Delineating Focus Areas for Bird Conservation in the Central Hardwoods Bird Conservation Region[1]

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Abstract

This paper reports on a process used to identify landscape-scale focus areas for the conservation of priority grassland, grass-shrubland, wetland and forest-woodland birds in the Central Hardwoods Bird Conservation Region (CHBCR). The areas were delineated by biologists and other technical staff of partner agencies and organizations in the CHBCR with the use of geospatial data layers that included land cover, maps of areas with large percentages of grass and forest cover, public lands, roads, state and county lines, surface water features, ecological land types, and The Nature Conservancy's ecoregional plan's portfolio sites. There are other areas within the BCR that do or could provide high quality bird habitat. However, focus areas have the highest conservation, restoration and management potential at a landscape scale because they have (1) significant blocks of public lands that can provide a core for conservation efforts, (2) good potential for public-private partnerships, and/or (3) have been identified by The Nature Conservancy or state Natural Heritage Programs as areas with noteworthy levels of biodiversity. We believe the ability to concentrate relatively scant resources for conservation in discrete landscapes will accomplish greater habitat gains at scales relevant to bird populations than will more isolated efforts. The use of both current land use data and ecological classification systems also allowed us to target specific areas for specific suites of priority birds based upon a landscape's ecological and socio-economic potential.

Introduction

The Central Hardwoods (*fig. 1*) is one of 67 Bird Conservation Regions (BCRs) across North America identified by the four major bird initiatives and their conservation partners under the auspices of the North American Bird Conservation Initiative (U.S. NABCI Committee 2000). Support for the Central Hardwoods partnership to date has come from most of the overlapping state wildlife agencies, the U.S. Fish and Wildlife Service, the U.S. Forest Service, the National Wild Turkey Foundation, the Wildlife Management Institute, and American Bird Conservancy. The BCR's priority bird species and their general conservation needs are derived from Partners in Flight (Pashley et al. 2000), the United States Shorebird Conservation Plan (Brown et al. 2001), The North American Waterbird Conservation Plan (Kushlan et al. 2002), the North American Waterfowl Management Plan (North American Waterfowl Management Plan Draft Update 2003), and the Northern Bobwhite Conservation Initiative (Dimmick et al. 2002). However, spatially explicit focus areas, where conservation actions for the various species and species suites are likely to have the greatest potential for success, had not been identified prior to the establishment of the BCR partnership. To fill that gap, biologists, managers and other technical staff from various conservation agencies and organizations across the BCR met in a series of three workshops held during 2002 to identify relatively large landscapes most able to support viable populations of priority wetland, grassland, grass-shrub, and woodland-forest birds. This paper reports on the process and geospatial tools used to delineate those areas.

Background and Conservation Issues

The Central Hardwoods BCR (*fig. 1*) straddles the Mississippi River between Illinois and Missouri; the region to the west is also known as the Ozarks or Interior Highlands, and the region to the east, the Interior Low Plateaus. The BCR occupies a transition zone between what historically were tallgrass prairie, oak savanna, and woodlands to its north and west; pine forests and woodlands to the south; and oak and mixed mesophytic forests to the east. Components of each were interspersed throughout the BCR, with their juxtapositions dependent to a large degree on topography and soils. Glades and

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[1]A version of this paper was presented at the **Third International Partners in Flight Conference, March 20-24, 2002, Asilomar Conference Grounds, California.**

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barrens (grass-dominated ecosystems on shallow soils) also were prevalent historically.

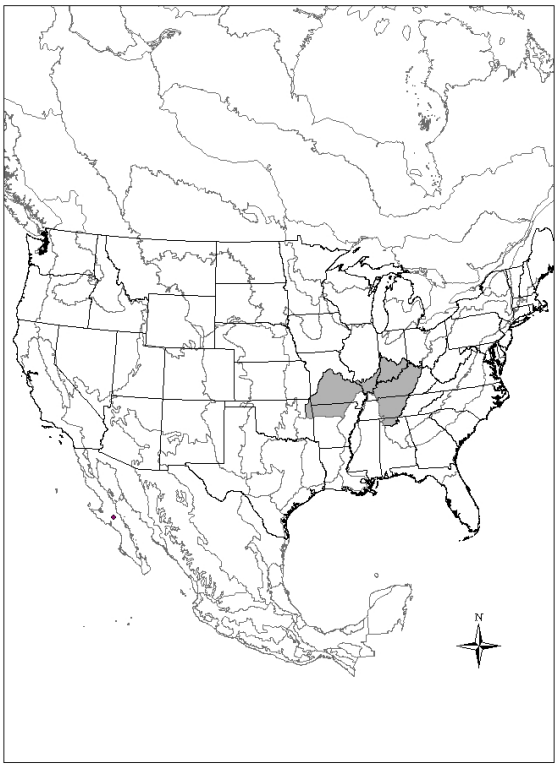

Figure 1—The Central Hardwoods Bird Conservation Region.

However, very little of the BCR's native prairie, with its more fertile and deeper soils, has escaped the plow. The glades, barrens, and extensive pine woodlands have largely converted to oak or oak-pine forests primarily as a result of fire suppression. Yet restoration of those ecosystems, which have been degraded but still persist over much of the region, is feasible. Restoration on public lands could help encourage private landowners in shared landscapes to undertake complementary efforts as well.

Bottomland forests and emergent wetland habitats in the Central Hardwoods largely were associated with the region's large rivers (e.g. the Missouri, Mississippi, Ohio, Tennessee, Cumberland) and their tributaries. All of those rivers are now impounded at least in some reaches, and much of the historical wetland habitat is submerged under large reservoirs or the floodplains drained and converted to agricultural uses. Restoration of wetland habitats has received the most attention where the BCR overlaps one of two Joint Ventures formed under the auspices of the North American Waterfowl Management Plan, and there is both opportunity and potential to do more. Wet meadows, a much more poorly understood and inadequately mapped wetland type, are in great need of attention.

The BCR's priority birds can be grouped into four suites of species based on general habitat affinities: grasslands, grass-shrublands, woodland-forests, and wetlands (see *Appendices 1-4* for a list of the BCR's highest priority bird species). Grassland birds such as Greater Prairie-Chicken (scientific names provided in *Appendices 1-4*), Henslow's Sparrow, and Grasshopper Sparrow typically require fairly large expanses of open grasslands with a minimum amount of woody vegetation before they are attracted to a given site and enjoy a level of reproductive success adequate to sustain local populations (see Fitzgerald and Pashley 2000, Fitzgerald et al. 2000a, Fitzgerald et al. 2000b). Species in the grassland suite were probably most abundant historically in the BCR's prairie and shrub-prairie dominated landscapes and in areas with large expanses of barrens.

The grass-shrubland species suite includes species that occupy a continuum of habitats from more open grasslands with scattered shrubs (e.g. Bell's Vireo and Northern Bobwhite) to those that inhabit a grassland matrix with shrubs in much greater densities (e.g. Prairie Warbler, Yellow-breasted Chat; James 1992). Native habitats that support these species are disturbance-dependent ecosystems such as glades, barrens, savannas, and early-successional forests (Thompson and DeGraaf 2001). There are opportunities for grassland and grass-shrubland bird conservation through private lands programs targeted toward the retirement of marginal agricultural lands. Improving conditions for priority birds associated with the restoration of native habitats and ecosystems also is an important goal of the BCR conservation plan.

The forest-woodland species suite is characterized by species such as Cerulean, Worm-eating and Kentucky Warblers, Acadian Flycatchers, Eastern Wood-Pewee, and Wood Thrush. However, most of the species in the suite are associated with the forests' mid- and understory components (Hamel 1992), and the response of those and other bird species to woodland restoration, which would result in a more open canopy and sparser understory (Taft 1997), has yet to be fully evaluated. Work in Illinois by Brawn (1998) indicated that several priority species we have grouped with the forest species suite are associated with restored woodlands (e.g. Yellow-billed Cuckoo, Whip-poor-will, Eastern Wood-Pewee and Great Crested Flycatcher). Others that were shown to benefit from woodland restoration included grass-shrubland species such as Northern Bobwhite, Brown Thrasher, and Field Sparrow. Several Central Hardwoods priority species that are associated with pine woodlands in the Ouachita Mountains of southern Arkansas (Wilson et al. 1995) either have been extirpated in the Central Hardwoods BCR (e.g. Red-cockaded Woodpecker) or now occur in small, isolated populations (e.g. Brown-headed Nuthatch and Bachman's Sparrow). Because pine woodlands once were much more prevalent in the Ozarks prior to fire suppression (Nigh and Shroeder 2002), efforts to restore both the habitat and its associated avifauna seem appropriate.

Wetlands in the Central Hardwoods presently appear to be most valuable to shorebirds while moving through the area during spring and fall migrations, and to waterfowl during both migration and winter. Some priority waterbirds breed in the Central Hardwoods in relatively small numbers, though populations were presumably larger and more widespread prior to the loss of wetlands to drainage and impoundments. The status of habitat types important to the BCR's priority species suites are summarized in *Appendix 5*.

Methods

Biologists, land managers and other technical staff from the region's conservation agencies and organizations were invited to a series of three workshops held in different regions of the BCR. Each of the workshops began with a day-long series of presentations designed to familiarize participants with the various bird initiatives, key conservation programs, conservation issues, and the ecological requirements of the BCR's priority species associated with four basic habitat types: wetland, grassland, grass-shrub, and woodland-forest. The following day, participants met in breakouts by habitat type to identify focus areas for the various habitat types and species groups. Hard-copy maps of land cover and laptop computers loaded with geographic information system software were available to each breakout. Geospatial data used in delineating bird conservation areas was compiled from a variety of sources. All data were reprojected into Albers Equal Area, NAD83.

Data layers

National Land Cover Data

Derived from the early to mid-1990s **Landsat** Thematic Mapper satellite data, the National Land Cover Data (NLCD) is a 21-class land cover classification scheme applied consistently over the United States. The spatial resolution of the data is 30 meters and mapped in the Albers Conic Equal Area projection, NAD 83. For more information, see: http://landcover.usgs.gov/natllandcover.html. Land cover derived from satellite imagery was used to assess basic land use patterns across the planning unit.

Roads, state lines, county lines

TIGER/Line® files (Topologically Integrated Geographic Encoding and Referencing system) from the U.S. Census Bureau contain data that were updated for the 2000 census. For more information, see: http://www.census.gov/geo/www/tiger/index.html. These were primarily used by the groups as a means of orientation.

Surface Water Features

The National Hydrography Dataset (NHD) is based upon USGS Digital Line Graph (DLG) hydrography data integrated with reach-related information from the EPA Reach File Version 3 (RF3). The NHD contains information about surface water features. For more information, see: http://nhd.usgs.gov/. The locations of rivers and steams were used as a means of orientation but also in the delineation of wetland focus areas.

Grass- and forest-dominated landscapes

Results of Donovan et al. 1995, and Robinson et al. 1995 suggest that reproductive success of forest birds breeding in landscapes with less than 70 percent forest cover within a 10-km radius of the breeding sites often is too low to sustain local populations due to high levels of nest predation and brood parasitism. Because reproductive success in large forested landscapes tends to be greater than needed to sustain local populations, these landscapes are thought to be the "sources" of birds that disperse to breed in forest fragments in other parts of the Midwest region where reproductive success often is extremely low (Donovan et al. 1995). Maintaining forest cover above the 70 percent threshold is therefore critical not only to breeding forest birds in the Central Hardwoods BCR, it may also be pivotal in maintaining forest bird communities and sustaining their ecological services in adjacent BCRs. Research also suggests that the amount of grass cover in landscapes surrounding grassland sites also can affect densities and reproductive success of local grassland-breeding bird populations[8] (Winter and Faaborg 1999; Winter et al. 2000) although the relationships appear to be more variable than those of forest-breeding birds with forest cover. However, as a precaution, Central Hardwoods BCR planners delineated conservation focus areas for open-grassland breeding birds in the Central Hardwoods in landscapes with greater than 30 percent or greater grass cover within a 3-km radius. Maps of areas meeting these thresholds were generated by the Missouri Resource Assessment Partnership using a neighborhood function in ESRI ArcInfo software (version 8.2; ESRI, Redlands, California) to sum the amount of target land cover. Neighborhood functions produce an output in which the value at each location is dependent on the input value at a location and the values of the cells in a specified neighborhood.

Public lands

World Wildlife Fund has put together a database of protected areas (PAD) for the United States and Canada (DellaSala et al. 2001). We supplemented these

[8] J. Herkert, unpublished data

data with updates from individual state and federal agencies. Most of the public land in the Central Hardwoods BCR is administered by BCR partner agencies with a desire to improve the condition of those lands for birds. The ability to overlay the locations of those lands on land cover and maps of grassland and forest-dominated landscapes (features associated with higher densities and enhanced reproductive success of birds in those species suites) was essential to providing those partner agencies with information regarding which species suites were most in need of conservation actions at each site.

Ecological subregions

Although much of the BCR's prairies, wetlands and pine woodlands have been converted to other community types and land uses, rather large expanses of barrens, glades, savannas, oak woodlands and forests still exist, although often in degraded conditions. In order to identify the areas where those ecosystems occurred historically and are most likely to benefit from restoration efforts, maps of ecological subregions identified by the U. S. Forest Service's National Hierarchy of Ecological Units (McNab and Avers 1994) were employed. Section and subsection coverages of the hierarchy were available for the entire BCR and were classified primarily on the basis of lithology, topography and geomorphology, regional soils, and regional potential vegetation. Landtype associations (LTAs), or ecological landscapes, are a finer scale of ecological delineation that further reflect local variation in topography, parent material, soil type, and vegetation communities. Maps of those were developed through the Missouri Ecological Classification System Project but were available for the Ozarks only (Nigh and Schroeder 2002). Landtype associations were grouped for us by Nigh into three categories: prairie and shrub prairie, glades and savanna, and forests and woodlands, with each grouping targeted for grassland, grass-shrubland and forest-woodland priority bird species suites, respectively.

The Nature Conservancy's (TNC) Ecoregional Planning Portfolio Sites

TNC had completed draft ecoregional planning portfolios for both the Ozarks and Interior Low Plateaus regions of the BCR. The portfolio sites typically identified large landscapes containing terrestrial and aquatic ecosystems with rare species and natural communities in need of conservation attention.

Overlay sequence

Maps of landscapes that met the thresholds for forest and grass cover were the first layer planners considered during the process of identifying bird conservation focus areas within the Central Hardwoods BCR for the forest and grassland-grass-shrub species suites, respectively. Discouraging loss and fragmentation of existing habitat in those areas will be important in maintaining adequate levels of nesting success for breeding birds. In the Ozarks, however, many areas that historically were glade-savanna or prairie-savanna complexes are now overgrown with densely stocked trees (Nigh and Schroeder 2002). Maps of landtype associations were used to delineate which areas now classified as forest should be considered for restoration of those habitat types.

Public lands were then overlain upon the percent cover maps. Public lands falling within forested areas were encircled by a 10-km buffer, and those within grassland areas encircled with a 3-km radius buffer to identify the matrix around the public lands that needed to be considered with regards to maintaining reproductive success of forest or grassland birds breeding on those sites.

TNC's portfolio sites were considered next. Biologists involved with the BCR planning effort believed that improving habitat for birds should be done in association with the restoration of the BCR's native ecosystems where possible so that other biodiversity components associated with those systems will benefit as well. TNC portfolio sites often overlaid public lands, but the planners felt that places where the TNC sites intersected largely forest or grass-dominated landscapes without public lands should be considered for future acquisition or easement projects.

Map layers used to identify wetland focus areas included large water bodies identified by the National Hydrography Data Set and lands classified as emergent or woody wetlands from the National Land Cover Dataset. Participants' knowledge of local conditions and wetland habitats also were incorporated.

Results

The workshops produced maps of species suite focus areas (*fig. 2*). Terrestrial habitat types are coded differently for the Ozarks than the Interior Low Plateaus due to differences in the spatial scale and arrangements of habitat types dominated by forests or woodlands versus those dominated by grasses and shrubs. The location and extent of savannas, glades, and prairies in the Ozarks are influenced by differences in soils, slope, and aspect and often are juxtaposed with woodland and forest systems at relatively small spatial scales (Nigh and Shroeder 2002).

Therefore, the focus area code for grassland bird sites in the Ozarks is prairie; glade-savanna-woodland complexes are targeted for the grass-shrub species suite; prairie-savanna-woodland focus areas are targeted for grass-shrub and woodland-forest birds; and woodland-forest for woodland-forest birds. Some large focus areas have components of each and are coded as "all" Although prairies, barrens and glades also can be found within forest-dominated landscapes in the Interior Low Plateaus, much larger expanses of glades and barrens occurred across relatively broad basins between the forest-dominated uplands that rim those landscapes (McNab and Avers 1994). The more distinct boundaries between habitat types in the Interior Low Plateaus allowed for simpler coding of landscape types there, and terrestrial focus area codes are simply grass-shrub for grassland and grass-shrubland birds, and forest for forest and woodland birds.

Discussion

Focus areas for bird conservation in the Central Hardwoods Bird Conservation Region were delineated by biologists and other technical staff of partner agencies and organizations in the CHBCR with the use of geospatial data layers.

While there are other areas within the BCR that do or could provide high quality bird habitat, the focus areas have the highest conservation, restoration, and management potential at a landscape scale because they have significant blocks of public lands that can provide a core for conservation efforts, good potential for public-private partnerships, and/or have been identified by TNC or state Natural Heritage Programs as areas with noteworthy levels of biodiversity. We believe the ability to concentrate the relatively scant resources available for conservation in discrete landscapes will accomplish greater habitat gains at scales relevant to bird populations than will more isolated efforts. The use of both current land use data and ecological classification systems also allowed us to target specific areas for specific suites of priority birds based upon a landscape's ecological and socio-economic potential.

Conservation strategies for the focus areas in the Central Hardwoods Bird Conservation Region will need to vary depending upon its landscape context and the habitat conditions within. Restoration of native grasses and forbs is needed in what historically were grassland and grass-shrubland areas where woody vegetation fragments the grassland landscape and non-native, cool-season grasses now predominate. While reforestation is needed in some forest focus areas to increase block size and reach the amounts of forest cover that have been associated with adequate levels of reproductive success for forest-breeding birds, in other

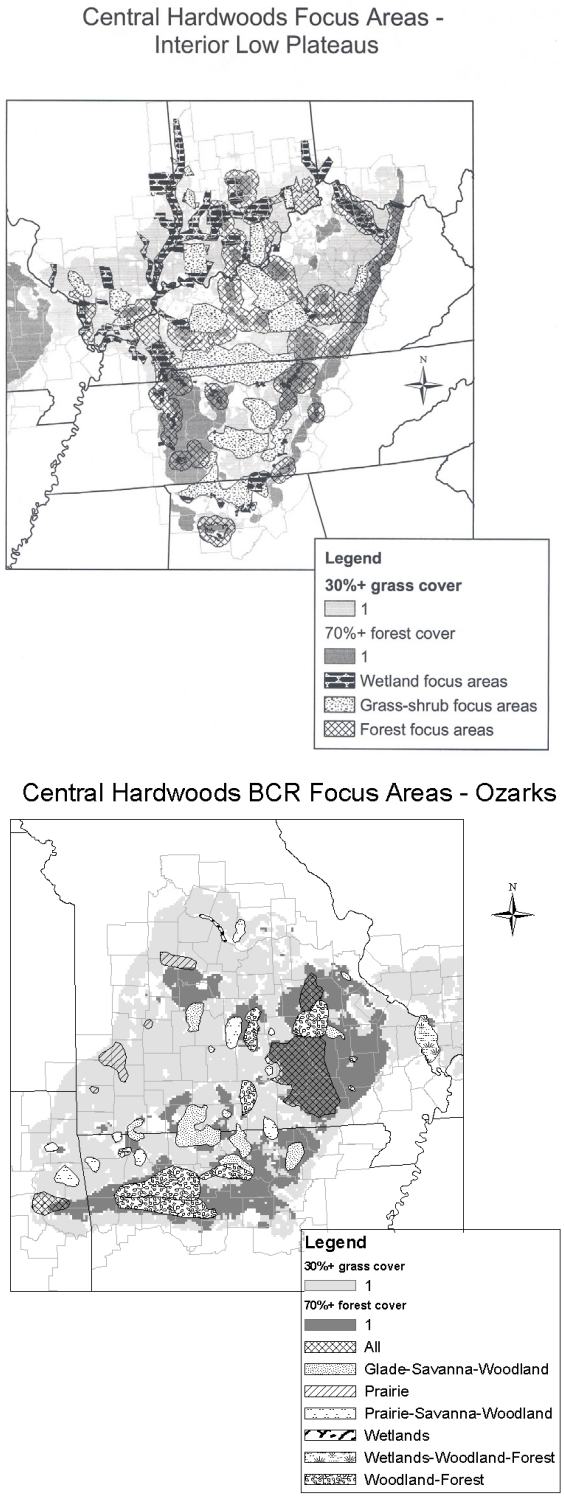

Figure 2—Bird conservation focus areas in the Central Hardwoods Bird Conservation Region.

focus areas the landscape context is adequate, but management is needed to improve the forest structure and perpetuate native oaks and pine as dominant species. Many wetland focus areas are in need of

restoration and especially in areas where the hydrology has been altered almost all will require some form of management. Finally, preventing the conversion of extant native vegetation to other, less "bird-friendly" land use is sure to pose a real and significant challenge as the public's demand for land and its associated resources continues to grow.

Acknowledgments

We would like to thank everyone who participated in the three BCR workshops held during 2002. Their collective expertise and enthusiasm for the project was invaluable to the process of delineating the Central Hardwoods' focus areas. We also thank the Central Hardwoods BCR Steering Committee for their support and their agencies' and organizations' efforts on behalf of all-bird conservation. Financial support that allowed us to build the geographic information system so useful to this endeavor was provided by Federal Aid grant TN M-1-P.

Literature Cited

Brawn, J. D. 1998. **Effects of oak savanna restoration on avian populations and communities in Illinois.** Final report to the Illinois Natural History Survey.

Brown, S., C. Hickey, B. Harrington and R. Gill, editors. 2001. **The U.S. shorebird conservation plan.** 2nd edition. Manomet, MA: Manomet Center for Conservation Sciences.

DellaSala, D. A., N. L. Staus, J. R. Strittholt, A. Hackman, and A. Iacobelli. 2001. **An updated protected areas database for the United States and Canada.** Natural Areas Journal 21(2): 124-135.

Dimmick, R. W., M. J. Gudlin, and D. F. McKenzie. 2002. **The Northern Bobwhite conservation initiative.** Miscellaneous publication of the Southeastern Association of Fish and Wildlife Agencies, South Carolina; 96 p.

Donovan, T. M., Thompson, F. R. III, Faaborg, J. and J. R. Probst. 1995. **Reproductive success of migratory birds in habitat sources and sinks.** Conservation Biology 9: 1380-1395.

Fitzgerald, J. A. and D. N. Pashley. [online] 2000. **Partners in Flight bird conservation plan for the Dissected Till Plains.** See: http://www.blm.gov/wildlife/pl_32_10.pdf.

Fitzgerald, J. A., J. R. Herkert, and J. D. Brawn. [online] 2000a. **Partners in Flight bird conservation plan for the Prairie Peninsula.** See: http://www.blm.gov/wildlife/pl_31_10.pdf.

Fitzgerald, J. A., B. Busby, M. Howery, R. Klataske, D. Reinking, and D. N. Pashley. [online] 2000b. **Partners in Flight bird conservation plan for the Osage Plains.** See: http://www.blm.gov/wildlife/plan/pl_33_10.pdf.

Hamel, P. B. 1992. **The land manager's guide to birds of the South.** Chapel Hill, NC: The Nature Conservancy; 436 p.

James, D. A. 1992. **Measuring shrubland vegetational structure using avian habitats as an example.** Proceedings of the Arkansas Academy of Science. 46: 46-48.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. **Waterbird Conservation for the Americas: the North American Waterbird Conservation Plan, Version 1.** Washington, DC, U.S.A.: Waterbird Conservation for the Americas; 78 p.

McNab, W. H., and P. E. Avers, compilers. 1994. **Ecological subregions of the United States: Section descriptions.** Administrative Publication WO-WSA-5. Washington, DC: Forest Service, U.S. Department of Agriculture; 267 p.

North American Waterfowl Management Plan Draft Update. 2003. **Strengthening the Biological Foundations.** http://birdhabitat.fws.gov/NAWMP/2003nawmpdraft.htm.

Nigh, T. A., and W. S. Schroeder. 2002. **Atlas of Missouri Ecoregions.** Jefferson City, MO: Missouri Department of Conservation; 208 p.

Pashley, D. N., C. J. Beardmore, J. A. Fitzgerald, R. P. Ford, W. C. Hunter, M. S. Morrison, and K. V. Rosenberg. 2000. **Partners in Flight: Conservation of the landbirds of the United States.** The Plains, VA: American Bird Conservancy.

Robinson, S. R., F. R. Thompson, III, T. M. Donovan, D. R. Whitehead, and J. Faaborg. 1995. **Regional forest fragmentation and the success of migratory birds.** Science 267: 1987-1990.

Taft, J. B. 1997. **Savanna and open woodland communities**. In M. W. Schwartz, editor. Conservation in highly fragmented landscapes. NewYork: Chapman and Hall; 24-54.

Thompson, F. R., III, and R. M. DeGraaf. 2001. **Conservation approaches for woody, early successional communities in the eastern United States.** Wildlife Society Bulletin 29: 483-494.

U.S. NABCI Committee. 2000. **North American Bird Conservation Initiative: Bird Conservation Region Descriptions.** Washington, DC: Fish and Wildlife Service, U. S. Department of the Interior. See: http://www.nabci-us.org/bcrs.html.

Wilson, C. W., R. E. Masters, and G. A. Bukenhofer. 1995. **Breeding bird response to pine-grassland community restoration for Red-cockaded Woodpeckers.** Journal of Wildlife Management 59: 56-67.

Winter, M., and J. Faaborg. 1999. **Patterns of area sensitivity in grassland-nesting birds.** Conservation Biology 13: 1424-1436.

Winter, M., D. H. Johnson and J. Faaborg. 2000. **Evidence for edge effects on multiple levels in tallgrass prairie.** Condor 102: 256-266.

Appendix 1—*Partners in Flight priority breeding bird species.*

Habitat type	Species	Score[1]	Tier[2]	% pop[3]	Comments
Forest	Cerulean Warbler (*Dendroica cerulea*)	28	I	12	Populations both in riparian areas and uplands
	Worm-eating Warbler (*Helmitheros vermivorus*)	27	I	20	Associated with forest understory on slopes
	Wood Thrush (*Hylocichla mustelina*)	25	I	7	Associated with the mid-canopy
	Kentucky Warbler (*Oporornis formosus*)	24	I	28	Associated with forest understory
	Louisiana Waterthrush (*Seiurus aurocapillus*)	24	I	18	Associated with small streams and riparian zones within forests
	Whip-poor-will (*Caprimulgus vociferous*)	24	I	35	
	Yellow-throated Vireo (*Vireo flavifons*)	23	I	12	
	Acadian Flycatcher (*Empidonax virescens*)	22	I	15	Associated with the mid-canopy
	American Woodcock (*Scolopax minor*)	22	I	4	Associated with stands of small diameter trees, and moist soils
	Chimney Swift (*Chaetura pelagica*)	21	IIA	10	Associated with top-killed trees, but more often with chimneys in urban and rural areas
	Eastern Wood-Pewee (*Contopus virens*)	21	IIA	18	Favors more open forests and woodlands
	Yellow-billed Cuckoo (*Coccyzus americanus*)	21	IIA	14	
	Blue-gray Gnatcatcher (*Polioptila caerulea*)	20	IIA	17	
	Great Crested Flycatcher (*Myiarchus crinitus*)	20	IIA	7	Cavity nester in more open forests and woodlands
	Sharp-shinned Hawk (*Accipter striatus*)	19	IIA	3	Associated with a pine component
Riparian zones	Swallow-tailed Kite (*Elanoides forficatus*)	29	I	0	Extirpated. Once bred in bottomlands with forest components associated with large river systems
	Swainson's Warbler (*Limnothlypis swainsonii*)	26	I	<1	Typically associated with cane thickets in forested riparian areas
	Prothonotary Warbler (*Protonotaria citrea*)	22	I	4	Associated with forested riparian areas
	Belted Kingfisher(*Ceryle alcyon*)	19	IIA	3	Associated with streams and flooded areas in a variety of habitat types
	Green Heron (*Butorides virescens*)	19	IIA	9	Associated with forested riparian areas
Early-successional forest	Blue-winged Warbler (*Vermivora pinus*)	26	I	16	
	Prairie Warbler (*Dendroica discolor*)	25	I	16	
	Field Sparrow (*Spizella pusilla*)	23	I	21	
	White-eyed Vireo (*Vireo griseus*)	22	I	9	
	Yellow-breasted Chat (*Icteria virens*)	22	I	13	

Appendix 1 *continued*

Habitat type	Species	Score[1]	Tier[2]	% pop[3]	Comments
	Brown Thrasher (*Toxostoma rufum*)	21	IIA	8	
	Eastern Towhee (*Pipilo erythophthalmus*)	19	IIA	9	
Pine woodlands	Red-cockaded Woodpecker (*Picoides borealis*)	29	I	0	Extirpated
	Bachman's Sparrow (*Aimophila aestivalis*)	26	I	<1	Now very rare in the BCR; also associated with glades, pine and mixed deciduous forest regeneration cuts.
	Brown-headed Nuthatch (*Sitta pusilla*)	22	I	0	Extirpated throughout much of the BCR, but small populations in the Boston Mountains in Arkansas
	Northern Bobwhite (*Colinus virginianus*)	21	IIA	9	
Grass-shrublands	Prairie Warbler (*Dendroica discolor*)	25	I	16	
	Bell's Vireo (*Vireo bellii*)	24	I	<1	
	Field Sparrow (*Spizella pusilla*)	23	I	21	
	Yellow-breasted Chat (*Icteria virens*)	22	I	13	
	Brown Thrasher (*Toxostoma rufum*)	21	IIA	8	
	Northern Bobwhite (*Colinus virginianus*)	21	IIA	9	
	Eastern Towhee (*Pipilo erythophthalmus*)	19	IIA	9	
Grasslands	Greater Prairie Chicken (*Tympanuchus cupido*)	29	I	<1	Now restricted to small isolated populations in the western part of the BCR and southern Illinois
	Henslow's Sparrow (*Ammodramus henslowii*)	26	I	18	Largest populations in the BCR associated with reclaimed minelands
	Grasshopper Sparrow (*Ammodramus savannarum*)	21	IIA	3	
	Eastern Meadowlark (*Sturnella magna*)	19	IIA	12	

[1] *Score* refers to the total score provided by the Partners in Flight Species Assessment Database (Information on the PIF species assessment process and associated scores are available at: http://www.rmbo.org/pif/pifdb.html)

[2] *Tier* refers to the level of conservation priority that should be afforded a species as suggested by the Partners in Flight species assessment process. Tier I identifies high-scoring species that require conservation consideration wherever they occur in manageable numbers. Tier IIA identifies species that occur in a Bird Conservation Region in relatively large numbers and whose trends are unknown or declining.

[3] *%pop* refers to the percentage of the global population estimated to breed within the Central Hardwoods Bird Conservation Region

Appendix 2— *Priority species from the North American Waterfowl Management Plan.*

Species[1]	Season	Geographic importance[2]	Conservation need[3]
Dabbling Ducks:			
Mallard (*Anas playrhynchos*)	nonbreeding	moderately high	high
American Black Duck (*Anas rubripes*)	nonbreeding	moderately high	high
Northern Pintail (*Anas acuta*)	nonbreeding	moderately low	moderate
American Wigeon (*Anas americana*)	nonbreeding	moderately low	moderately low
Gadwall (*Anas strepera*)	nonbreeding	moderately low	moderately low
Blue-winged Teal (*Anas discors*)	nonbreeding	moderately low	moderately low
Perching Ducks:			
Wood Duck (*Aix sponsa*)	breeding	moderately high	moderately high
	non-breeding	moderately low	moderately low
Diving Ducks:			
Greater Scaup (*Aythya marila*)	nonbreeding	moderately low	moderately low
Lesser Scaup (*Aythya affinus*)	nonbreeding	moderately low	moderate
Canvasback (*Atythya valisineria*)	nonbreeding	moderately low	moderately low
Ring-necked Duck (*Aythya collaris*)	nonbreeding	moderately low	moderately low
Sea Ducks:			
Common Goldeneye (*Buchephala clangula*)	nonbreeding	moderately high	moderately high
Hooded Merganser (*Lophodytes cucullatus*)	nonbreeding	moderately high	moderate
Bufflehead (*Buchephala alveola*)	nonbreeding	moderately low	moderately low
Geese:			
Canada Goose (*Branta Canadensis*)			
Southern James Bay population	non-breeding	moderately high	high
Mississippi Valley population	non-breeding	high	high
Mississippi Flyway Giant	breeding	moderately high	moderate
	non-breeding	moderately high	moderate

[1] Species list is from the June 2003 draft update to the North American Waterfowl Management Plan
[2] Importance of the Central Hardwoods Bird Conservation Region (BCR) to a species based upon a combination of the percentage of the species inhabiting the BCR, its density relative to other BCRs, and threats to its habitat within the region
[3] Level of need for habitat conservation and/or monitoring efforts in the Central Hardwoods Bird Conservation Region

Appendix 3— *Priority species from the Upper Mississippi Valley Great Lakes Shorebird Conservation Plan.*

Species	Season	Priority[1]
American Golden-Plover (*Pluvialis dominica*)	migration	3
Killdeer (*Charadrius vociferous*)	migration and breeding	3
Greater Yellowlegs (*Tringa melanoleuca*)	migration	4
Upland Sandpiper (*Bartramia longicauda*)	migration and breeding	4
Semipalmated Sandpiper (*Calidris pusilla*)	migration	3
Least Sandpiper (*Calidris minutilla*)	migration	3
Solitary Sandpiper (*Tringa solitaria*)	migration	3
Dunlin (*Calidris alpina*)	migration	3
Stilt Sandpiper (*Calidris himantopus*)	migration	3
Buff-breasted Sandpiper (*Tryngites subruficollus*)	migration	4
Short-billed Dowitcher (*Limnodromus griseus*)	migration	4
Common Snipe (*Gallinago gallinago*)	migration	3
American Woodcock (*Scolopax minor*)	migration and breeding	4

[1] Scaled from 1-5, with 5 being the highest priority

Appendix 4— *Priority Waterbirds of the Upper Mississippi Great Lakes Regional Waterbird Plan (draft 2002).*

Species	Season	Priority[1]
Bonaparte's Gull (*Larus philidelphia*)	winter and migration	moderate
Franklin's Gull (*Larus pipixcan*)	migration	moderate
Common Tern (*Sterna hirundo)*	migration	high
Forster's Tern (*Sterna forsteri*)	migration	moderate
Least Tern (*Sterna antillarum*)	breeding season and migration	high
Black Tern (*Childonius niger*)	breeding and migration	moderate
Little Blue Heron (*Egretta caerulea*)	breeding and migration	high
Snowy Egret (*Egretta thula*)	breeding	high
Yellow-crowned Night-Heron (*Nyctanassa violacea*)	breeding	moderate
Black-crowned Night-Heron (*Nycticorax nycticorax*)	breeding and winter	moderate
Least Bittern (*Ixobrychus exilis*)	breeding and migration	high
King Rail (*Rallus elegans*)	breeding	high
Black Rail (*Laterallis jamaicensis*)	breeding	high
Whooping Crane (*Grus americana*)	migration	high

[1] Refers to the species need for conservation action

Appendix 5— *Native habitats of the Central Hardwoods: current status and conservation needs.*

Habitat type	Current status	Conservation needs
Upland forest and woodlands	Although oak-hickory and pine-oak forests and woodlands were once prevalent in various areas within the Central Hardwoods BCR, little of the native pine woodlands or pine-dominated forests exist today.	Restoration of large expanses of native short-leaf pine dominated woodlands is needed to support populations of the now rare Bachman's Sparrow and possible re-introductions of Brown-headed Nuthatch and Red-cockaded Woodpecker. Oak woodlands also should be restored on appropriate land types. A variety of forest management and harvest techniques are needed to provide the range of conditions needed by the entire suite of priority bird species
Shrublands	Native grass-shrubland habitats are provided by barrens, glades, savannas, and shrub-prairies, and forest regeneration cuts. Most of these habitat types have been converted to other land uses or have been degraded by decades of fire suppression.	Restoration of these habitat types are needed not only to enhance habitat for shrubland-associated birds, but also to secure populations of other rare, threatened and endangered species associated with those systems. However, maintaining a shrub component at some stage in the life- cycle of these ecosystems will be important if birds are to benefit.
Grasslands	Native grasslands historically were represented by prairies and shrub-prairies. These habitats were most extensive in the western part of the Ozarks and in the large barrens of the Interior Low Plateaus, although small prairie intrusions were scattered among many woodland land-type associations across the BCR. Only small remnants of those habitat types exist today.	Restoration of native prairies should be attempted wherever possible, especially where the restorations can be embedded within landscapes with containing relatively large amounts of other grassland types. Conversion of fescue to native warm-season grass and forb mixes can also help to provide habitat for the grassland bird species suite, but linear strips of woody vegetation that fragment grassland landscapes should be removed to reduce predation and parasitism rates.
Wetlands	Most of the wetland habitats in the BCR are and were associated with the region's larger river systems. Many of those habitats have been drained and converted to other land uses. However, many restoration projects have been undertaken in the BCR, though they are scattered and fairly isolated at this point. Wet meadows are another potentially important wetland habitat type that are associated with hydric soils in prairie ecosystems.	Wetland restoration projects and the protection of existing wetlands of various kinds continue to be needed in the Central Hardwoods. Locations of wet meadows need to be mapped and the kinds of priority birds they support throughout the year should be assessed.
Bottomland hardwood forest and associated cane thickets	Bottomland forests in the BCR were associated with the floodplains of both rivers and larger creeks across the BCR. Much of the forest acreage has been converted to crop or pasture land. Cane thickets (*Arundinaria gigantea*) once formed extensive corridors along many of the BCR's riparian areas and were an important component of the breeding habitat of the high-priority Swainson's Warbler, but now exist in relatively small and isolated patches.	Extensive tracts of extant bottomland forest need to be identified and secured through acquisition, easements, or voluntary incentive programs. Restoration of bottomland forests should be targeted in areas where existing fragments could be consolidated into large tracts. Restoration of cane thickets should be targeted in areas where existing fragments could be consolidated and restoration efforts would provide thickets along relatively long stretches of river adjacent to large tracts of high quality forest.