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INTEGRATING GRASSLAND AND SHRUBLAND BIRD CONSERVATION WITH THE NORTHERN BOBWHITE CONSERVATION INITIATIVE FOR THE CENTRAL HARDWOODS BIRD CONSERVATION REGION

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Abstract. Much attention has focused on management options to increase Northern Bobwhite (*Colinus virginianus*) habitat availability including the organization of the Southeast Quail Study Group Technical Committee and the creation of the Northern Bobwhite Conservation Initiative (NBCI). As the NBCI moves from the planning stages to implementation, there is a need to understand how management options for Northern Bobwhite populations will affect populations of other early successional bird species including birds that use grassland and shrubland habitats. Integrating habitat needs for other early successional species with the NBCI will help the overall goal of Habitat Joint Ventures "to deliver the full spectrum of bird conservation." The goal of this analysis was to provide decision support tools for the initial steps in Strategic Habitat Management for early successional bird species in the Central Hardwoods BCR. We built upon current population estimation methods to evaluate population goals for grassland and shrubland songbirds in specific target areas within the Central Hardwoods BCR. We then estimated population goals and area of habitat needed to achieve population goals. We compared these habitat goals with existing area of private lands enrolled in the Conservation Reserve Program (CRP). For many widespread focal species, like Grasshopper Sparrow (*Ammodramus savannarum*) and Yellow-breasted Chat (*Icteria virens*), the amount of land in CRP would need to be increased by 3 to 10 times current levels to achieve population goals. Successful conservation of priority grassland and shrubland species will require management actions on private lands that go well beyond that which can be provided by current CRP programs.

Key Words: Northern Bobwhite, grassland bird, shrubland bird, decision support.

INTEGRANDO LA CONSERVACIÓN DE LAS AVES DE PASTIZAL Y HÁBITAT ARBUSTIVO CON LA INICIATIVA DE CONSERVACIÓN DE LA CODORNIZ COUTÍ PARA LA REGIÓN DE CONSERVACIÓN DE AVES DE LOS BOSQUES MADERABLES CENTRALES

Resumen. Demasiada atención ha sido enfocada en las opciones de manejo adecuadas que permitan incrementar el habitat disponible para la Codorniz coutí (Colinus virginianus) incluyendo la organización del Grupo de estudio Suroriental de las Codornices "así como la creación del la Iniciativa de Conservación para la Codorniz coutí (NBCI por sus siglas en ingles). Mientras la NBCI cambia de únicamente considerar las etapas de planeación a la implementación, aún existe una gran necesidad por entender el cómo las estrategias de manejo para las poblaciones de la Codorniz coutí afectarán otras poblaciones de aves que utilizan hábitats en sucesión temprana, incluyendo aquellas especies que utilizan pastizales y habitats arbustivos. La integración de los requerimientos del hábitat de otras especies sucesionales dentro de la NBCI ayudará a alcanzar la meta principal del Habitat Joint Ventures "mostrar el espectro completo para la conservación de las aves." El propósito del presente análisis es proveer las herramientas necesarias que soporten las decisiones de las etapas iníciales del manejo estratégico del hábitat para las especies de hábitat de sucesión temprana en los Bosques maderables Centrales BCR. Nos basamos en los métodos de estimación poblacional existentes para evaluar las metas poblacionales de aquellas especies de aves de pastizal y habitat arbustivo dentro de áreas especificas en la zona de conservación de aves de los Bosques maderables Centrales. Posteriormente, se estimaron las metas poblaciones y la cantidad de hábitat necesaria

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para alcanzar las metas poblaciones. Dichas metas concernientes al hábitat fueron comparadas con el área disponible en las tierras privadas inscritas en el programa de conservación de reservas (CRP por sus siglas en inglés). Para muchas especies focales de amplia distribución, como el Gorrión Chapulin (Ammodramus savannarum) y la Buscabreña (Icteria virens) la cantidad de tierra dentro del CRP necesitaría ser incrementada de 3 a 10 veces más para poder alcanzar las metas poblaciones. La conservación exitosa de aquellas especies de pastizal y hábitat arbustivo prioritarias requerirá acciones de manejo en tierras privadas que van mucho más allá de aquellas acciones que puedan ser provistas por los programas del CRP actuales.

INTRODUCTION

The Northern Bobwhite (see Table 1 for scientific names) is one of the most economically important, and thus one of the most studied wild bird species in North America (Brennan 1999). In spite of the Northern Bobwhite's importance and the extensive knowledge of its biology and management, populations have been declining range-wide by 3.9% annually between 1980 and 2005 (Sauer et al. 2006). The range-wide decline in Northern Bobwhite populations led to the organization of the Southeast Quail Study Group (SEQSG) in 1995 and the subsequent creation of the Northern Bobwhite Conservation Initiative (Dimmick et al. 2002, NBCI). The NBCI's goal is to restore Northern Bobwhite populations to 1980 levels by increasing habitat availability.

Much less attention has focused on other early successional bird species in grassland and shrubland habitats. In the Eastern BBS region, 9 of 13 grassland species and 17 of 36 shrubland species have experienced significant population declines (Sauer et al. 2006). As NBCI moves from the planning stages to implementation, there is a need to understand how the management strategy for Northern Bobwhites will affect populations of other early successional bird species. Integrating habitat needs for other early successional species with the NBCI will help the overall goal of Joint Ventures "to deliver the full spectrum of bird conservation" (Fitzgerald et al. 2003), as well as mutually advancing the goals of both the NBCI and Partners in Flight (PIF; Rich et al. 2004). The goal of this analysis was to provide decision support tools for the initial steps in Strategic Habitat Management

TABLE 1. Breeding Bird Survey average density estimates for a route of 50 stops (birds per route) in the Central Hardwoods Bird Conservation Region (1996–2006). Densities were calculated for all Central Hardwoods Joint Venture high priority grassland and shrubland species; means were calculated for all points, points within focal counties for Northern Bobwhite conservation, and points within non-focal counties.

		Breeding Bird Survey Results 1996–2006					
		All Points		Focal Counties		Non-focal Counties	
Common Name	Scientific Name	*n*	Birds/route	*n*	Birds/route	*n*	Birds/route
Greater Prairie-chicken	*Tympanuchus cupido*	132	0.02	47	0.04	85	0.00
Northern Bobwhite	*Colinus virginianus*	132	16.40	47	18.55	85	15.20
Short-eared Owl[1]	*Asio flammeus*	132	0.00	47	0.00	85	0.00
Eastern Kingbird	*Tyrannus tyrannus*	132	6.10	47	6.23	85	6.03
Bell's Vireo	*Vireo bellii*	132	0.09	47	0.13	85	0.07
Bewick,s Wren	*Thryomanes bewickii*	132	0.42	47	0.38	85	0.45
Brown Thrasher	*Toxostoma rufum*	132	4.61	47	4.99	85	4.40
Blue-winged Warbler	*Vermivora pinus*	132	0.53	47	0.47	85	0.56
Prairie Warbler	*Dendroica discolor*	132	1.87	47	1.03	85	2.33
Yellow-breasted Chat	*Icteria virens*	132	9.13	47	9.40	85	8.98
Eastern Towhee	*Pipilo erythrophthalmus*	132	7.14	47	8.10	85	6.61
Bachman's Sparrow[1]	*Aimophila aestivalis*	132	0.00	47	0.00	85	0.00
Field Sparrow	*Spizella pusilla*	132	14.93	47	15.23	85	14.77
Grasshopper Sparrow	*Ammodramus savannarum*	132	2.40	47	2.77	85	2.19
Henslow's Sparrow	*Ammodramus henslowii*	132	0.17	47	0.16	85	0.18
Indigo Bunting	*Passerina cyanea*	132	44.13	47	43.93	85	44.23
Painted Bunting	*Passerina ciris*	132	0.17	47	0.00	85	0.26
Dickcissel	*Spiza americana*	132	11.73	47	11.95	85	11.61
Eastern Meadowlark	*Sturnella magna*	132	29.81	47	32.74	85	28.19
Orchard Oriole	*Icterus spurius*	132	4.03	47	3.68	85	4.23

[1] Not detected on Breeding Bird Survey routes. Minimal values assumed based upon species range in Central Hardwoods Bird Conservation Region (0.0005 for Short-eared Owl and 0.001 for Bachman's Sparrow).

(adaptive management) for early successional bird species in the Central Hardwoods BCR (National Ecological Assessment Team 2006).

We built upon current population estimation methods to evaluate population goals for grassland and shrubland songbirds in specific target areas within the Central Hardwoods BCR that overlap with the NBCI. We estimated population size and area of habitat needed to achieve population goals. We compared these habitat goals with existing area of private lands enrolled in the U.S. Department of Agriculture's (USDA) Conservation Reserve Program (CRP) to serve as a baseline for further conservation and habitat management.

Our objectives were to 1) examine habitat similarities among Northern Bobwhites and other priority grassland and shrubland species; 2) step down population and habitat goals for priority grassland and shrubland birds in the Central Hardwoods BCR in the context of Northern Bobwhite management goals; 3) examine how 3-, 5-, and 10-year disturbance intervals affect total area of suitable habitat needed to meet population goals; 4) compare area of land needed to meet population goals with existing area of CRP enrollment. Results from these analyses are meant to refine the conservation planning processes for PIF, the NBCI revision, and the Central Hardwoods Joint Venture (CHJV).

METHODS

Study area

We focused on early successional bird species in the Central Hardwoods BCR that were considered priority for the Central Hardwoods Joint Venture (Fig. 1). Of the 29 815 052 ha total in the Central Hardwoods BCR, Gudlin and Dailey (2002) estimated that 187 300 ha of CRP grass and 421 329 ha of improvable agricultural land needed to be converted to native warm-season grasses, and 72 641 ha of pinelands needed to be properly thinned and burned to restore Northern Bobwhite populations to 1980 densities. Most of these habitat improvements are expected to be on private lands, especially land under Farm Bill programs like the CRP. Using farmland information from the USDA's Census of Agriculture and estimated areas of habitat needed for each of the CHJV high priority early successional bird species, we evaluated the ability of the current configuration of the CRP to provide sufficient habitat for these species under various management regimes.

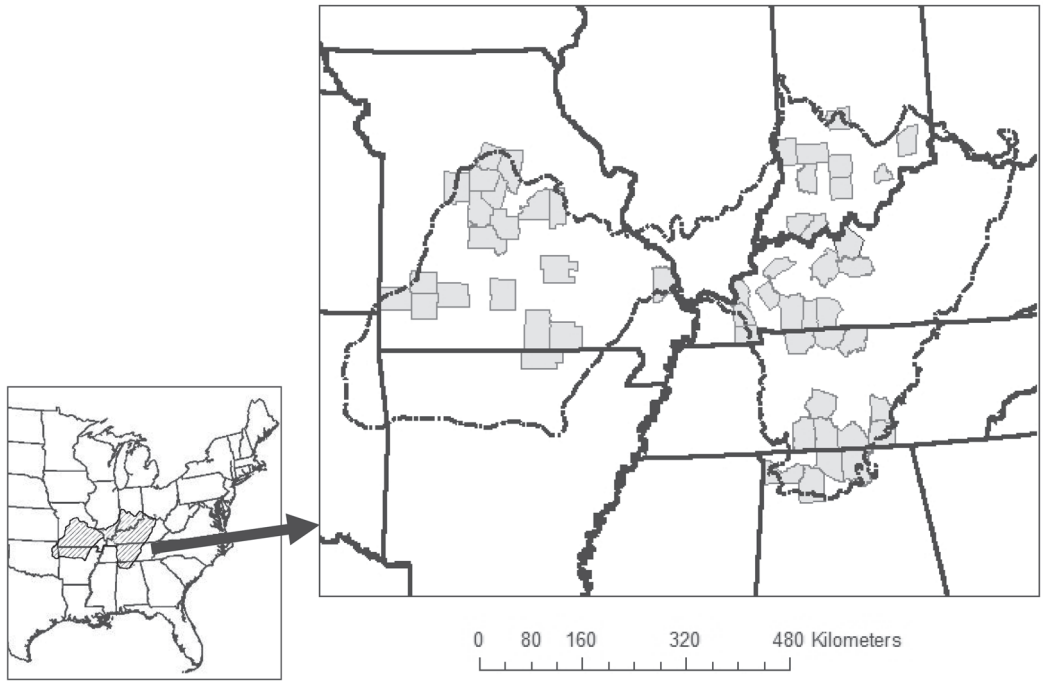

FIGURE 1. Selected priority areas (by county) for Northern Bobwhite conservation in the Central Hardwoods Bird Conservation Region including portions of Missouri, Arkansas, Illinois, Indiana, Tennessee, Kentucky, and Alabama.

In 2006, Central Hardwoods Joint Venture planning meetings were held to establish focal areas for Northern Bobwhite conservation efforts in most states within the Central Hardwoods BCR (Fig. 1). These focal areas were established using the best available information including models of potential Northern Bobwhite habitat created by W. Burger (unpublished report) and others (biologically-based), and expert opinion from the various state agencies (opportunity-based), to form the basis for our analysis. Focal counties were selected to represent counties where habitat management efforts for Northern Bobwhites could be increased either due to the presence of large areas of grass and agricultural habitat or due to local political and social contexts.

Habitat Comparisons

Habitats used by Northern Bobwhites were identified by season of use (nesting, brooding, wintering), and were compiled from various sources including summary literature from the SEQSG, the Northern Bobwhite species account in the *Birds of North America Series* (Brennan 1999), and field observations. Nesting habitats for the other early successional species found in the Central Hardwoods BCR were compiled from species accounts in the *Birds of North America Series* and supplemented with field observations. For this analysis, we only considered breeding habitat because we assumed breeding habitat is more limiting than wintering habitat for most of the species. Where possible, habitat descriptions from the Central Hardwoods BCR were used to describe habitat for species with ranges that extended beyond the Central Hardwoods BCR. Habitats were classified along a successional gradient into 16 categories within five broader classes: agricultural, mostly herbaceous cover, edge, early successional, and forest cover.

Population and Habitat Goals

We developed indices from the North American Breeding Bird Survey (BBS, Sauer et al. 2006), following the methods used by Bart (2005) and Rosenberg and Blancher (2005), to extrapolate populations. Working at the county scale, we used the BBS indices (birds per route) with several assumptions about the area sampled and the detectability of each species to estimate total populations in (a) the whole BCR, and (b) the identified focal area counties for Northern Bobwhite conservation. Where estimates from BBS were not available (Bachman's Sparrow and Short-eared Owl), we assumed an arbitrary minimal density based on the proportion of the species breeding range within the Central Hardwoods BCR.

Following is a brief explanation of how we generated population estimates (territorial pairs) of the total population in focal areas (by county); for a full discussion of the mathematics and assumptions, see Bart (2005) and Rosenberg and Blancher (2005). First, we multiplied the BBS density average by a time of day adjustment, to account for differences in species detectability during the BBS sampling period. This value was then multiplied by the ratio of total area in the focal counties to the area sampled by BBS (number of routes × 50 points × (3.14 × (Max. Detection distance)^2)) (Rosenberg and Blancher 2005). We did not double the estimated population because we were interested in the number of territories (i.e., number of singing males), and not the number of individuals (i.e., males and females). We then multiplied the estimated population by the PIF population goal (Rich et al. 2004) for the CHJV to obtain the total number of territories needed to reach the goals for each species.

We used the number of territories needed from the focal counties to generate the area of habitat needed each year (assuming "ideal" habitat conditions for each species) by multiplying the number of territories by an average territory size obtained from published literature. We recognize the area of habitat needed each year will be a minimum estimate because there is can be space left unused in a seemingly suitable habitat patch. We attempted to obtain average territory size estimates from studies within or as close to the Central Hardwoods BCR as possible. The territory estimate represents the breeding territory, and assumes exclusive use of the territory during the breeding season for all activities.

To account for the successional nature of the annually changing habitats, we provided a way to classify habitat "quality" for each species based upon time since disturbance. For each species, we ranked average habitat "quality" based on expert opinion from 0 through 10 for each year after disturbance, with 0 representing habitat not used to 10 where all the habitat is used for breeding activities (TABLE 3). For example, Henslow's Sparrows need habitats with dead standing vegetation from the previous year's growth for nest sites, but will not use habitats with too many small trees. For the first year (growing season) after disturbance, we assigned a value of 0 for habitat "quality" because the habitat is not suitable (no dead standing vegetation from the previous year's growth). After the first year and for the next 3

years we assigned a value of 10. After the year 4 the habitat is unsuitable because of woody encroachment and was assigned a value of 0. The sum of the ten habitat "quality" values divided by 100 would equal the proportion of habitat available through the full 10-year management rotation (e.g., Henslow's Sparrow habitat available = [0 + 10 + 10 + 10 + 5 + 0 + 0 + 0 + 0 + 0]/100 = 0.35). The sum of the first 5 habitat "quality" values divided by 50 would equal the proportion of habitat available through the 5 year management rotation (e.g., Henslow's Sparrow habitat available = [0 + 10 + 10 + 10 + 5]/50 = 0.70).

To obtain area of managed land needed to account for changes in the habitat due to succession, we divided the area of habitat needed by the proportion of habitat available for each species under a 10-year, 5-year, and 3-year management rotation. The 10-year management rotation represents a typical CRP contract length and assumes the habitat starts with bare ground to near bare ground conditions (e.g., recently burned, herbicide sprayed, disked, mowed) and no disturbance occurs within the 10-year period to set back succession. A 5-year rotation is similar to mid-contract management provisions for CRP and assumes succession is set back in the middle of the 10-year period, and 3-year rotation assumes succession is set back every 3 years. This allowed us to examine different management scenarios and the trade-offs among species. We then calculated the percent of the total land area needed by dividing area of land needed by the total area of land in the focal-area counties (7 579 705 ha).

Finally, we compared the available CRP land area to the estimated area needed for management of each species to evaluate how well the CRP program meets the need. To simplify the analysis, we assumed CRP land is managed appropriately for breeding habitat for each species and all management starts at the same time.

RESULTS

Habitat associations ranged from very specialized species (<5 habitat associations) like Eastern Meadowlark and Bell's Vireo to more generalist species (>10 habitat associations) like Indigo bunting and Field Sparrow (Fig. 2). Some species were associated with grassland habitats (e.g., Grasshopper Sparrow), others were associated with shrubland habitat (e.g., Yellow-breasted Chat), (Fig. 2). Finally, and some species, like Indigo Bunting, were associated with both habitats (Fig. 2). Many species were associated with savanna habitats with 20–50% canopy cover and grass or grass-dominated understory.

There were 132 BBS routes used for the analysis of the Central Hardwoods BCR, including 47 in the focal counties and 85 in the non-focal counties (Table1). Densities per route ranged from 44.13 for Indigo Buntings to 0.02 for Greater Prairie-chicken; two species that are known to breed in the BCR were not detected by the BBS (Short-eared Owl and Bachman's Sparrow).

Estimated total territorial male populations within the focal areas in the BCR ranged from 10 Short-eared Owls to 699 491 Indigo Buntings (Table 2). The minimum area of habitat needed in the focal areas each year to obtain the PIF goal ranged from 106 ha for Short-eared Owls to 1 814 374 ha for Eastern Meadowlarks (Table 3). Accounting for habitat available along the successional gradient on a disturbance rotation of 3, 5, or 10 years increased the total amount of habitat needed (Table 4). Some species, like Grasshopper Sparrow, needed more than twice the managed area on a 10-year rotation than on a 3- or 5-year rotation. Others, like Bell's Vireo and Painted Bunting, needed less total area under management in a 10-year rotation than in a 3- or 5-year rotation (Table 4).

In about half the species, the area of land enrolled in CRP was less than the area of managed land needed to attain the PIF goal population levels within the focal counties (Table 4). For example, to attain the Northern Bobwhite population goals through CRP alone, the area of land in the program would need to be increased by 12 to 14 times 2005 levels, if all habitat created by the program was ideal for Northern Bobwhites. Henslow's Sparrows would need area equal to 2–4% of the land area set aside in the CRP program in 2005 to meet PIF population goals, if the habitat created is ideal habitat for Henslow's Sparrows.

DISCUSSION

Based on our analysis, the management of Northern Bobwhite habitat to produce sustainable populations at 1980 levels can provide significant conservation benefits for other priority grassland and shrubland birds in the Central Hardwoods BCR. Management restoring Northern Bobwhite habitat, like creating native grass-dominated habitats for nesting, will benefit some species (e.g., Grasshopper Sparrow) but not others (e.g., Bell's Vireo and Orchard Oriole; Fig. 2). Managing adjacent areas to provide nonbreeding habitat for Northern Bobwhites will provide nesting habitats needed for other priority bird species across the successional gradient. Species with specialized habitat needs like Henslow's Sparrows and Bachman's Sparrows

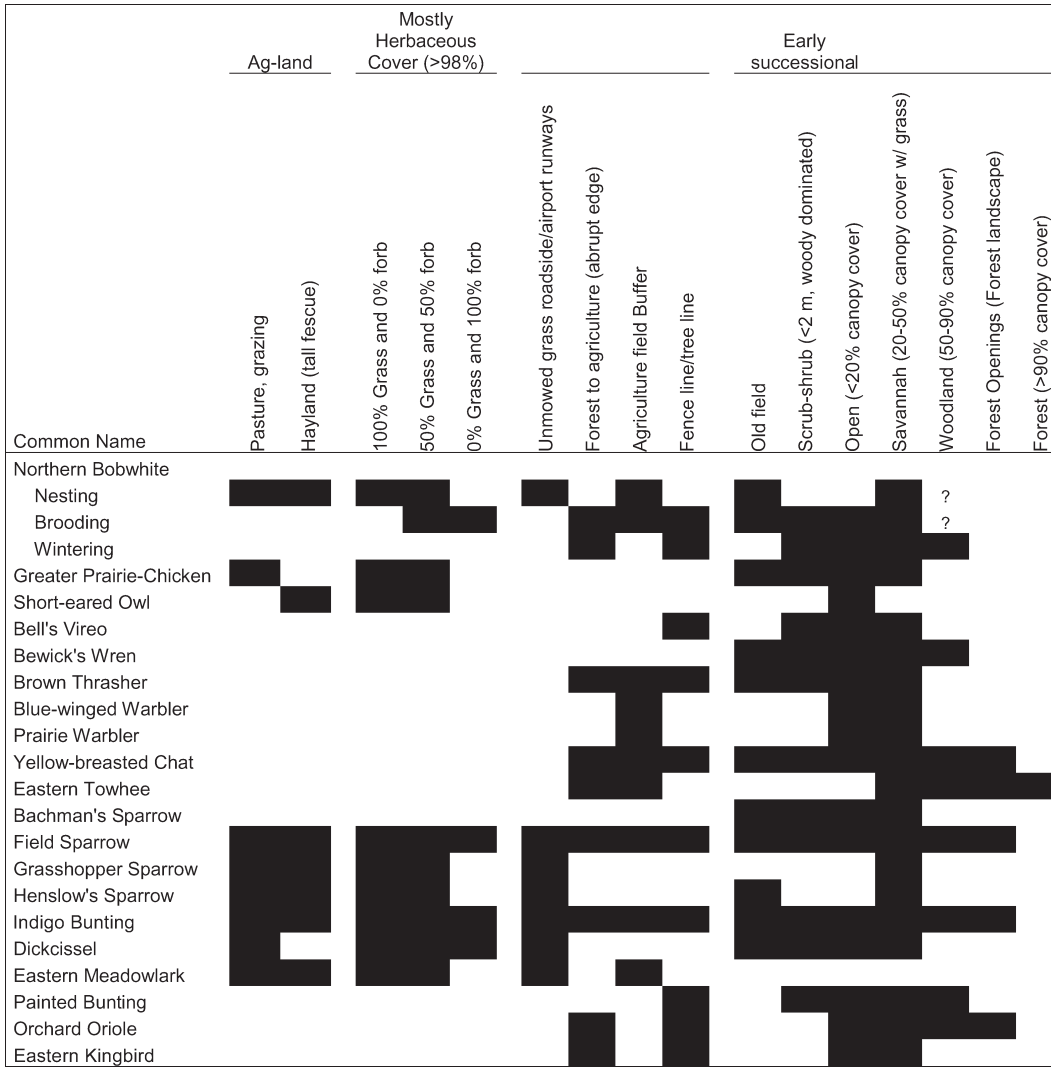

FIGURE 2. Summary of habitats related to Northern Bobwhite management and habitat use by other early successional bird species in the Central Hardwoods Bird Conservation Region.

will need to be attended to specifically (Herkert et al. 1996, Dunning 1993).

In contrast to mature forest habitats, habitat within grasslands and shrublands can change dramatically within a short time period (2–10 years). We extended current population estimation methods to convert number of birds into area of habitat needed, and then accounted for changes in habitat quality related to the natural successional process within potential habitat areas. We also accounted for the possible frequency of habitat management by including 3-, 5-, and 10-year management cycles.

One of the key findings in our analysis is we need to account for the effects of management rotation when considering habitat needs of specific bird species. This management rotation actually increases the total amount of area needed to provide adequate habitat for each species every year, in some cases by >100%. For example, if we assume each pair of Northern Bobwhites need 4 ha of habitat for nesting activities, 1.8 million ha of suitable habitat in the focal areas will be needed each year, but when management rotation is factored into the calculation, 2.1 to 2.6 million ha of managed habitat are needed depending upon the frequency and type of management. The amount of habitat area needed increased for some species as the amount of time between disturbances increased. For example,

TABLE 2. Assumptions used to calculate population estimates, population estimates, and the total number of territories needed to reach Partners in Flight (PIF) population goals in the Central Hardwoods Bird Conservation Region.

Common Name	From Rosenberg and Blancher (2005)			Total population	Focal area Population	Focal area % of total population	PIF population goal	Total territories needed	Focal area territories needed
	Time of day adjust	Max. detection distance (m)	Area sampled (ha)						
Greater Prairie-chicken	1.32	80	101	5 892	3 600	61.1	2	11 784	7 200
Northern Bobwhite	1.00	200	628	776 685	223 793	28.8	2	1 553 369	447 586
Short-eared Owl	1.60	200	628	38	10	25.5	2	76	19
Eastern Kingbird	1.32	200	628	381 726	99 242	26.0	1.5	572 589	148 864
Bell's Vireo	1.32	125	245	14 419	5 117	35.5	2	28 838	10 235
Bewick's Wren	1.32	125	245	67 415	15 335	22.7	2	134 830	30 669
Brown Thrasher	1.12	200	628	244 690	67 435	27.6	1.5	367 035	101 152
Blue-winged Warbler	1.21	125	245	77 238	17 722	22.9	2	154 476	35 444
Prairie Warbler	1.21	125	245	274 235	38 417	14.0	2	548 469	76 835
Yellow-breasted Chat	1.32	125	245	1 461 881	383 181	26.2	1.5	2 192 822	574 772
Eastern Towhee	1.32	125	245	1 143 191	330 074	28.9	1.5	1 714 787	495 111
Bachman's Sparrow	1.32	125	245	160	41	25.5	2	320	82
Field Sparrow	1.07	125	245	1 937 916	503 215	26.0	2	3 875 833	1 006 430
Grasshopper Sparrow	1.47	80	101	1 044 415	307 220	29.4	2	2 088 830	614 440
Henslow's Sparrow	1.66	200	628	13 630	3 183	23.4	1.5	20 446	4 774
Indigo Bunting	1.32	200	628	2 759 186	699 491	25.4	1.2	3 311 023	839 390
Painted Bunting	1.32	200	628	10 687	44	00.4	2	21 374	88
Dickcissel	1.32	200	628	733 570	190 323	25.9	1.5	1 100 355	285 485
Eastern Meadowlark	1.32	200	628	1 864 021	521 372	28.0	1.2	2 236 825	625 646
Orchard Oriole	1.32	200	628	252 278	58 633	23.2	1.5	378 417	87 950

TABLE 3. Areas of (suitable) habitat needed annually for each grassland and shrubland species in the Central Hardwoods Bird Conservation Region. Also presented is the assumed habitat quality for each species in a habitat by number of years since last disturbance (0 years to 10 years), and the proportion of available habitat given a 10, 5, or 3-year management rotation.

Common Name	Citation	Average territory (ha)	Area of habitat needed each year (ha)	Habitat quality/year post-management (0–10)										Proportion Available		
				0	1	2	3	4	5	6	7	8	9	10-yr rotation	5-yr rotation	3-yr rotation
Greater Prairie-chicken	Schroeder and Robb 1993	0.4	2 880	0	10	10	5	0	0	0	0	0	0	0.25	0.50	0.67
Northern Bobwhite	Brennan 1999	4.0	1 790 343	1	10	10	10	10	10	10	10	1	1	0.73	0.82	0.70
Short-eared Owl	Holt and Leasure 1993	5.5	106	0	10	10	5	0	0	0	0	0	0	0.25	0.50	0.67
Eastern Kingbird	Murphy 1996	0.3	44 659	1	10	5	5	5	0	0	0	0	0	0.26	0.52	0.53
Bell's Vireo	Brown 1993	0.5	5 117	0	0	1	10	10	10	10	10	10	10	0.71	0.42	0.03
Bewick's Wren	Kennedy and White 1997	1.6	49 071	0	10	10	10	10	10	5	5	0	0	0.60	0.80	0.67
Brown Thrasher	Cavitt and Haas 2000	0.8	80 922	0	5	10	10	10	10	10	10	5	0	0.70	0.70	0.50
Blue-winged Warbler	Gill et al. 2001	1.1	38 988	0	5	10	10	10	10	5	0	0	0	0.50	0.70	0.50
Prairie Warbler	Nolan et al. 1999	1.2	92 202	0	0	5	10	10	10	5	5	0	0	0.45	0.50	0.17
Yellow-breasted Chat	Eckerle and Thompson 2001	1.2	689 726	1	5	10	10	10	10	10	10	5	0	0.71	0.72	0.53
Eastern Towhee	Greenlaw 1996	1.2	594 134	0	1	1	10	10	10	10	10	10	5	0.67	0.44	0.07
Bachman's Sparrow	Dunning 1993	2.5	204	10	7	1	0	0	0	0	0	0	0	0.18	0.36	0.60
Field Sparrow	Carey et al. 1994	0.8	805 144	5	10	10	10	10	10	10	10	5	5	0.85	0.90	0.83
Grasshopper Sparrow	Vickery 1996	1.0	614 440	10	10	10	5	0	0	0	0	0	0	0.35	0.70	1.00
Henslow's Sparrow	Herkert et al. 2002	0.5	2 387	0	10	10	10	5	0	0	0	0	0	0.35	0.70	0.67
Indigo Bunting	Payne 1992	1.4	1 175 145	5	10	10	10	10	10	10	5	1	0	0.71	0.90	0.83
Painted Bunting	Lowther et al. 1999	3.2	277	0	1	5	5	10	10	10	10	10	5	0.66	0.42	0.20
Dickcissel	Temple 2002	0.7	199 839	0	10	10	10	5	0	0	0	0	0	0.35	0.70	0.67
Eastern Meadowlark	Lanyon 1995	2.9	1 814 374	10	10	10	5	0	0	0	0	0	0	0.35	0.70	1.00
Orchard Oriole	Scharf and Kren 1996	0.5	43 975	0	0	1	1	5	5	5	10	10	10	0.47	0.14	0.03

TABLE 4. Area of managed land needed to provide enough suitable habitat for each priority species in the Central Hardwoods Bird Conservation Region under a 10-, 5-, and 3-year management rotation. Percent total area represents the percent of the land area in the focal counties. Percent of Conservation Reserve Program (CRP) area represents the managed land area needed compared to area of land enrolled in the USDA Conservation Reserve Program in 2005.

	Area of Managed Land Needed (ha)			% of focal area[1]			% of CRP area		
Common Name	10-yr rotation	5-yr rotation	3-yr rotation	10-yr rotation	5-yr rotation	3-yr rotation	10-yr rotation	5-yr rotation	3-yr rotation
Greater Prairie-chicken	11 519	5 760	4 320	0.15%	0.08%	0.06%	7%	3%	2%
Northern Bobwhite	2 452 525	2 183 345	2 557 633	32.40%	28.80%	33.70%	**1398%**	**1244%**	**1458%**
Short-eared Owl	425	212	159	0.01%	0.00%	0.00%	0%	0%	0%
Eastern Kingbird	171 766	85 883	83 736	2.30%	1.10%	1.10%	98%	49%	48%
Bell's Vireo	7 207	12 184	153 519	0.10%	0.20%	2.00%	4%	7%	88%
Bewick's Wren	81 784	61 338	73 606	1.10%	0.80%	1.00%	47%	35%	42%
Brown Thrasher	115 602	115 602	161 843	1.50%	1.50%	2.10%	66%	66%	92%
Blue-winged Warbler	77 976	55 697	77 976	1.00%	0.70%	1.00%	44%	32%	44%
Prairie Warbler	204 892	184 403	553 209	2.70%	2.40%	7.30%	**117%**	**105%**	**315%**
Yellow-breasted Chat	971 446	957 953	1 293 237	12.80%	12.60%	17.10%	**554%**	**546%**	**737%**
Eastern Towhee	886 767	1 350 304	8 912 004	11.70%	17.80%	117.60%	**505%**	**770%**	**5080%**
Bachman's Sparrow	1 132	566	340	0.01%	0.01%	0.00%	1%	0%	0%
Field Sparrow	947 228	894 605	966 173	12.50%	11.80%	12.70%	**540%**	**510%**	**551%**
Grasshopper Sparrow	1 755 544	877 772	614 440	23.20%	11.60%	8.10%	**1001%**	**500%**	**350%**
Henslow's Sparrow	6 820	3 410	3 581	0.10%	0.00%	0.00%	4%	2%	2%
Indigo Bunting	1 655 134	1 305 717	1 410 174	21.80%	17.20%	18.60%	**943%**	**744%**	**804%**
Painted Bunting	420	661	1 387	0.01%	0.01%	0.02%	0%	0%	1%
Dickcissel	570 969	285 485	299 759	7.50%	3.80%	4.00%	**325%**	**163%**	**171%**
Eastern Meadowlark	5 183 926	2 591 963	1 814 374	68.40%	34.20%	23.90%	**2955%**	**1477%**	**1034%**
Orchard Oriole	93 564	314 108	1 319 252	1.20%	4.10%	17.40%	53%	**179%**	**752%**

[1]Total area = 29 764 538 ha, focal areas = 7 579 705 ha (25.5% of total), Total CRP area= 175 442 ha.

a grassland species like Grasshopper Sparrow, needed more than twice as much area under a 10-year rotation as a 3-year rotation (614 440 to 1 755 544 ha respectively). In contrast, Yellow-breasted Chat, a shrubland species, needed more managed habitat area under more frequent management scenarios than under a 10-year management rotation.

It also should be noted however, that some habitats that are regularly disturbed (grazing lands and haylands) are affected more by the timing of the disturbance within season than by the frequency of disturbance among seasons. Mowing fields during the breeding season can have severe negative impacts at the population level on ground nesting birds (Giocomo 2005).

We used the amount of land in the CRP to highlight the difference between the needed area for habitat conservation and the current amount of habitat provided in one of the largest private land conservation programs. For half of the high priority species, current CRP area alone would not be adequate to provide habitat for the target populations, even assuming CRP was managed optimally for these species. Currently CRP covers about 2% of the land area in the focal counties and can be much less in individual counties (USDA 2002 Census of Agriculture).

Federal landowner assistance programs, like the CRP need to be part of the solution for habitat loss and degradation, but our analysis shows for many species that isn't nearly enough. In the focal counties, Henslow's Sparrows and Bachman's Sparrows should be targeted with CRP efforts (Herkert 2006). Other species with more generalized and extensive habitat needs will require additional private lands strategies working with the agricultural community. These strategies include incorporating native warm-season fields for grazing and haying enterprises where there already are economic incentives in place to drive the habitat conservation.

There were many assumptions included in the calculation of the area of habitat needed for each species, including detection distance, management rotation, territory size, and habitat quality (Rosenburg and Blancher 2005). More research will be needed to identify where species overlap and where species can tolerate similar habitats (i.e., work toward compatible management for multiple species and understand habitat "quality" for each species). Our analysis does not include the effects of edges or area sensitivity on the use and availability of habitats for these early successional species. In some cases, small fields included in the total area available would not be used by species that are particularly sensitive to patch size. On the other hand, potential habitat along forest edges for some of the shrub species was not included in the calculation of available habitat, thus underestimating available habitat for those species.

Our process was designed to be scalable to smaller portions of the BCR, but we were unable to work at scales smaller than a few counties. Our main limitation was the availability of bird population information. There were less BBS routes than counties within the Central Hardwoods BCR. Targeted monitoring within focal counties would greatly enhance our estimates of populations. Given the available data, we believe counties are a good functional management unit for focusing management efforts and for monitoring success.

By using a spreadsheet design, we were able to allow assumptions and population goals to be changed to see what the changes would do to the area of habitat needed for each species, thus creating a dynamic decision support tool. We were able to examine the effects of possible choices for managers and policy makers. As assumptions are validated or modified the population and habitat area estimates can be updated quickly in the spreadsheet using the most up-to-date information available. Although this analysis is simplistic in many respects, we feel it provides a good starting point to incorporate the rapidly changing nature of successional habitat into long-term, landscape-scale bird conservation planning incorporating the needs for Northern Bobwhites and other priority grassland and shrubland bird species in the Central Hardwoods BCR.

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