Bohm	Sweet William
<i>Branta canadensis</i>	Canada Goose	11	4	7
<i>Buteo jamaicensis</i>	Red-tailed Hawk	-	2	-
<i>Cathartes aura</i>	Turkey Vulture	2	1	-
<i>Catharus guttatus</i>	Hermit Thrush	-	1	3
<i>Charadrius vociferous</i>	Killdeer	1	-	-
<i>Coccyzus erythrophthalmus</i>	Black-billed Cuckoo	1	-	1
<i>Colinus virginianus</i>	Northern Bobwhite	3	3	5
<i>Dendroica tigrina</i>	Cape May Warbler	1	-	-
<i>Helmitheros vermivorum</i>	Worm-eating Warbler	-	-	2
<i>Passerina caerulea</i>	Blue Grosbeak	-	-	-
<i>Spizella pusilla</i>	Field Sparrow	11	3	8
<i>Sturnella magna</i>	Eastern Meadowlark	1	-	-
<i>Vermivora pinus</i>	Blue-winged Warbler	1	-	-
<i>Zenaida macroura</i>	Mourning Dove	3	1	2

Table 8. Observations of additional species encountered outside of sampling period and not included in species richness or density estimates.

Species	Common Name	Bluebell	Bohm	Sweet William
<i>Circus cyaneus</i>	Northern Harrier	-	1	-
<i>Megaceryle alcyon</i>	Belted Kingfisher	-	1	-
<i>Strix varia</i>	Barred Owl	-	1	-
<i>Vermivora chrysoptera</i>	Golden-winged Warbler	-	1	-
<i>Vireo bellii</i>	Bell's Vireo	-	-	1

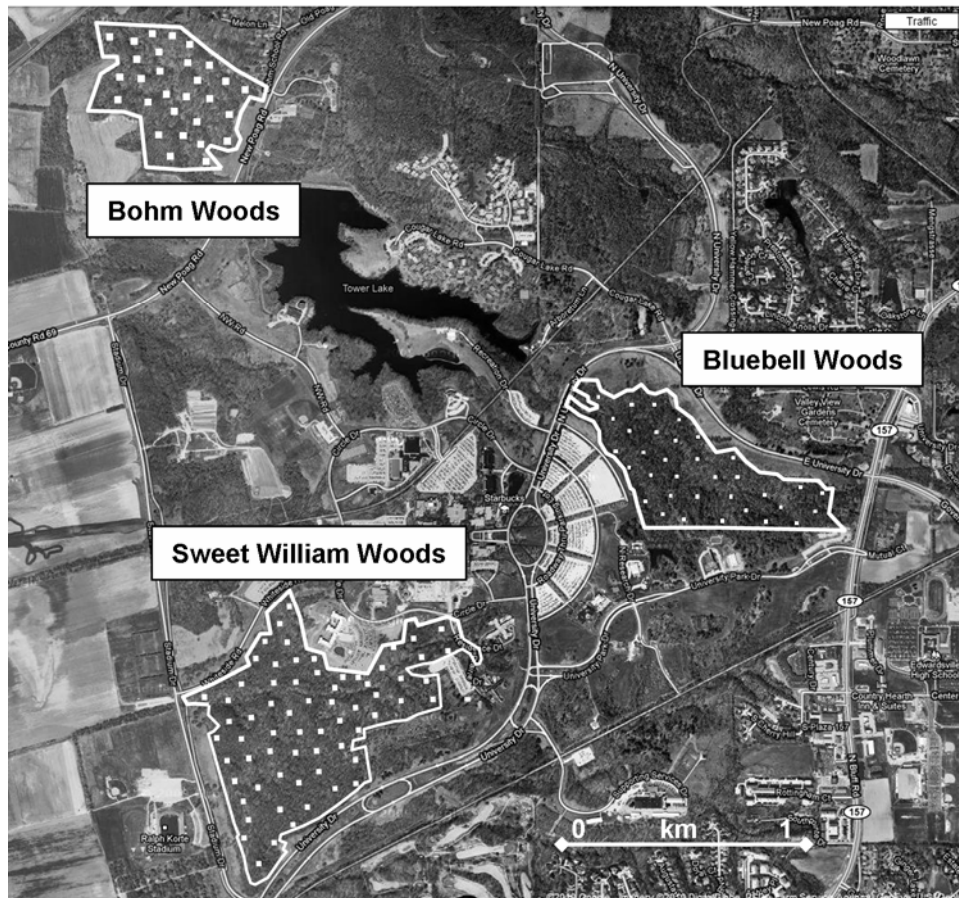


Fig. 1. Aerial photo of 3 forest patches in Madison County, IL where avian point count surveys were conducted. White lines indicate boundaries of sampled areas and dots indicate locations of sampling plots (N=129).

APPENDIX

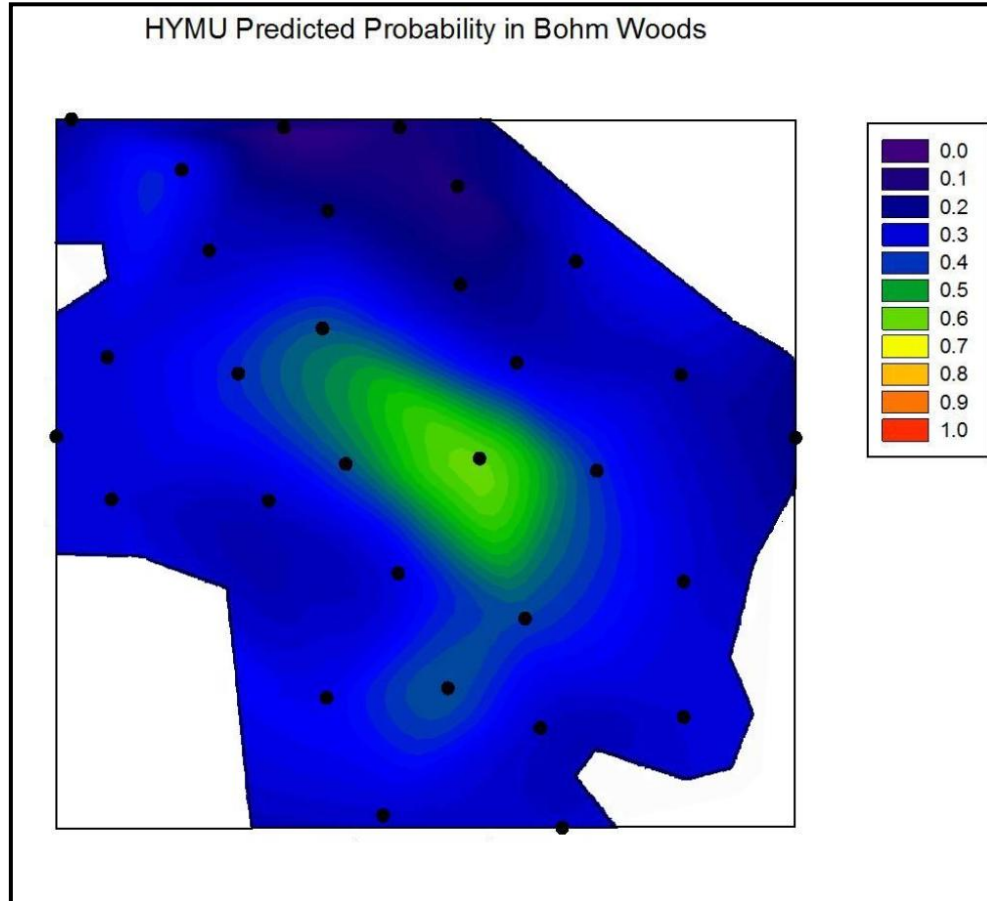


Figure 1. Habitat model for the Wood Thrush, *Hylocichla mustelina* in Bohm Woods. Colors indicate probability of encountering a Wood Thrush based on a logistic regression model. The model indicated a positive association with distance to edge and NMDS axis 1 (areas dominated by oak, hickory, and ash forest; Richter et al., in prep).



Figure 2. Canopy photo of Bohm Woods State Nature Preserve.



Figure 3. Ravine habitat in Bluebell Woods on the campus of Southern Illinois University Edwardsville.



Figure 4. Tufted Titmouse, *Baeolophus bicolor*, from Bohm Woods State Nature Preserve.



Figure 5. Red-bellied Woodpecker, *Melanerpes carolinus*, from Bluebell Woods on campus of Southern Illinois University Edwardsville.



Figure 6. Yellow-bellied Sapsucker, *Sphyrapicus varius*, from Sweet William Woods located within the SIUE Nature Preserve.



Figure 7. Bottomland Forest in Bohm Woods State Nature Preserve. This area of the forest provides high-quality habitat for neotropical migrants such as the state threatened Cerulean Warbler, *Dendroica cerulea*, which was identified in this area during the study.