



A Report on the Monitoring Avian Productivity and Survivorship Program (MAPS) in Mammoth Cave National Park 2004-2007

Natural Resource Report NPS/CUPN/NRTR—2009/175



ON THE COVER

Photos clockwise from top left: Kentucky Warbler; Brice Leech, Biologist, Mammoth Cave National Park processing an Indigo Bunting; Worm-eating Warbler, Black and White Warbler, Cerulean Warbler being processed in-hand
Photograph by: courtesy of Mammoth Cave National Park

A Report on the Monitoring Avian Productivity and Survivorship Program (MAPS) in Mammoth Cave National Park *2004-2007*

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Bill Moore
Ecologist/Data Manager
Cumberland Piedmont Network
P.O. Box 8
Mammoth Cave, KY 42259

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Executive Summary

In 2004, Mammoth Cave National Park (MACA), Science and Resources Management staff in cooperation with the Kentucky Department of Fish and Wildlife Resources (KDFWR) initiated a Monitoring Avian Productivity and Survivorship (MAPS) station on MACA near Dennison Ferry (DEFE). During the 2004-2007 banding seasons, a total of 432 captures were recorded with 324 birds being newly banded at DEFE. The Worm-eating Warbler (*Helmitheros vermivorum*) and Kentucky Warbler (*Oporornis formosus*) were among the most commonly encountered species. Both are considered high priority species within the Central Hardwoods Bird Conservation Region (BCR), as well as species of greatest conservation need by KDFWR. While direct season to season comparisons for the 2005-2007 seasons are currently unavailable, reproductive indices for both species greatly exceeded long-term averages (1992-2003) at both the continental and Central Hardwoods BCR scales. This is a positive finding for managers at MACA in that it provides the only known (to this author) direct evidence that species preferring large contiguous blocks of mature or relatively mature forest for breeding are not only establishing territories, but are successfully fledging high numbers of offspring on the park. This finding not only has positive ramifications for park managers, but also the BCR.

Introduction

With millions being spent each year on bird watching, birds are arguably the most highly visible and highly sought vertebrate group amongst the general public. In addition, birds perform many important ecological functions such as seed dispersal and insect control, making them of high interest to the scientific community as well. As a result of their high profile and ecological importance, numerous monitoring initiatives were established resulting in large datasets available for comparisons and/or pooling of monitoring results. Analysis of these data in recent decades, pointed to steady declines in many populations of eastern migratory songbirds (Robbins et al. 1989, Franzreb and Rosenberg 1997). However, traditional methods of monitoring provided little insight into the question of why these declines were occurring. The fact that many of these species spend portions of the year in highly disjunct geographic areas (in many cases across two continents) only compounded this problem. Land managers knew species were declining but had little or no empirical data for assessing whether declines were driven by local factors on the breeding range or in Central/South America on the winter range.

The Monitoring Avian Productivity and Survivorship (MAPS) methodology was developed to circumvent these limitations by directly monitoring temporal trends in productivity and survivorship. MAPS was designed to answer the questions “Are birds surviving from one breeding season to the next?” and “Are young being fledged within the area of influence of the MAPS station?” Without data on productivity and survivorship, it is extremely difficult to identify effective management and conservation actions to reverse declines.

MAPS was first implemented in the United States by the Institute for Bird Populations (IBP) in 1989 (DeSante and Nott 2000). The United States Geological Survey/ Biological Resources Division reviewed the MAPS program and concluded it was technically sound and based upon the best available biological and statistical methods and provides useful information on landbird demographics that is not available elsewhere (Geisler 1996; Cited in DeSante and Nott 2000). Since its inception the MAPS program has grown into a continent-wide network of over 500 stations.

In 2004, Mammoth Cave National Park (MACA), Science and Resources Management staff hosted a multi-agency MAPS training and initiated a MAPS station on MACA near Dennison Ferry (DEFE) (Moore 2003). In 2005, 2006, and 2007 MACA continued to operate the DEFE MAPS station with field assistance from the Kentucky Department of Fish and Wildlife Resources (KDFWR). This report summarizes data collected as part of these activities at DEFE.

Common and scientific names within this report adhere to the American Ornithologists’ Union (AOU) Check-list of North American Birds 7th edition, 45th supplement (2004).

Methods

The MAPS methodology is described in detail in a protocol published each year by IBP. This protocol was consulted and followed each season of operation at MACA (DeSante et al. 2004, 2005, 2006, 2007). The most recent version of this protocol can be accessed from IBP’s website at <http://www.birdpop.org/manuals.htm>.

MAPS utilizes a constant-effort mist netting approach whereby a set of mist-nets (typically 10) are established at permanent locations, with net density approximating 1.25 to 1.5 nets per hectare. A typical 10 net station will comprise a seven to eight hectare study area with average distance between nets approximating 75-100 meters. In the pilot year of operation at MACA (i.e., 2004), 10 net sites were selected and utilized. Two nets (03 and 05) were moved within the station prior to the commencement of the 2005 season to new locations (3A and 5A) (Figure 1). Net locations have remained constant since 2005.

Captured birds were identified to species, age, sex, reproductive condition, and molt status, among other variables. Before release, birds were banded with a uniquely numbered metal leg band issued by the USGS Bird Banding Laboratory (BBL). Per MAPS protocol guidelines (DeSante et al. 2004, 2005, 2006, 2007), nets were opened at MACA eight mornings during the MAPS season which began May 21 and ended August 8 each year. Nets were opened at sunrise and closed six hours later. Thus, up to 480 net-hours of effort were logged at MACA during each season (10 nets x 6 hours x 8 mornings).

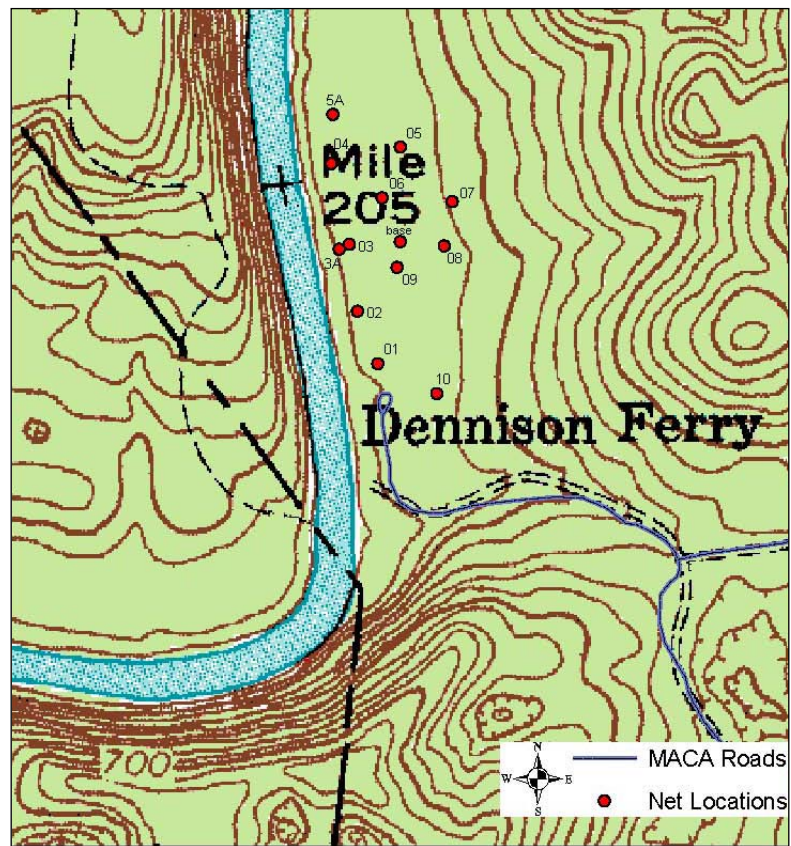


Figure 1. Net locations in the Dennison Ferry MAPS Station at Mammoth Cave National Park.

Field activities and data reporting were in compliance with the General Conditions for Scientific Research and Collecting Permit issued by the National Park Service (Study #:MACA-00402, Permit #:MACA-2004-SCI-0002). All banding activities were conducted under the authority of MACA's master station permit (Permit #23318; Responsible Individual, William J. Moore) issued by the BBL and in accordance with the guidelines contained in the North American Bird Banding Manual (Environment Canada, Canadian Wildlife Service and U.S. Fish and Wildlife Service 1991). MAPS station operation adhered to the guidelines contained in DeSante et al. (2004, 2005, 2006, 2007). Pyle (1997) was utilized as the authority for all sex and age determinations. Data entry, verification, and validation procedures followed the guidelines contained in Froehlich et al. (2004, 2006). A copy of all validated data files were submitted to IBP. Additionally, banding data were submitted to the BBL in accordance with federal bird banding permit requirements.

Study Site

The DEFE MAPS station was situated within a large contiguous forest block. In 2004, two primary habitat types were delineated within the station boundary by Michelle Webber, Contract Botanist, Western Kentucky University, utilizing the methodology found in Nott et al. (2003). These included a mature, deciduous, hardwood riparian community comprising approximately 65% of the station. Predominant upper-story (>15m) species include sycamore (*Platanus occidentalis*), black walnut (*Juglans nigra*), maple (*Acer spp.*), elm (*Ulmus spp.*) and ash (*Fraxinus spp.*). The cover class of the upper-story was estimated at 70% where cover is defined as the sum of the areas delimited by the vertical projections of plant perimeters onto the ground and not to light passing through the foliage of a single plant (i.e., any area inside the drip line of an individual tree is considered fully covered and any overlap of cover between neighboring individuals is only considered once). The cover class for the mid-story (5-15m) and under-story (0.5-5m) were estimated at 40% and 80% respectively. In essence this was a mature canopy community with interspersed shrubs and significant herbaceous ground cover influenced by periodic winter flooding from the Green River. Additionally, a thin band of early successional vegetation was present immediately adjacent to the Green River edge. This band was maintained through frequent scouring resulting from high water events.

The remaining 35% of the station was comprised of a successional eastern red cedar (*Juniperus virginianus*) thicket which occurred on the “transitional toe-slope” between the bottomland riparian community and the upland hardwood communities. It was virtually devoid of a mid-story component with the cover class estimated at <5%. Oak (*Quercus spp.*) and other deciduous species were present in this layer. The under-story cover was estimated at 40% and was dominated by woody broad-leaved species such as redbud (*Cercis spp.*), dogwood (*Cornus spp.*), and papaw (*Asimina triloba*). This community was essentially an even-aged (possibly 60+ years?) cedar community resulting from past disturbance, such as agriculture (an old fence is present).

Results

From 2004-2007, a total of 432 captures were recorded and 324 birds banded during the four seasons of operation at the DEFE MAPS station (Table 1). Capture totals were lowest in 2004 with only 86 total captures. During that season, net 03 and 05 resulted in only five total captures in 2004. In an effort to increase capture success, prior to the commencement of the 2005 season, these nets were relocated within the station boundaries (i.e., 3A and 5A) (Figure 1.). The desired result was achieved as these new locations resulted in a mean of 39 captures for the 2005-2007 seasons. As a result of this change, 2004 data are not directly comparable to 2005, 2006 and 2007 totals. Station ‘adjustments’ such as this are not uncommon following the initial season, and as a result, IBP largely views the first season as a pilot effort and does not routinely include ‘pilot’ years in analyses.

From 2005-2007, 29 species were banded at the station with thirteen of these species captured two or fewer times (Table 1). Four species, the Worm-eating Warbler (*Helminthos vermivorum*), Common Yellowthroat (*Geothlypis trichas*), Kentucky Warbler (*Oporornis*

Table 1. Capture Summary for the Dennison Ferry MAPS station, 2004-2007. N=Newly banded, U=Unbanded, R=Recapture of banded birds.

Species	2004 ¹			2005			2006			2007			Total		
	N	U	R	N	U	R	N	U	R	N	U	R	N	U	R
Yellow-billed Cuckoo										1			1		
Ruby-throated Hummingbird ²		1									1			2	
Downy Woodpecker	2						5			2			9		
Acadian Flycatcher	1	1		3			2						6	1	
White-eyed Vireo										1			1		
Red-eyed Vireo	1			1			1		2	4			7		2
Blue Jay	1												1		
Carolina Chickadee	1			1						1	1		3	1	
Tufted Titmouse	4			1			2			1		1	8		1
White-breasted Nuthatch										2			2		
Carolina Wren	12	1	1	13		9	8	2	8	6		1	39	3	19
Veery ³							1						1		
Swainson's Thrush ³							1						1		
Wood Thrush	2			1			5			2			10		
Northern Parula				2									2		
Yellow-throated Warbler										1			1		
Prairie Warbler				2									2		
Cerulean Warbler							1			1			2		
Black-and-White Warbler				1						4			5		
Worm-eating Warbler	14			10			17	1	5	16	1	1	57	2	6
Ovenbird	4			4			11	1		5			24	1	
Louisiana Waterthrush	1			3		1	2						6		1
Kentucky Warbler	13	1	5	12		4	15	1	7	6		3	46	2	19
Common Yellowthroat	1	1		11		9	11		6	9		5	32	1	20
Hooded Warbler	1			3			1			6			11		
Yellow-breasted Chat										1			1		
Scarlet Tanager	2			1						1			4		
Eastern Towhee	1									1			2		
Northern Cardinal	2	1		2		3	5	1	1	4		1	13	2	5
Indigo Bunting	7		4	7		4	3		3	10	1	8	27	1	19
All Species Pooled	70	6	10	78		30	91	6	32	85	4	20	324	16	92
Total Captures		86			108			129			109			432	
Total Species		19			18			17			23			30	

¹ Net locations were adjusted following the 2004 pilot season

² Special authorization required to band hummingbirds, thus all individuals released unbanded.

³ Late migrant, species does not breed within the Mammoth Cave Region.

formosus), and Carolina Wren (*Thryothorus ludovicianus*) were the dominant catch. Collectively these four comprised 57 % of the total captures from 2005 to 2007 and were the only species to average more than 10 individuals banded each season.

Due to extenuating circumstances (primarily weather), total net-hours at DEFE varied slightly from season to season. Effort was lowest in 2007 with 445.97 net-hours. Highest effort was in 2005 with 478.67 net-hours. There were 472.0 net-hours in 2006. For the purposes of analyses,

IBP divides the MAPS season into two “super periods.” These include an adult super period, during which adults usually predominate in the number of captures, and a young super period, during which hatch year birds (i.e., birds hatched that year) typically predominate in the catch. For MACA these periods are May 12 – July 9 and July 10 – August 8, respectively. A minimum of three periods (mornings) must be completed during the adult super period and a minimum of two during the young super period before data are considered adequate for analyses (DeSante et al. 2007). Effort must also be made up if the missing effort amounts to more than half of a normal day’s operation. Standards for minimum allowable effort were met during each of the seasons of operation at MACA.

The 2005, 2006, and 2007 capture rates (per 600 net-hours) of aged individuals (adult or young) and reproductive indices (# young birds divided by # adult birds) are presented for each species and for all species pooled in Table 2. MAPS station results are commonly reported per 600 net-hours, rather than absolute numbers. This standardization facilitates comparisons among stations which, because of vagaries due to weather or other extenuating circumstances, will likely differ from one another in regard to effort (i.e., net-hours). At DEFE the adult capture rate was greatest in 2007 (79.4 adults per 600 net-hours) with little difference between the 2005 (67.7 adults per 600 net-hours) and 2006 (66.1 adults per 600 net-hours) seasons (Table 2). Capture rate for young was highest in 2006 (57.2 young per 600 net-hours). The reproductive index was also greatest in 2006 at 0.81 young per adult. The 2007 season experienced a decrease in the pooled capture rate for young and the reproductive index, indicating an increase in adult population size but a decrease in productivity between 2006 and 2007.

To date, implementation of the MAPS program at MACA has been a cooperative effort with KDFWR. KDFWR also provided assistance in the establishment and/or follow-up assistance to stations at Clark’s River National Wildlife Refuge in western Kentucky and Natural Bridge State Resort Park in eastern Kentucky. Collectively, these stations are a component of KDFWR’s efforts to monitor species of greatest conservation need, identified in the Kentucky State Wildlife Action Plan (Vorisek 2007). To date, the results from the DEFE MAPS appear favorable when compared to other individual stations in operation in Kentucky (Table 3). Based on pooled values for the 2005-2007 seasons, the DEFE MAPS station has captured and aged an average of 115.8 individuals per 600 net-hours, slightly more than the total obtained at either Clark’s River or Natural Bridge (Table 3.). Dennison Ferry’s pooled 2005-2007 reproductive index of 0.64 young per adult was double that obtained at either of the other stations (Table 3). From a species richness standpoint, a total of 26 species were captured during the 2005-2007 seasons at both Clark’s River and DEFE. Natural Bridge captured 20 species during the same time frame (Table 3).

Results from Clark’s River, Natural Bridge, and Dennison Ferry were pooled for the time frame 2005-2007 to estimate adult survival and recapture probabilities and proportion of residents in Vorisek (2007). These results are not provided in this report.

Table 2. Number of aged individual birds captured per 600 net-hours and reproductive index (young/adult) at the DEFE MAPS station, in Mammoth Cave National Park, 2005-2007. Data for each species are included only if the station is within the breeding range of the species.

Species	2005			2006			2007		
	Ad.	Yg.	Repr. Index	Ad.	Yg.	Repr. Index	Ad.	Yg.	Repr. Index
Yellow-billed Cuckoo							1.3	0.0	0.00
Downy Woodpecker				2.5	3.8	1.50	1.3	1.3	1.00
Acadian Flycatcher	2.5	0.0	0.00	2.5	0.0	0.00			
White-eyed Vireo							1.3	0.0	0.00
Red-eyed Vireo	0.0	1.3	und. ¹	1.3	0.0	0.00	5.4	0.0	0.00
Carolina Chickadee	1.3	0.0	0.00				1.3	0.0	0.00
Tufted Titmouse	1.3	0.0	0.00	2.5	0.0	0.00	1.3	1.3	1.00
White-breasted Nuthatch							2.7	0.0	0.00
Carolina Wren	7.5	10.0	1.33	5.1	8.9	1.75	2.7	4.0	1.50
Wood Thrush	1.3	0.0	0.00	5.1	1.3	0.25	1.3	1.3	1.00
Northern Parula	2.5	0.0	0.00						
Yellow-throated Warbler							1.3	0.0	0.00
Prairie Warbler	0.0	2.5	und. ¹						
Cerulean Warbler				1.3	0.0	0.00	1.3	0.0	0.00
Black-and-White Warbler	1.3	0.0	0.00				4.0	1.3	0.33
Worm-eating Warbler	6.3	6.3	1.00	12.7	10.2	0.80	9.4	12.1	1.29
Ovenbird	1.3	3.8	3.00	6.4	7.6	1.20	2.7	4.0	1.50
Louisiana Waterthrush	0.0	2.5	und. ¹	0.0	2.5	und. ¹			
Kentucky Warbler	10.0	7.5	0.75	7.6	12.7	1.67	6.7	5.4	0.80
Common Yellowthroat	13.8	0.0	0.00	10.2	5.1	0.50	10.8	4.0	0.38
Hooded Warbler	2.5	1.3	0.50	0.0	1.3	und. ¹	5.4	1.3	0.25
Yellow-breasted Chat							0.0	1.3	und. ¹
Scarlet Tanager	1.3	0.0	0.00				1.3	0.0	0.00
Eastern Towhee							0.0	1.3	und. ¹
Northern Cardinal	3.8	0.0	0.00	3.8	3.8	1.00	4.0	1.3	0.33
Indigo Bunting	11.3	0.0	0.00	5.1	0.0	0.00	13.5	1.3	0.10
Species Pooled	67.7	35.1	0.43 ²	66.1	57.2	0.81 ²	79.4	41.7	0.49 ²
Number of Species	15	8		15	10		20	14	
Total Species		18			17			22	

¹ Reproductive index is undefined because no adults were captured at the station in this year.

² Species for which the reproductive index was undefined (no adult birds captured in the season) are not included in the mean reproductive index for the respective season.

Table 3. Mean number of aged individual birds captured per 600 net-hours and reproductive index (young per adult) at the three individual MAPS stations operated in Kentucky, and all stations pooled, averaged over the three years, 2005-2007. Data for each species are included only from stations that lie within the breeding range of the species (Vorisek 2007).

Species	Clark's River NWR			Natural Bridge			Dennison Ferry			All stations pooled		
	Ad.	Yg.	Repr. Index ¹	Ad.	Yg.	Repr. Index ¹	Ad.	Yg.	Repr. Index ¹	Ad.	Yg.	Repr. Index ¹
Yellow-billed Cuckoo	0.4	0.0	0.00				0.4	0.0	0.00	0.3	0.0	0.00
Belted Kingfisher				0.0	1.0	und. ²				0.0	0.3	und. ²
Red-bellied Woodpecker	0.0	0.8	und. ²							0.0	0.3	und.
Downy Woodpecker	2.5	0.0	0.00	1.3	0.4	0.00	1.3	1.7	1.25	1.7	0.7	0.42
Hairy Woodpecker	0.9	0.0	0.00							0.3	0.0	0.00
Pileated Woodpecker				0.5	0.0	0.00				0.1	0.0	0.00
Eastern Wood-Pewee	3.0	0.4	0.11							1.0	0.1	0.11
Acadian Flycatcher	21.6	2.5	0.12	8.3	0.0	0.00	1.7	0.0	0.00	10.6	0.9	0.08
Eastern Phoebe				0.0	0.4	und.				0.0	0.1	und.
White-eyed Vireo	3.4	0.0	0.00				0.4	0.0	0.00	1.3	0.0	0.00
Yellow-throated Vireo	1.7	0.0	0.00							0.6	0.0	0.00
Red-eyed Vireo	3.0	0.0	0.00	3.4	0.0	0.00	2.2	0.4	0.00	2.9	0.1	0.06
Blue Jay				0.0	0.4	und.				0.0	0.1	und.
Carolina Chickadee	3.4	0.4	0.00				0.9	0.0	0.00	1.4	0.1	0.33
Tufted Titmouse	5.5	0.4	0.07	1.3	0.0	0.00	1.7	0.4	0.33	2.9	0.3	0.09
White-breasted Nuthatch							0.9	0.0	0.00	0.3	0.0	0.00
Carolina Wren	3.3	1.3	0.43	2.6	0.0	0.00	5.1	7.7	1.53	3.7	3.0	0.87
Blue-gray Gnatcatcher	2.6	0.0	0.00							0.9	0.0	0.00
Wood Thrush	3.0	0.0	0.00	3.8	0.4	0.17	2.6	0.9	0.42	3.1	0.4	0.40
Northern Parula	1.3	0.0	0.00				0.8	0.0	0.00	0.7	0.0	0.00
Black-throated Grn Warb.				0.0	0.5	und.				0.0	0.1	und.
Yellow-throated Warbler							0.4	0.0	0.00	0.1	0.0	0.00
Prairie Warbler							0.0	0.8	und. ²	0.0	0.3	und.
Cerulean Warbler							0.9	0.0	0.00	0.3	0.0	0.00
Black-and-white Warbler				3.7	1.3	0.17	1.8	0.4	0.17	1.8	0.6	0.82
Prothonotary Warbler	3.4	0.0	0.00							1.2	0.0	0.00
Worm-eating Warbler				11.1	2.1	0.22	9.5	9.5	1.03	6.8	3.9	0.58
Swainson's Warbler				0.4	0.4	0.00				0.1	0.1	0.00
Ovenbird	0.8	0.0	0.00	8.3	1.7	0.17	3.4	5.1	1.90	4.2	2.3	0.59
Louisiana Waterthrush	3.8	0.0	0.00	7.5	7.1	1.01	0.0	1.7	und.	3.7	2.9	0.83
Kentucky Warbler	17.5	3.4	0.22	0.4	0.0	0.00	8.1	8.5	1.07	8.7	4.0	0.48
Common Yellowthroat							11.6	3.0	0.29	3.9	1.0	0.29
Hooded Warbler				22.9	7.8	0.35	2.6	1.3	0.38	8.3	2.9	0.35
Yellow-breasted Chat							0.0	0.4	und.	0.0	0.1	und.
Summer Tanager	3.4	0.0	0.00							1.2	0.0	0.00
Scarlet Tanager	1.3	0.0	0.00	0.4	0.0	0.00	0.9	0.0	0.00	0.9	0.0	0.00
Eastern Towhee							0.0	0.4	und.	0.0	0.1	und.

Table 3. Mean number of aged individual birds captured per 600 net-hours and reproductive index (young per adult) at the three individual MAPS stations operated in Kentucky, and all stations pooled, averaged over the three years, 2005-2007. Data for each species are included only from stations that lie within the breeding range of the species (Vorisek 2007) (continued).

Species	Clark's River NWR			Natural Bridge			Dennison Ferry			All stations pooled		
	Ad.	Yg.	Repr. Index ¹	Ad.	Yg.	Repr. Index ¹	Ad.	Yg.	Repr. Index ¹	Ad.	Yg.	Repr. Index ¹
Northern Cardinal	9.8	0.0	0.00	0.4	0.4	0.00	3.9	1.7	0.44	4.7	0.7	0.14
Indigo Bunting	7.7	0.0	0.00				9.9	0.4	0.03	5.9	0.1	0.02
Common Grackle	0.4	0.0	0.00							0.1	0.0	0.00
Brown-headed Cowbird	0.4	0.0	0.00							0.1	0.0	0.00
American Goldfinch	0.4	0.0	0.00							0.1	0.0	0.00
All Species Pooled	104.5	9.3	0.09	76.4	24.0	0.32	71.1	44.7	0.64	84.1	25.9	0.31
Number of Species	25	7		16	13		22	17		34	26	
Total Species		26			20			26			42	

¹ Years for which the reproductive index was undefined (no adult birds were captured in the year) are not included in the mean reproductive index.

² The reproductive index is undefined at this station because only young individuals (i.e., no adults) were captured.

Discussion

The MAPS station at DEFE provides station specific indices of adult population size and post-fledging productivity, in addition to other metrics. In 2007, the adult breeding bird capture rate at the DEFE MAPS station (per 600 net-hours) increased 19% from the 2005 and 2006 average. Yet, productivity decreased in 2007. Such alternating cycles of population increases and decreases with “out-of-phase” decreases and increases in productivity are exhibited at many MAPS stations in the U.S. This pattern is apparently related to density-dependent effects on productivity and recruitment, and potentially with lower productivity of first time breeders (Siegel et al. 2007a). In 2007, 37% or 22 adult individuals captured were aged as second year birds (i.e., hatched the previous year). This percentage was greater than what was observed in 2005 (19%) or 2006 (25%). Because second year birds typically are not as successful at attracting a mate and producing offspring, this may at least partially explain the observed decrease in production in 2007.

As noted earlier, the DEFE MAPS station’s seasonal catch is heavily skewed toward individuals of only a few species. These include the Worm-eating Warbler, Common Yellowthroat, Kentucky Warbler, and Carolina Wren. Though not captured with the same frequency as these, a fifth species whereby a high number of individuals have been captured is the Indigo Bunting (*Passerina cyanea*). Collectively, these five comprise >60% of the individuals banded during the 2005-2007 seasons. With the exception of Common Yellowthroat, Monroe (2005) found that these species were widespread throughout the park and among the 20 most abundant species surveyed. In fact, all of the 20 most abundant species as determined by Monroe (2005) are regularly observed at the DEFE MAPS station. Thus, the species assemblage observed at the DEFE MAPS station approximates patterns observed across the park as a whole. However, life

history characteristics (e.g., canopy nesters, canopy foragers, etc.) limit the effectiveness of ground level mist-nets, greatly limiting the probability of capture for some.

The five most commonly banded species are a variable group in that the Worm-eating Warbler and Kentucky Warbler are typically associated with mature or nearly mature forest, while the Common Yellowthroat and Indigo Bunting are associated with early successional habitat. The Carolina Wren is a highly adaptable species found in a variety of wooded habitats from mature forest to fence rows and woodlots in fairly open areas (Palmer-Ball 2003). To date, the Worm-eating and Kentucky Warbler (and Carolina Wren) have exceeded the pooled reproductive indices observed at the DEFE MAPS station, while early successional species have been below the station's pooled average.

Direct comparisons of species reproductive indices for the seasons 2005-2007 are currently unavailable at the continental and Central Hardwoods Bird Conservation Region scales (Figure 2). However, pooled values for the 1992-2003 seasons have been calculated in Saracco et al. (2006). Looking at the values in Saracco et al. (2006), the pooled reproductive index of 1.03 obtained for the Worm-eating Warbler at DEFE exceeds the pooled reproductive indices of 0.57 (SE = 0.08) obtained at the continental scale and 0.43 (SE = 0.08) at the Central Hardwoods Bird Conservation Region (BCR). The pooled reproductive index of 1.07 obtained for the Kentucky Warbler at DEFE also exceeds values obtained at the continental (0.33, SE = 0.03) and Central Hardwoods BCR (0.46, SE = 0.04) scales (Saracco et al. 2006). While some have argued reproductive indices may not accurately reflect productivity, Saracco et al. (*In press*) provide compelling evidence to suggest otherwise. Thus, it is reasonable to conclude that data collected at DEFE indicate habitat within MACA is supporting populations of Worm-eating and Kentucky Warblers that are fledging a greater proportion of young than the surrounding region. This is a positive finding for managers at MACA in that it provides the only known (to this author) direct evidence that species preferring large contiguous blocks of mature or relatively mature forest for breeding are not only establishing territories but are successfully fledging high numbers of offspring on the park.

Reproductive indices for early successional species were not as compelling. The pooled 2005-2007 reproductive index for Common Yellowthroat at DEFE was below the available pooled value for this species at the continental scale (Saracco et al. 2006). The DEFE reproductive index for this species was slightly more than the pooled Central Hardwoods BCR reproductive index but within the standard error. The pooled reproductive index obtained for the Indigo Bunting at DEFE was well below the 1992-2003 pooled values at the continental and Central Hardwoods BCR scales (Saracco et al. 2006).

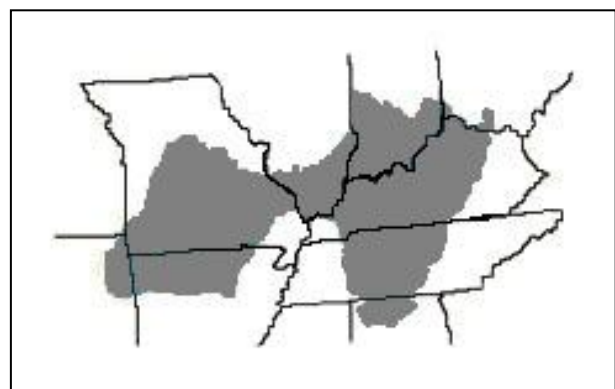


Figure 2. The Central Hardwoods Bird Conservation Region (BCR).

Considering the fact that early successional habitat is confined to a narrow band along the edge of the Green River (i.e., high edge-to-area ratio), these results are not unexpected. While both early successional species regularly establish territories within the DEFE MAPS station and are relatively common within the Green River riparian corridor on MACA (National Park Service, Bill Moore, Ecologist, unpublished data), this corridor is not the prototypical habitat for this species guild and might easily be viewed as marginal. Fifty percent of Indigo Buntings aged to second year or after second year at DEFE were second year birds. This high proportion of second year birds lends evidence to the notion that this area is marginal breeding habitat, as older birds typically occupy higher quality habitat, displacing second year birds to lower quality areas.

While these data indicate early successional species are not faring as well within the riparian corridor on MACA, this should not be viewed as a negative in need of correction by park managers, as these species are among the most common breeders in the landscape surrounding MACA. On the contrary, large contiguous blocks of forest, as provided by MACA, are thought to be important not only to the success of local populations of breeding forest birds, but throughout the region. Citing other sources, Fitzgerald et al. (2003) note research suggests that reproductive success of forest breeding birds in landscapes with less than 70% forest cover (within 10km of breeding sites) is often too low to sustain local populations due to high rates of nest parasitism and predation. Higher than average levels of reproductive success in large forest blocks, as observed on MACA, are thought to be the “sources” of birds that breed in more fragmented landscapes throughout the region (Fitzgerald et al. 2003).

It should be noted that Brown-headed Cowbirds (*Molothrus ater*), a brood parasite, are occasionally observed within the Green River corridor on MACA (National Park Service, Bill Moore, Ecologist, unpublished data). However, in four seasons of banding at DEFE, no fledglings have been captured or observed. This is a positive finding because Kentucky Warbler, Indigo Bunting and Common Yellowthroat are among the favored host species of the cowbird (Lowther 1993).

Several breeding bird monitoring efforts are currently being conducted on MACA. These include point count routes established on Collie Ridge (16 points), Jim Lee Ridge (8 points) and point counts conducted in the riparian corridor along the Green River (47 points). These “routes” were established in 2000, 2000, and 2003 respectively. The Collie Ridge and Jim Lee Ridge efforts were initially established by KDFWR as part of its state-wide monitoring. The riparian corridor route was established in part to assist in monitoring the effects of the multi-agency Conservation Reserve Enhancement Program (i.e., CREP) efforts currently underway in the Green River Watershed.

In addition to the above efforts, a North American Breeding Bird Survey (BBS) route was established on the south side of the park (Mammoth Cave #39900) in 1995 (USGS Patuxent Wildlife Research Center 2005). A portion of the Demunbruns Route (#39028) also occurs on MACA along the Houchins Ferry Road. This route was established in 1966 with some periods of time where data were apparently not collected (USGS Patuxent Wildlife Research Center 2005). Data have been consistently collected and reported since 1994. An “unofficial” BBS route was established on the north side of the park in 1995(?). This route remains unofficial due to a lack of maintained roads in that area of the park making it difficult to establish the required 50 points for

an official route within park boundaries. All BBS routes are conducted by volunteers with data collection and submission coordinated by the state BBS coordinator (Brainard Palmer-Ball, Jr., Kentucky State Nature Preserves Commission).

The aforementioned efforts are indicative of the high profile nature of birds to the scientific community and public, as well as concerns pertaining to species status and trends. While the efforts are varied, all rely on the basic point count methodology whereby a trained observer goes to an established set of points each year during the breeding season and records all species seen and/or heard within a specified time frame. The method is designed to provide data on species abundance and trend. At first glance, these efforts may appear duplicative, but should be viewed as complimentary; since the different routes were established to address different objectives. In addition, different efforts on MACA detect different suites of species. For example, the Cerulean Warbler (*Dendroica cerulea*), a species at one time petitioned for listing on the federal threatened and endangered species list is a commonly encountered species along the Green River route. However, it is absent from the Collie and Jim Lee Ridge Routes and only rarely encountered on the BBS routes. The MAPS program also fills a unique niche in avian monitoring.

MAPS is a continent-wide network of constant effort, mist-netting and banding stations. Broad-scale data on landbird productivity and survivorship are not available from any other monitoring program in North America (Siegel et al. 2007b). While trend information is useful for determining which species are most in need of conservation efforts, information on vital rates as obtained from MAPS is important in determining which conservation actions are likely to be most successful and where they should be applied. This is critical for migratory species as factors affecting productivity and survival largely act at differing times of the year and in very distinct geographic areas. Siegel et al. (2007a) have also concluded MAPS data are vital in understanding the consequences of climate change on birds. National Parks, such as Mammoth Cave, provide ideal and much needed “control sites” for monitoring because large scale global and regional change patterns are typically not confounded by localized land use changes (Simmons et al. 1990: Cited in Siegel et al. 2007b).

The Kentucky Warbler and Worm-eating warbler have been identified as Tier I, Priority Species in the Central Hardwoods BCR, receiving two of the four highest conservation scores within forested habitat (Fitzgerald et al. 2003). Both are also included on KDFWR’s list of species of greatest conservation need (KDFWR 2005). The DEFE MAPS station provides substantial contributions for these species in the BCR (Dr. Jim Saracco, Institute for Bird Populations, pers. comm.). Thus, while a single MAPS station places some limits on the statistical inferences that can be made in regard to how bird populations are faring specifically on MACA, the DEFE station is providing unique and valuable data that will aid in the long-term conservation of priority species within the region.

Lack of replication, also, does not imply that a single station cannot yield biologically meaningful results. As an example, data from a single station was used to elucidate the link between landbird productivity in central coastal California and El Nino events (DeSante 1993).

As additional years of data are collected, future planned analysis include plotting population trends and reproductive output of individual target species. Comparison of species trends obtained from the Green River corridor point counts with MAPS data should also be valuable.

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