

Kentucky Partners in Flight Point Counts

2021 Analysis

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Photo by Mark Lowry

Contents

Introduction	3
Methods.....	4
Point Counts.....	4
Data Analysis.....	4
Results.....	5
Ano Strip Mine	5
Cane Creek	7
Curd Garden.....	9
Fort Campbell.....	12
Green River Lake WMA.....	14
Jefferson County Memorial Forest	17
Otter Creek Outdoor Recreation Area	19
Peabody WMA	20
Shaker Village.....	24
Shillalah Creek WMA.....	28
Starfire Mine	30
Discussion.....	34
Acknowledgements.....	36
Literature Cited	36

Introduction

The Kentucky Department of Fish and Wildlife Resources (KDFWR) has been conducting songbird point counts since the establishment of the avian monitoring program in 1995 and retaining data from previous surveys since 1993. This project was designed to monitor avian population trends on public and private lands, to document the species supported on specific management areas, and to document avian-habitat relationships. In their analysis of the point count data from 1993–2009, Buehler and Vorisek (2010) provided suggestions for changes in survey protocol to improve the surveys. Suggested improvements that were implemented included changing the protocol to record time in one-minute intervals and developing targeted monitoring efforts for species that were not observed by the overall monitoring program. Prior to the 2010 survey, many routes were surveyed for this project, but in recent years the focus of this project has been narrowed to a subset of routes that would collect data on rare species or habitat management practices. These point counts are still being performed with eight active routes (as of 2021) that are conducted annually.

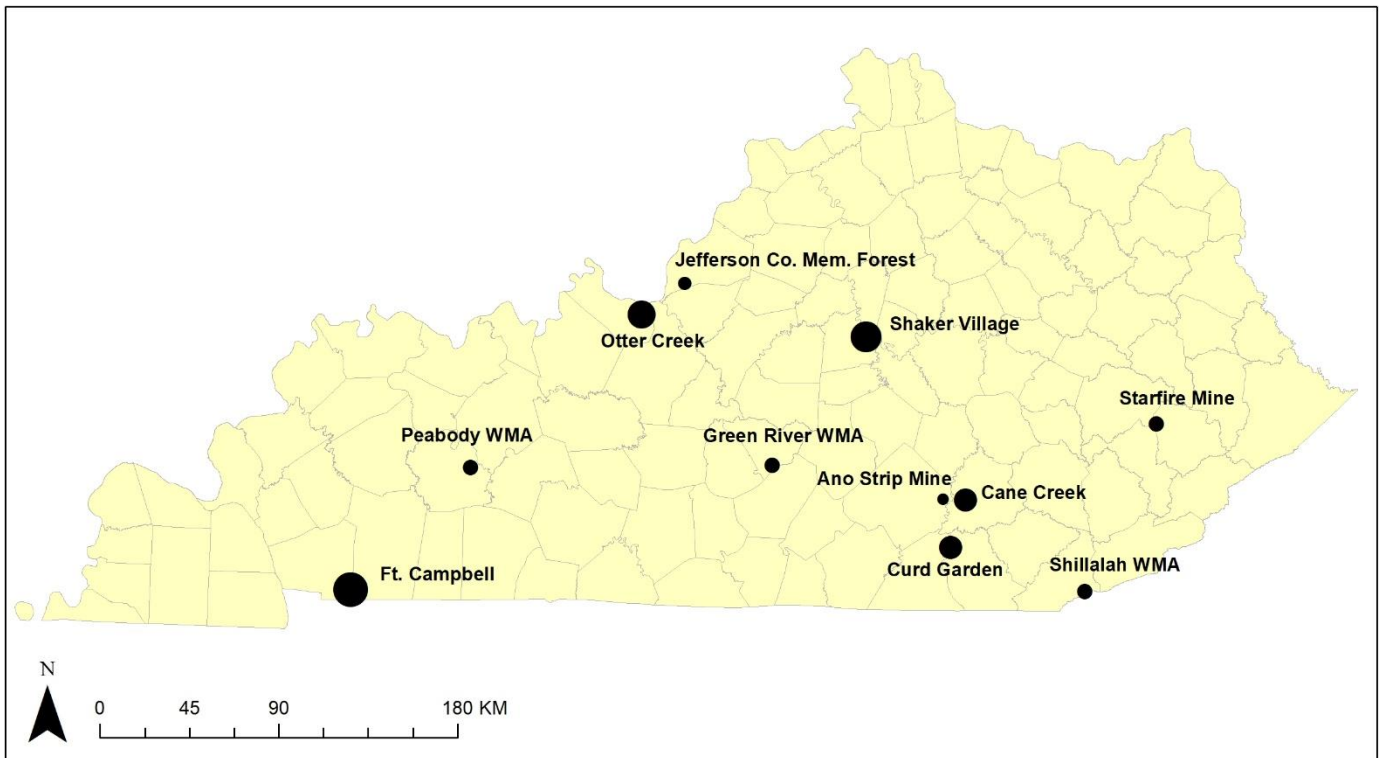


Figure 1. Partners in Flight point count routes surveyed between 2010 and 2021. Point size correlates to the species richness of each site.

Methods

Point Counts

From 2010 to 2021, 11 routes were surveyed for songbirds during the breeding season (Table 1). Ten-minute, fixed radius point counts were conducted at each of the sites (Hamel *et al.* 1996). Each survey route was comprised of 7-25 points which could be visited by an observer in 1-3 mornings. The same points were visited each year and effort was made to have the same observer conduct the surveys between years, as much as possible. All surveys took place between mid-May and mid-June until 2012, when surveys took place between May 15 and June 15. Counts started at sunrise and were completed by 10:00 AM. Numbers of individuals detected by sight and/or sound were recorded by the observer on paper, bullseye-style datasheets. Detected species were recorded as being located in one of 5 distance bands: 25 m of plot center, 26–50 m, 51–75 m, 76–100 m, and 100+ m. Data for birds observed flying over was also recorded. Birds were recorded in time bins of each minute. Point counts were passive (no calls or attractants were used). Surveys were not conducted if wind strength was a sustained 4 or greater on the Beaufort Scale or if it was raining harder than a drizzle. Three routes were discontinued before 2021 due to lack of observer or property access.

All habitat management data was provided by the current (2021) managers of the greater area surrounding the survey routes. Management data included the year management occurred and the type of manipulations performed.

Data Analysis

Raw data was entered and stored in the Point Blue database (Point Blue 2021). Species relative abundance was calculated using the program, *AbundanceR* (Mordecai 2012). This program accounts for detection probability using time-removal methods (Allredge 2007) and computes abundance as birds per survey point using Program Mark and Program R (White and Burnham 1999, R Core Team 2022, Vienna Austria). Data were pooled for unmanaged areas for all the years the areas were surveyed between 2010 and 2021 to produce estimates of abundance for species of greatest conservation need (SGCN) listed in Kentucky's State Wildlife Action Plan (KDFWR 2013). Field sparrows, eastern meadowlarks, yellow-billed cuckoos were included with the state listed SGCN in this analysis due to more recent conservation interest.

At selected managed areas, where feasible, abundance for SGCN was calculated for the years before and after management took place. At least three years prior to and after management were used to determine the management's effects on SGCN abundance. Confidence intervals (95%) were used to determine significant differences in abundance before and after management treatments. Trends were used for several areas where there was no management or management occurred too regularly for a separate analysis of certain years. Species trends during the management timeframes were calculated by using a linear regression of the number of detections at each site per survey year.

There were several species for which *AbundanceR* could not produce abundance estimates due to small sample sizes. Species with less than ten detections per route were not included in the estimates of abundance or calculation of trends. Changes in the abundance of SGCN between 1993–2009 and 2010–2021 were also evaluated for areas which had at least 4 years of survey data during each timeframe. For this comparison, data for points surveyed during both timeframes was used and points only surveyed during one timeframe were omitted. Throughout this summary, we report abundance as birds per survey.

Table 1: The maximum number of points surveyed for each route in any year and the number of years each route was conducted during 2010-2021.

Route Name	Number of Points	Years Surveyed
Ano Strip Mine	7	3
Cane Creek (DBNF)	24	12**
Curd Garden (DBNF)	24	12**
Fort Campbell	22	11
Green River WMA	19	6
Jefferson Co. Memorial Forest	9	4
Otter Creek Outdoor Recreation Area	12	10
Peabody WMA	14	12
Shaker Village of Pleasant Hill	25	12*
Shillalah Creek WMA	10	8
Starfire Mine	6	4

*Route was partially surveyed in 2020, but this data was not included in the analysis.

**Route was surveyed in 2021, but this year was not included in the analysis due to a change in observer.

Results

Ano Strip Mine

The Ano Strip Mine, located in Pulaski county, is part of an approximately 5000-acre area of reclaimed mine land owned by both public and private landowners. The area surveyed is owned by the U.S. Forest Service as part of the London Ranger District in the Daniel Boone National Forest (DBNF). The area encompassed by this point count survey is comprised of scrubby grasslands and forested areas varying from dry ridgetop to riparian forest.

The most abundant species detected during the surveys at Ano were the American crow, indigo bunting, yellow-breasted chat, eastern towhee, and prairie warbler, respectively. The point count surveys in 2010 and 2012–2013 at Ano Strip Mine detected four SGCN (Figure 2, Table 13). Two of these, field sparrows and prairie warblers, were detected frequently enough for trends analysis and both had a positive trend during 2010-2013 (Table 2).



Field Sparrows
Photo by Mark Lowry

Due to a change in observers and small sampling effort at this site in recent years, we did not compare 2010-2013 data to 2000-2009 data.

Species Richness (2010-2013): 29

Years Surveys were Conducted: 2000–2010, 2012–2013

Management Practices: No management during 2010–2013 surveys

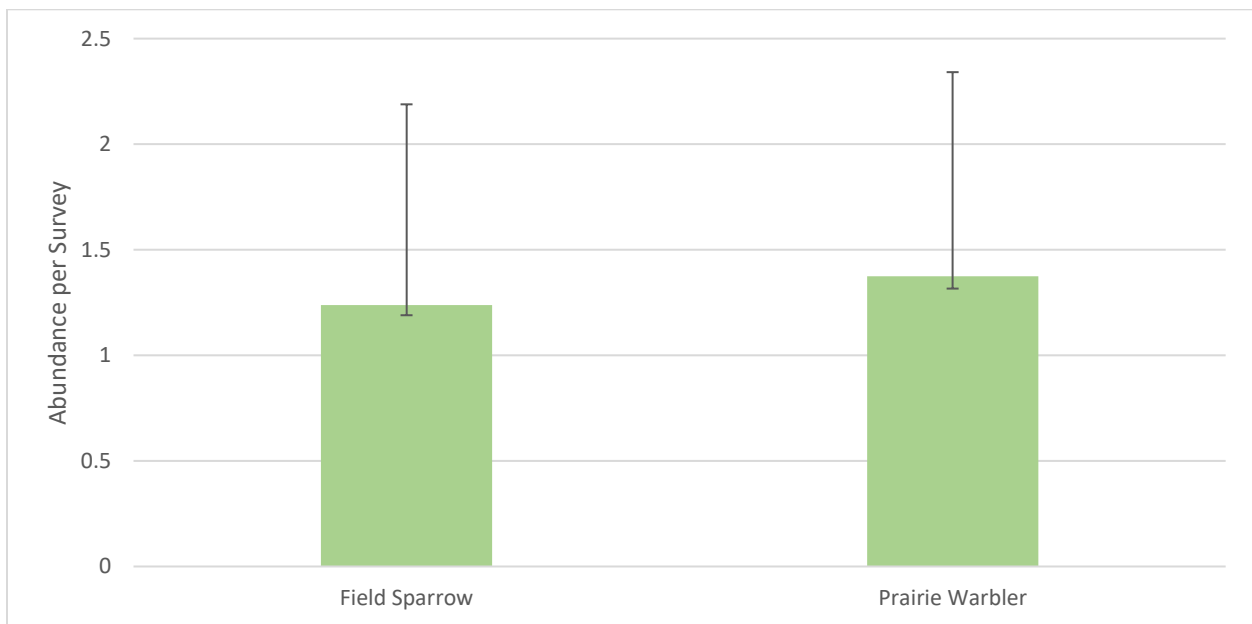


Figure 2. The abundance of SGCN at Ano Strip Mine from 2010, 2012–2013.

Table 2. The trends of SGCN at Ano Strip Mine from 2010, 2012–2013.

Species	Trend	St. Error
Field Sparrow	1.786	0.619
Prairie Warbler	3.643	1.856

Cane Creek

Cane Creek is a driving route initiated by the United States Forest Service (USFS) in 1993 on the London Ranger District of the DBNF in Laurel County. KDFWR assumed responsibility for the route in 2000. The area encompassed by this point count survey route consists of mixed pine and hardwood forest.

The most frequently detected species at Cane Creek were red-eyed vireo, hooded warbler, ovenbird, American crow, and tufted titmouse. Abundance was calculated for black-throated green warblers, Louisiana waterthrush, prairie warbler, worm-eating warbler, wood thrush, and yellow-billed cuckoo (Figure 3). Three other SGCN were detected at Cane Creek but were not detected frequently enough to calculate abundance (Table 13).

Compared with the 1993–2009 surveys, the pooled abundance for 2010–2020 was significantly lower for the following SGCN: blue-winged warbler, field sparrow, Kentucky warbler, prairie warbler. The following SGCN had significantly higher abundance: black-throated green warbler, Louisiana waterthrush, worm-eating warbler, wood thrush, and yellow-billed cuckoo (Figure 4). These results likely indicate succession and the maturation of canopy trees at this site.

Species Richness (2010-2020): 60

Years Surveys were Conducted: 1993–1994, 1996–1997, 2000–2020

Management Practices: Prescribed burning and precommercial thinning

Timing of Treatment: 2010, 2013, 2016, 2020

Bird Response to Management: Louisiana waterthrush, prairie warbler, wood thrush, and yellow-billed cuckoos showed increasing trends over the years when management occurred (2010-2020). Black-throated green warblers and worm-eating warblers had a declining trend during the same time period. (Table 3). However, despite the recent declining trend, black-throated green warblers and worm-eating warblers were still significantly more abundant during 2010-2020 than they had been during 1993-2009 and black-throated green warblers were more abundant at Cane Creek than any other site during 2010-2021. Declines in black-throated green warbler abundance after commercial thinning or logging have been documented in other studies (Freedman *et al.* 1981, Flaspohler *et al.* 2002). Meanwhile, worm-eating warblers have been documented to decline after burns, as the leaf litter and understory vegetation that is used for nesting and foraging is reduced (Artman *et al.* 2001, Blake 2004).



Black-throated Green Warbler
Photo by Mark Lowry

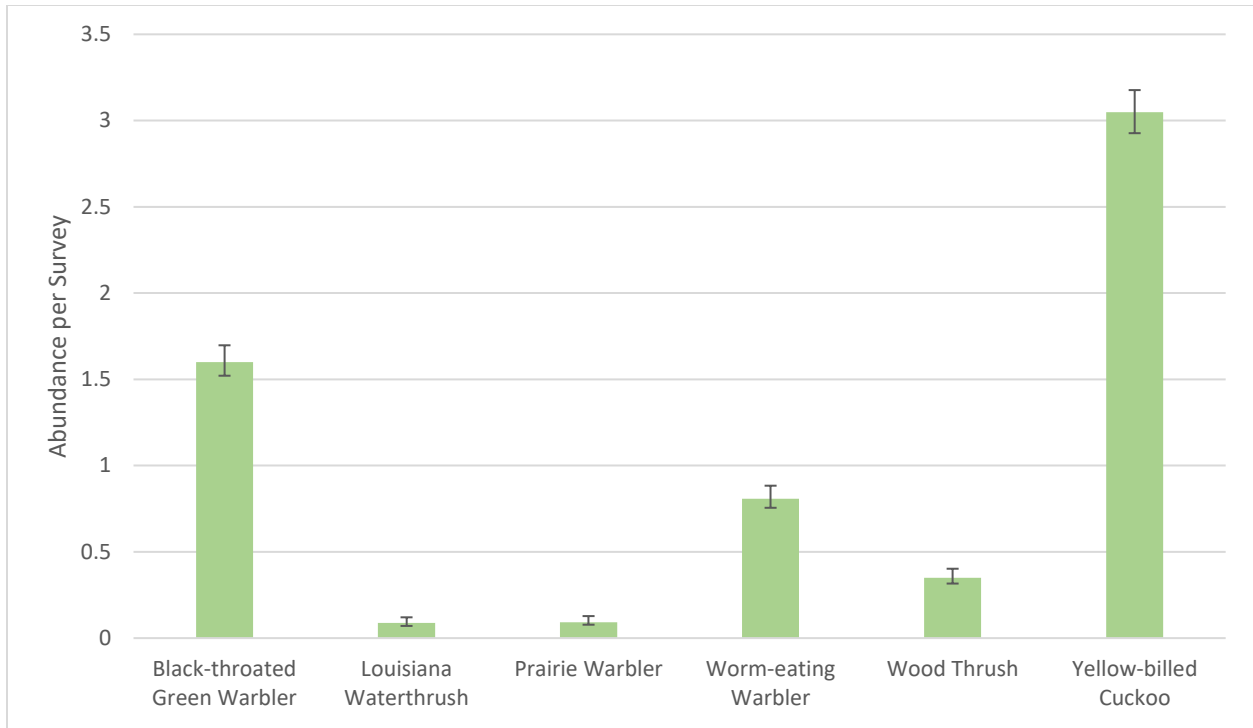


Figure 3. The abundance of SGCN at Cane Creek from 2010–2020.

Table 3. The trends of SGCN at Cane Creek from 2010–2020.

Species	Trend	St. Error
Black-throated Green Warbler	-0.718	0.552
Louisiana Waterthrush	0.118	0.144
Prairie Warbler	0.055	0.156
Worm-eating Warbler	-0.609	0.412
Wood Thrush	0.555	0.233
Yellow-billed Cuckoo	0.673	0.855

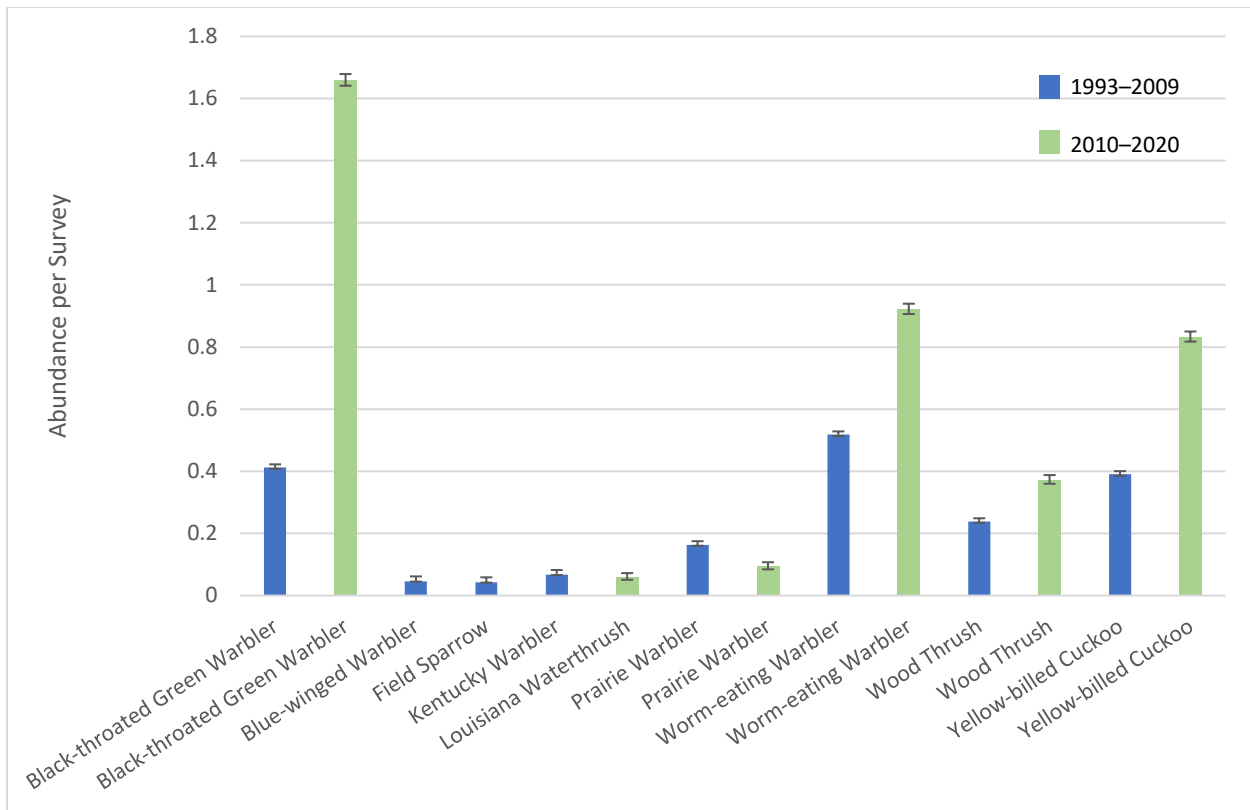


Figure 4. The abundance of SGCN at Cane Creek from 1993–2009 and 2010–2020.

Curd Garden

Curd Garden is a driving route on the London Ranger District of the Daniel Boone National Forest in Whitley county, established by the USFS in 1993. The landcover in this transect is comprised of pine and mixed pine and hardwood stands. KDFWR assumed responsibility for the route in 2000.

The five most detected species at Curd Garden were hooded warbler, red-eyed vireo, American crow, tufted titmouse, and black-throated green warbler. There were ten SGCN detected at Curd Garden between 2010 and 2020 (Table 13). Of these, abundance could be calculated for black-throated green warblers, Kentucky warblers, Louisiana waterthrushes, prairie warblers, worm-eating warblers, wood thrushes, and yellow-billed cuckoos (Figure 5).

Compared with the 1993–2009 surveys, the 2010–2020 surveys saw a significant decrease in the abundance of the following SGCN: prothonotary warbler and wood thrush. The following SGCN significantly increased in abundance: black-throated



Kentucky Warbler
Photo by Mark Lowry

green warbler, Louisiana waterthrush, prairie warbler, worm-eating warbler, and yellow-billed cuckoo (Figure 6).

Species Richness (2010-2020): 61

Years Surveys were Conducted: 1994, 1996–1997, 2000–2020

Management Practices: Prescribed burning

Timing of Treatment: 2011, 2018, and 2021

Bird Response to Management: Black-throated green warblers, and Louisiana waterthrushes showed an increasing trend during the timeframe of prescribed fires at Curd Garden. Kentucky warblers also showed an increasing trend during this timeframe, but it was slight (Table 4). Similar to Cane Creek, Curd Garden showed a declining trend for worm-eating warblers, likely for the same reasons. However, Curd Garden also showed a declining trend in prairie warblers and wood thrush. Wood thrush were also found to be significantly less abundant during 2010-2020 than 1993-2009. A possible explanation for this decline is that Curd Garden was burned with hotter fires in upland areas leading to loss of some midstory which these species require for nesting. Despite burning, canopy trees have likely matured at this site, especially in riparian areas, possibly leading to increases in black-throated green warbler and Louisiana waterthrush.

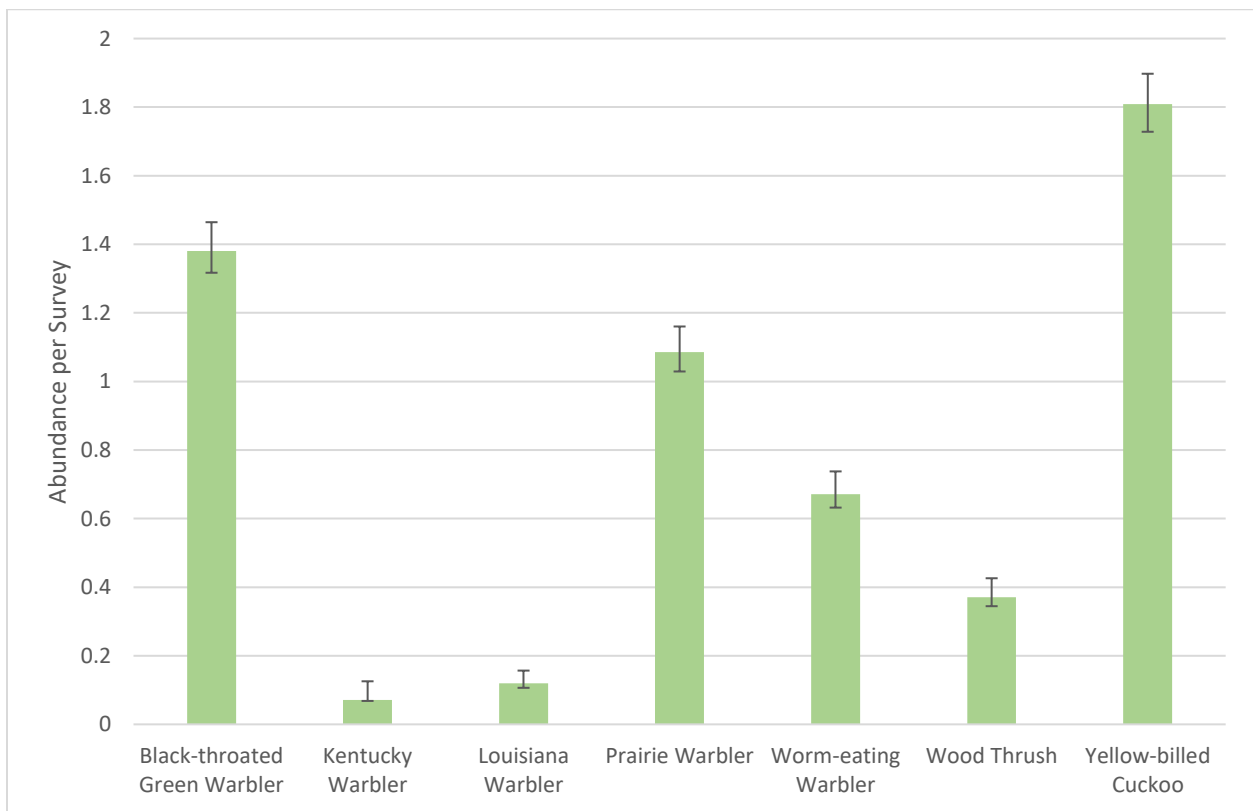


Figure 5. The abundance of SGCN at Curd Garden from 2010–2020.

Table 4. The trends of SGCN at Curd Garden from 2010–2020.

Species	Trend	St. Error
Black-throated Green Warbler	0.873	0.492
Kentucky Warbler	0.009	0.137
Louisiana Waterthrush	0.355	0.130
Prairie Warbler	-0.418	0.377
Wood Thrush	-0.736	0.484
Worm-eating Warbler	-0.918	0.378
Yellow-billed Cuckoo	-0.363	1.072

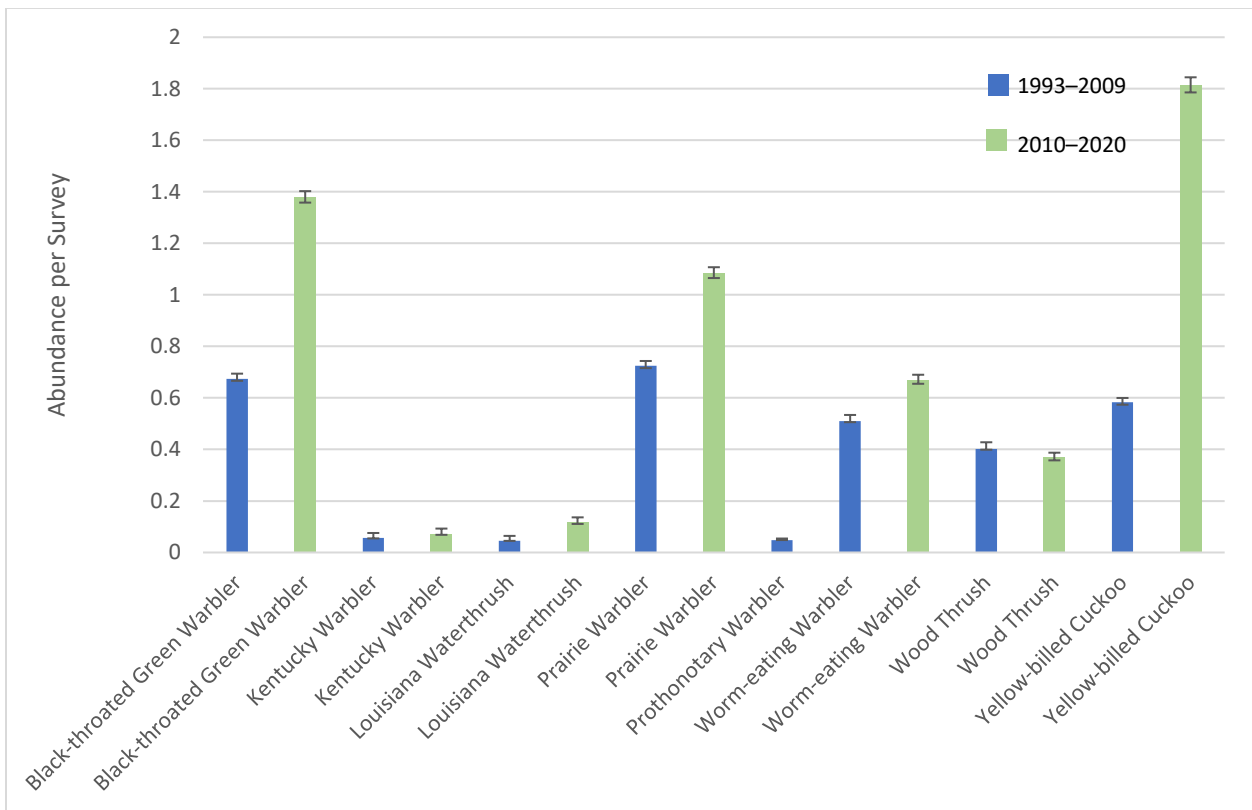


Figure 6. The abundance of SGCN at Curd Garden from 1993–2009 and 2010–2020.

Fort Campbell

Fort Campbell is a United States Army installation located in Christian and Trigg counties. Expanding into Tennessee, the total area of the fort in Kentucky is 26,500 acres. In 1997, surveys were modified to fit the PIF protocol with over 49 survey points in Kentucky. In 2001, the points were reduced in number to 21. A wide variety of habitats are covered in the survey area, including native grassland, hayfields, riparian forest, upland forest, and open pine forest.

Twenty SGCN were detected at Ft. Campbell from 2010 to 2021. Of these, dickcissel, eastern meadowlark, field sparrow, grasshopper sparrow, Henslow's sparrow, Kentucky warbler, northern bobwhite, prairie warbler, prothonotary warbler, red-headed woodpecker, worm-eating warbler, wood thrush, and yellow-billed cuckoo were detected regularly enough to calculate abundance (Figure 7, Table 13). The trend for each SGCN varied by species (Table 5). The most abundant species, in order of most abundant to least, were the Acadian flycatcher, indigo bunting, red-eyed vireo, northern bobwhite, and tufted titmouse.



Yellow-billed Cuckoo
Photo by Mark Lowry

Compared with the 1993–2009 surveys, the 2010–2021 surveys saw a significant decrease in the abundance of the following SGCN: blue-winged warbler, and Henslow's sparrow. The following SGCN significantly increased in abundance: dickcissel, eastern meadowlark, field sparrow, grasshopper sparrow, northern bobwhite, prairie warbler, prothonotary warbler, red-headed woodpecker, worm-eating warbler, wood thrush, and yellow-billed cuckoo (Figure 8).

Species Richness: 92

Years Surveys were Conducted: 1997, 1998, 2000, 2003–2006, 2008–2010, 2012–2020

Management Practices: mowing, disking, prescribed burns, herbicide application

Timing of Treatment: 2010, 2012–2020

Bird Response to Management: Management occurred too regularly at Fort Campbell for an analysis of the direct relationship between management and the response of SGCN abundance. Species trends show that the majority of SGCN increased during the management timeframe (Table 5). Notably, yellow-billed cuckoos experienced a trend of 1.093 ± 0.921 individuals per year. The trend of dickcissels increased by 0.799 ± 0.522 individuals per year and northern bobwhites decreased by 0.706 ± 0.378 individuals per year. However, northern bobwhite abundance was still significantly higher during 2010–2021 than 1993–2009. The stability in SGCN abundance/counts seen in recent years at Fort Campbell may be due to regularly scheduled management (causing stable amounts of early successional habitat). The same observer has been conducting these counts since 2003, which also helps to avoid drastic fluctuations in species counts due to observer bias.

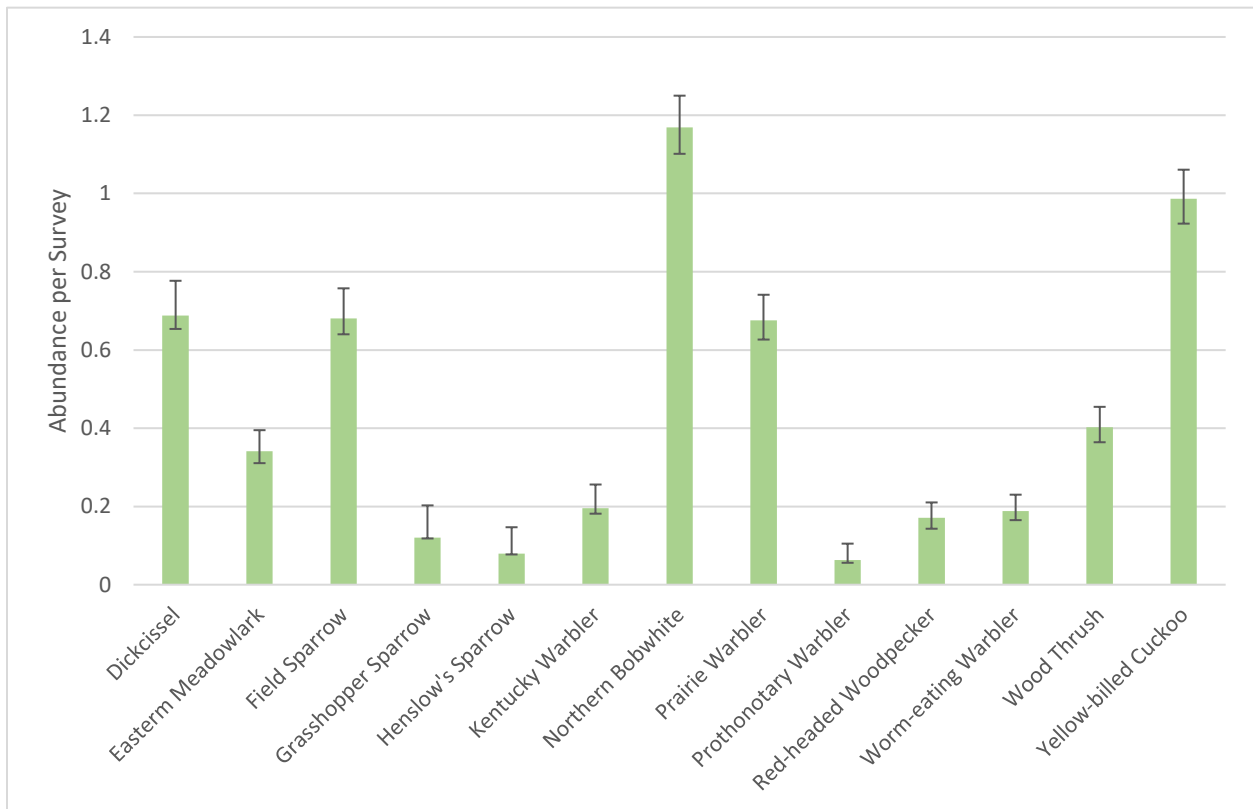


Figure 7. The abundance of SGCN at Ft. Campbell.

Table 5. Trends of SGCN at Ft. Campbell from 2010, 2012–2020.

Species	Trend	St. Error
Dickcissel	0.799	0.522
Eastern Meadowlark	0.182	0.342
Field Sparrow	-0.320	0.362
Grasshopper Sparrow	0.002	0.227
Henslow's Sparrow	0.067	0.146
Kentucky Warbler	-0.028	0.168
Northern Bobwhite	-0.706	0.378
Prairie Warbler	-0.043	0.379
Prothonotary Warbler	0.089	0.132
Red-headed Woodpecker	0.089	0.144
Wood Thrush	0.424	0.231
Worm-eating Warbler	0.303	0.113
Yellow-billed Cuckoo	1.093	0.921

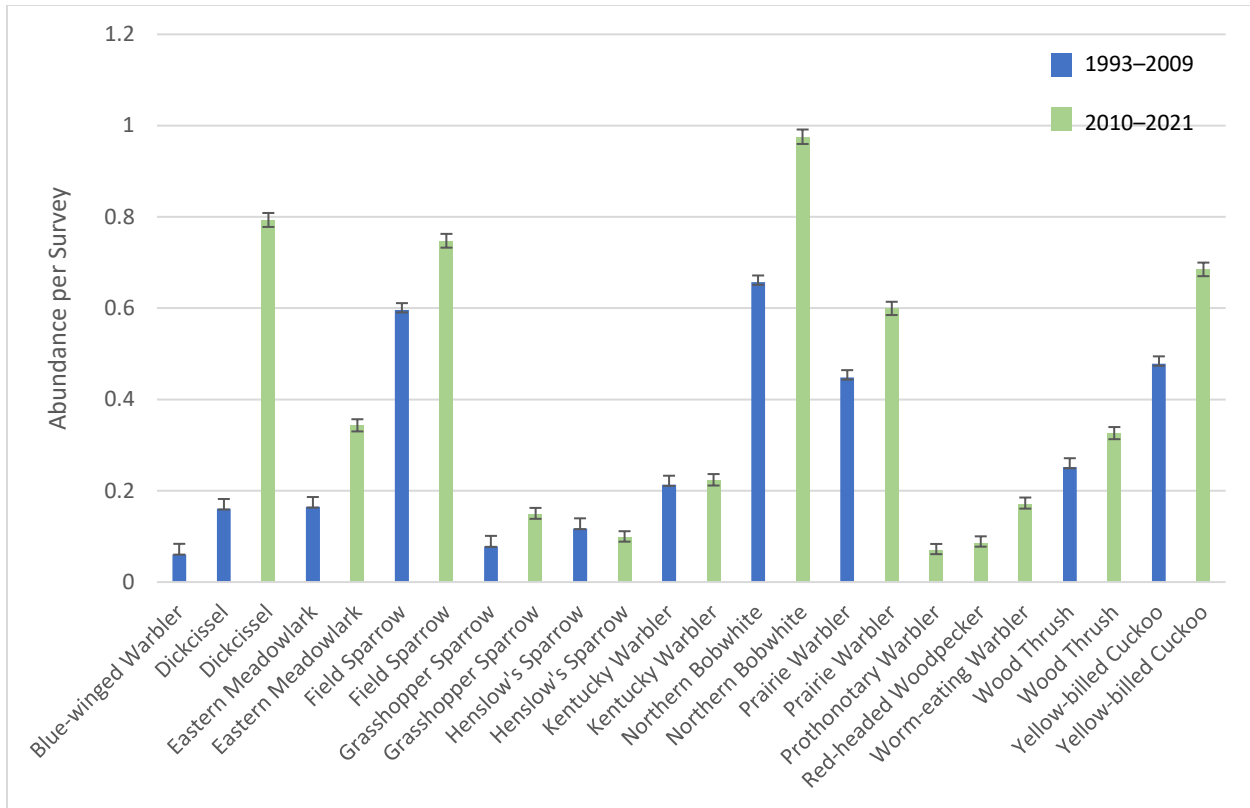


Figure 8. The SGCN abundance at Ft. Campbell from 1993–2009 and 2010–2021.

Green River Lake WMA

Green River Lake Wildlife Management Area (WMA) consists of 20,500 acres surrounding Green River Lake in Adair and Taylor counties. The WMA is owned by the United States Army Corp of Engineers and managed by KDFWR.

The most abundant species in descending order at Green River Lake WMA were the red-eyed vireo, wood thrush, tufted titmouse, red-bellied woodpecker, and Acadian flycatcher. Six SGCN were detected at Green River Lake WMA, but only four were regularly detected enough to calculate abundance (Figure 9, Table 13).

Compared with the 1993–2009 surveys, the 2010–2021 surveys saw a significant decrease in the abundance of the following SGCN: Kentucky warbler, prothonotary warbler, worm-eating warbler, and yellow-billed cuckoo. The following SGCN significantly increased in abundance: Louisiana waterthrush, and wood thrush (Figure 10).

Species Richness: 43

Years Surveys were Conducted: 1996–2007, 2016–2021

Management Practices: prescribed burns

Timing of Treatment: 2019–2021

Bird Response to Management: When looking at pooled abundance before and after management, worm-eating warbler and yellow-billed cuckoo showed a significantly lower abundance after prescribed burns (Table 6). The decline in worm-eating warblers may be attributable to a decrease in leaf litter after prescribed burning (Artman 2001). No change was observed in Louisiana Waterthrush and Wood Thrush abundance after prescribed fire. The burning at Green River WMA only consumed the leaf litter and did not impact woody vegetation (Brian Gray *Personal Communication 2021*).

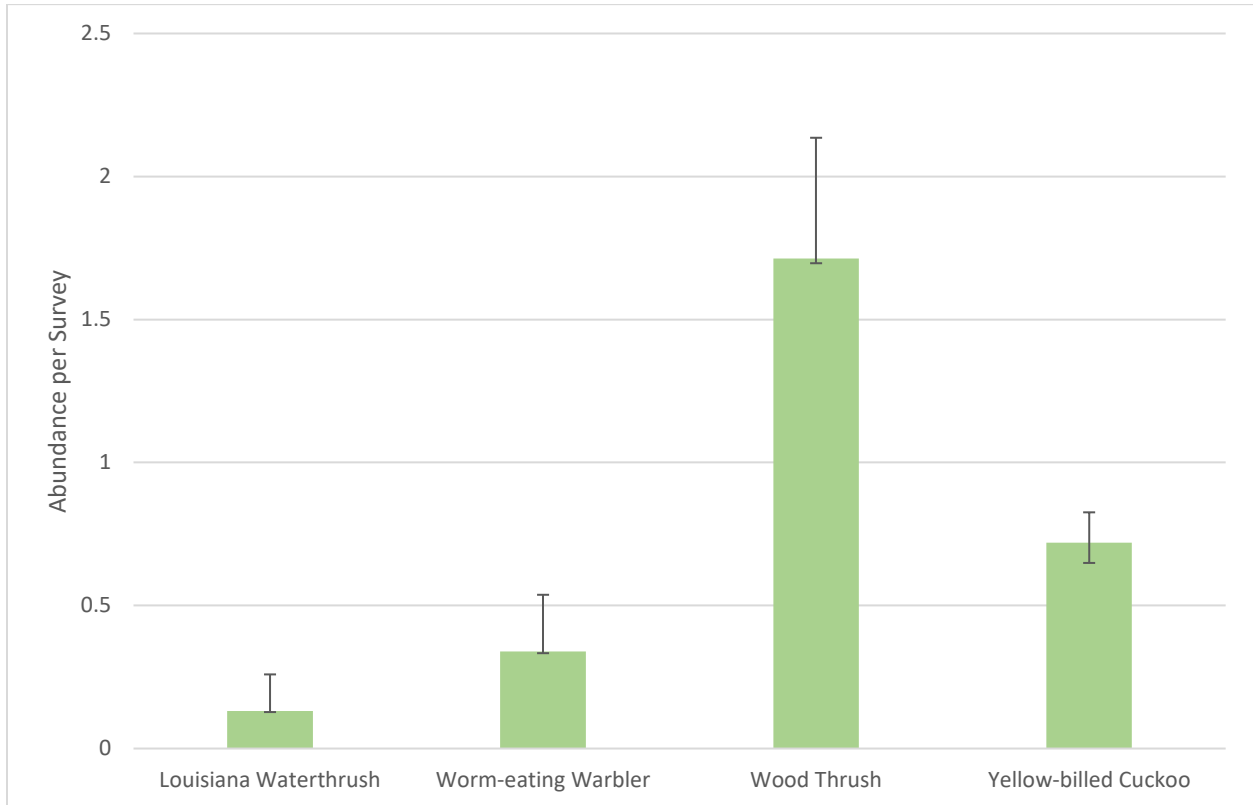


Figure 9. The abundance of SGCN at Green River Lake WMA from 2016–2021.

Table 6. The abundance of SGCN, pooled in years prior to and after prescribed burning, during 2016-2021 surveys. Significant differences are noted as follows: *significantly different with a 95% confidence interval **significantly different with a 90% confidence interval

Management	Species	Surveys	Abundance per Survey	90% LCI	90% UCI	95% LCI	95% UCI
Before	Louisiana Waterthrush	45	0.113	0.111	0.193	0.111	0.283
During	Louisiana Waterthrush	57	0.142	0.140	0.226	0.140	0.314
Before	Worm-eating Warbler**	45	0.450	0.445	0.627	0.445	0.798
During	Worm-eating Warbler**	57	0.249	0.246	0.361	0.246	0.476
Before	Wood Thrush	45	1.754	1.734	2.130	1.734	2.432
During	Wood Thrush	57	1.686	1.668	2.015	1.667	2.272
Before	Yellow-billed Cuckoo*	45	1.129	1.069	1.204	1.058	1.220
During	Yellow-billed Cuckoo*	57	0.396	0.360	0.450	0.354	0.462

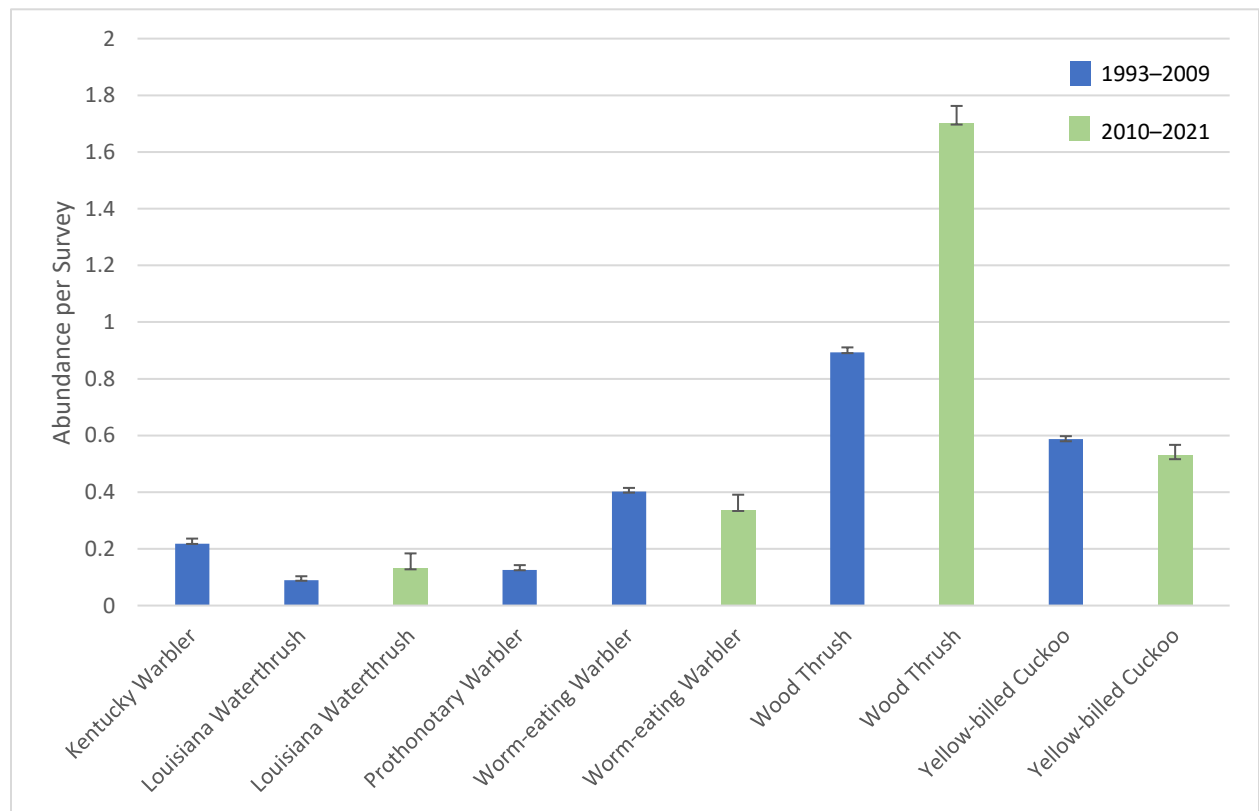


Figure 10. The SGCN abundance at Green River WMA from 1993-2009 and 2010-2021.

Jefferson County Memorial Forest

Jefferson County Memorial Forest is a 5,112-acre forest in Jefferson and Bullitt counties. The property is owned by Jefferson County Government. The most abundant species at Jefferson County Memorial Forest were the wood thrush, red-bellied woodpecker, tufted titmouse, red-eyed vireo, and eastern wood-pewee. Four SGCN were detected during the surveys and three were detected frequently enough to calculate abundance (Figure 11, Table 13). During 2010-2013, worm-eating warblers had a decreasing trend of -0.200 ± 0.283 . Kentucky warblers and wood thrushes had increasing trends (Table 7).

Compared with the 1993–2009 surveys, the 2010–2013 surveys saw a significant decrease in the abundance of yellow-billed cuckoo. The following SGCN significantly increased in abundance: Kentucky warbler, and wood thrush (Figure 12).

Species Richness: 35

Years Surveys were Conducted: 1996–2013

Management Practices: No management during 2010–2013 surveys

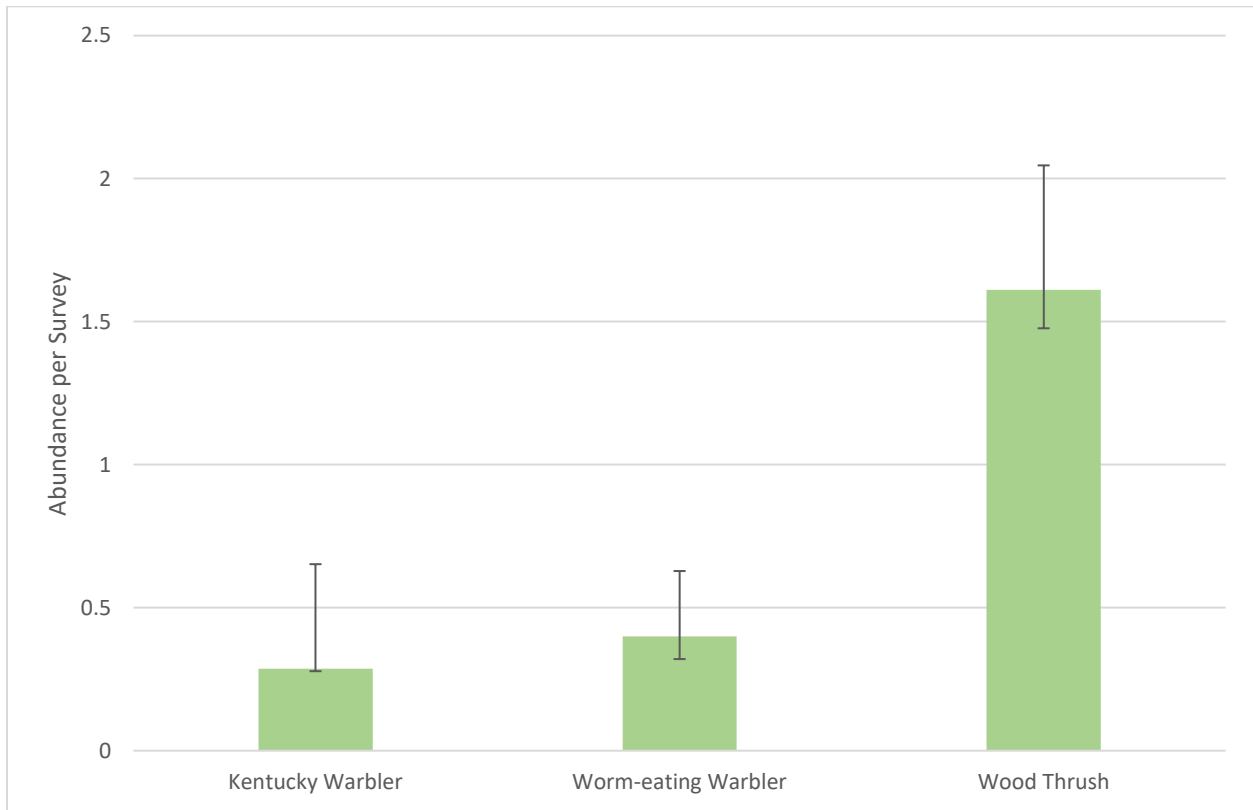


Figure 11. The abundance of SGCN at Jefferson County Memorial Forest from 2010–2013.

Table 7. The trends of SGCN at Jefferson County Memorial Forest from 2010–2013.

Species	Trend	St. Error
Kentucky Warbler	1.000	0.775
Worm-eating Warbler	-0.200	0.283
Wood Thrush	0.500	1.072

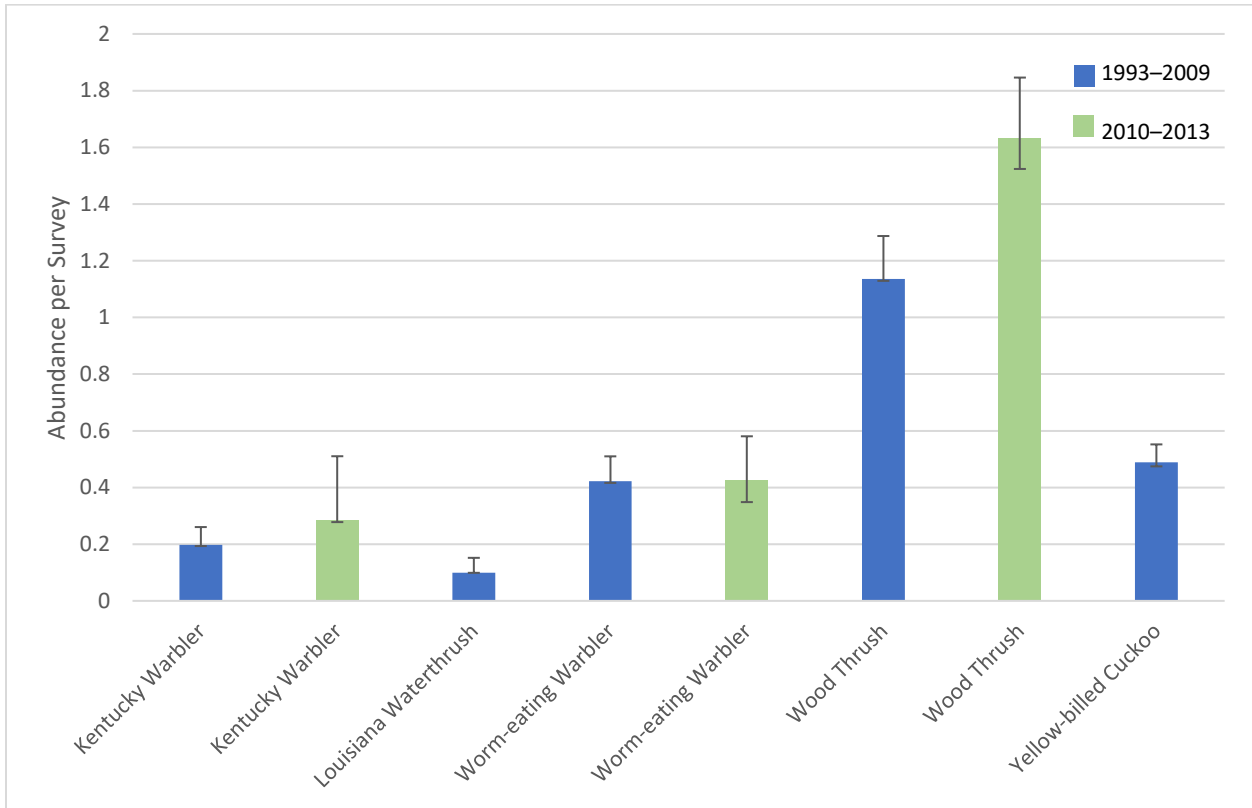


Figure 12. The SGCN abundance at Jefferson County Memorial Forest from 1993–2009 and 2010–2013.

Otter Creek Outdoor Recreation Area

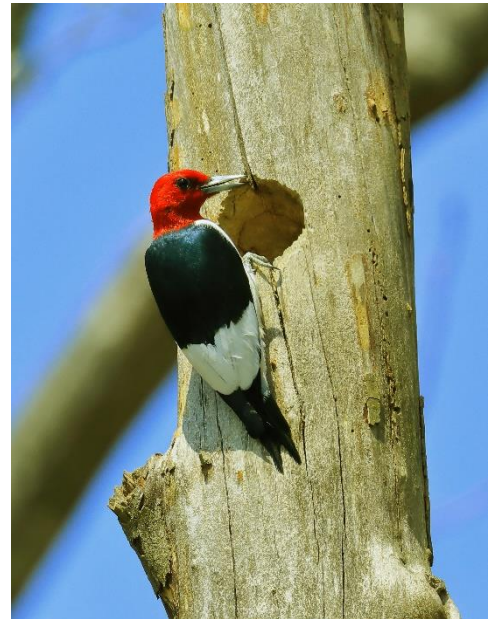
Otter Creek Outdoor Recreation Area is a 2,261-acre area managed by KDFWR. The recreation area is located in Meade county. The most abundant species detected during the surveys were the American crow, wood thrush, blue-gray gnatcatcher, red-eyed vireo, and northern cardinal. Twelve SGCN were detected during the surveys (Table 13). Of these, 8 were detected frequently enough to calculate abundance (Figure 13).

During the 2012-2021 surveys, field sparrows and red-headed woodpeckers had an increasing trend. Kentucky warblers, wood thrushes, and yellow-billed cuckoos had decreasing trends (Table 8).

Species Richness: 74

Years Surveys were Conducted: 2012–2021

Management Practices: No management during 2010–2021 surveys



Red-headed Woodpecker
Photo by Mark Lowry

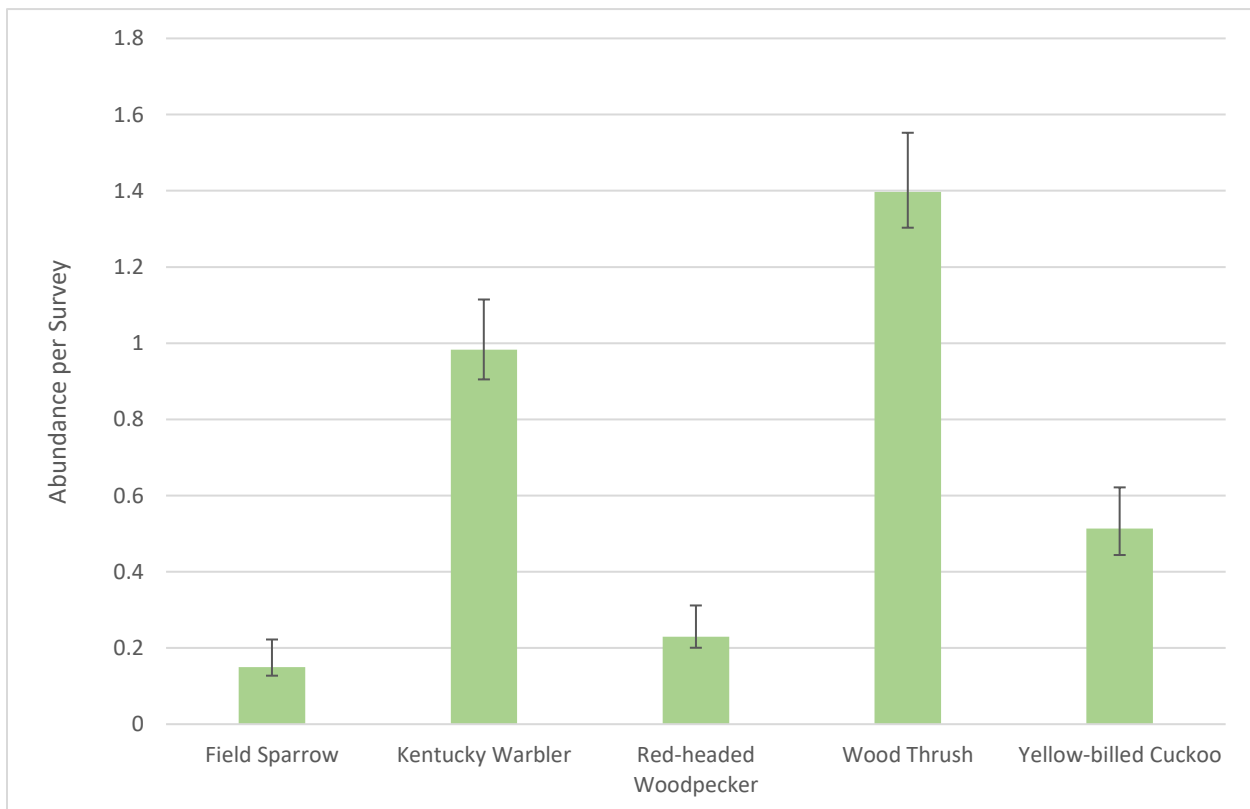


Figure 13. The abundance of SGCN at Otter Creek Outdoor Recreation Area from 2012–2021.

Table 8. The trends of SGCN at Otter Creek Outdoor Recreation Area from 2012–2021.

Species	Trend	St. Error
Field Sparrow	0.473	0.156
Kentucky Warbler	-0.436	0.298
Red-headed Woodpecker	0.236	0.290
Wood Thrush	-0.121	0.446
Yellow-billed Cuckoo	-0.630	0.565

Peabody WMA

Peabody WMA is a 41,323-acre area located in Ohio, Hopkins, and Muhlenberg counties. Much of the WMA is a reclaimed surface mine and consists of grasslands, shrubs, and woodlands. The Sinclair, Homestead and Ken units of Peabody WMA were designated as a Kentucky Quail Focal Area in 2008 and much research for Northern Bobwhite has been conducted at this area over the past decade (Morgan and Robinson 2015). With the objective of increasing Northern Bobwhite populations, the area was managed from 2010-2017 and left unmanaged from 2018-2021. The five most abundant species recorded during PIF surveys at the WMA were the northern bobwhite, field sparrow, indigo bunting, red-winged blackbird, and bell’s vireo. Nine SGCN were detected during the surveys (Table 13). Of these, seven species were observed often enough to calculate abundance (Figure 14).

Compared with the 1993–2009 surveys, the 2010–2021 surveys saw a significant decrease in the abundance of the following SGCN: dickcissel, eastern meadowlark, grasshopper sparrow, and yellow-billed cuckoo. The following SGCN significantly increased in abundance: Bell’s vireo, Henslow’s sparrow, northern bobwhite, prairie warbler, and willow flycatcher (Figure 15).



Henslow’s Sparrow
Photo by Mark Lowry

Species Richness: 40

Years Surveys were Conducted: 2000–2021

Management Practices: Disking, herbicide application, and prescribed burns

Timing of Treatment: 2010–2017

Bird Response: The abundance of Bell’s vireo, prairie warbler, and willow flycatcher abundance was significantly higher after cessation of management. Conversely, the abundance of dickcissel, field sparrow, and grasshopper sparrow decreased after the cessation of management (Table 11, Figure 17). During 2010-2017, the habitat at Peabody WMA was managed using disking, herbicide application, and prescribed burns. These methods were

used to set back succession which resulted in higher abundances of dickcissels, field sparrows, and grasshopper sparrows (Zimmerman 1992, Swengel 1996). Conversely, Bell's vireo, prairie warbler, and willow flycatcher abundance increased after management stopped and succession was allowed to progress at Peabody WMA. These species generally prefer shrubby, early successional habitat with some woody cover (Powell 2006).

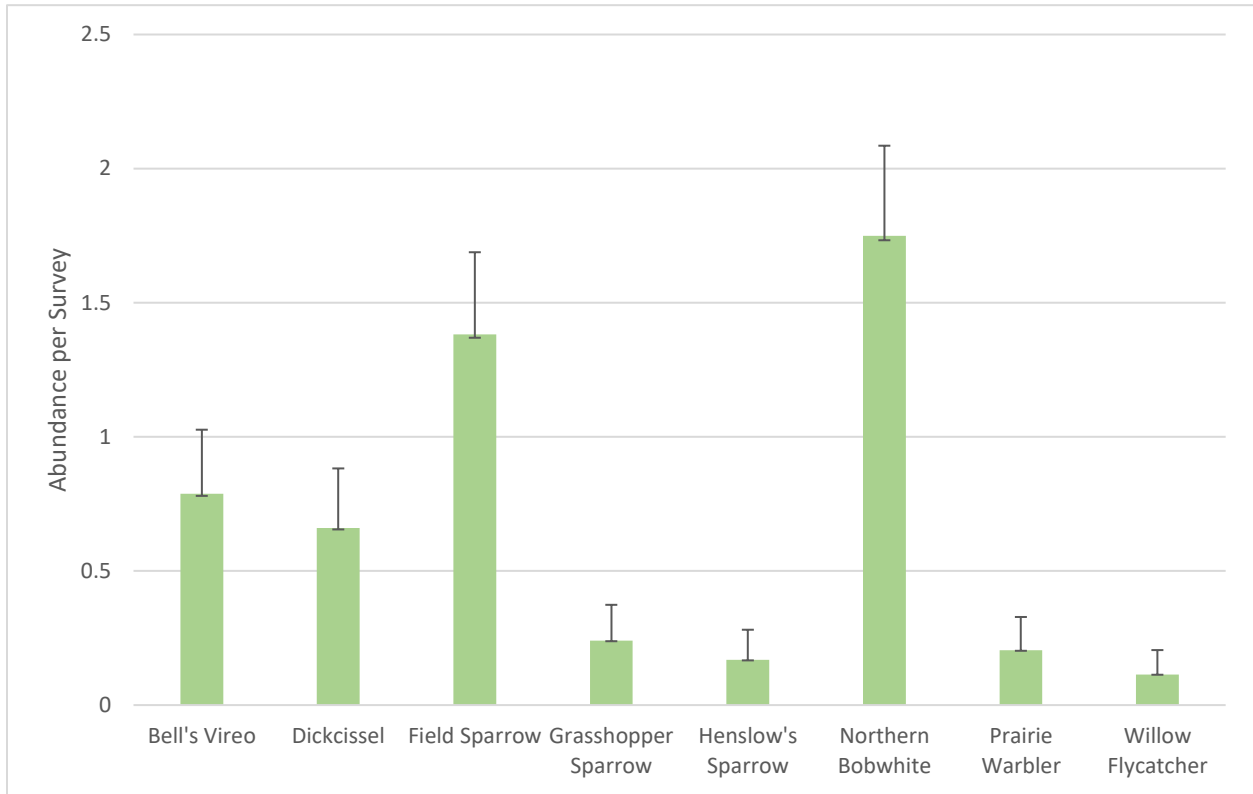


Figure 14. The abundance of SGCN at Peabody WMA from 2010–2021.

Table 9. The abundance of SGCN, pooled in years coinciding with management (2010-2017) and after management ceased (2018-2021), during 2010-2021 surveys. Significant differences are noted as follows: *significantly different with a 95% confidence interval **significantly different with a 90% confidence interval

Management	Species	Surveys	Abundance per Survey	90% LCI	90% UCI	95% LCI	95% UCI
During	Bell's Vireo*	112	0.703	0.689	0.847	0.688	0.938
After	Bell's Vireo*	56	0.967	0.964	1.125	0.964	1.327
During	Dickcissel*	112	0.812	0.804	0.968	0.804	1.093
After	Dickcissel*	56	0.358	0.357	0.444	0.357	0.562
During	Grasshopper Sparrow**	112	0.280	0.277	0.367	0.277	0.448
After	Grasshopper Sparrow**	56	0.161	0.161	0.207	0.161	0.278
During	Henslow's Sparrow	112	0.178	0.171	0.254	0.170	0.300
After	Henslow's Sparrow	56	0.161	0.161	0.209	0.161	0.280
During	Northern Bobwhite	112	1.810	1.788	2.040	1.787	2.183
After	Northern Bobwhite	56	1.632	1.625	1.902	1.625	2.183
During	Prairie Warbler*	112	0.152	0.144	0.222	0.144	0.261
After	Prairie Warbler*	56	0.322	0.321	0.408	0.321	0.522
During	Willow Flycatcher*	112	0.075	0.072	0.127	0.072	0.167
After	Willow Flycatcher*	56	0.197	0.196	0.267	0.196	0.359

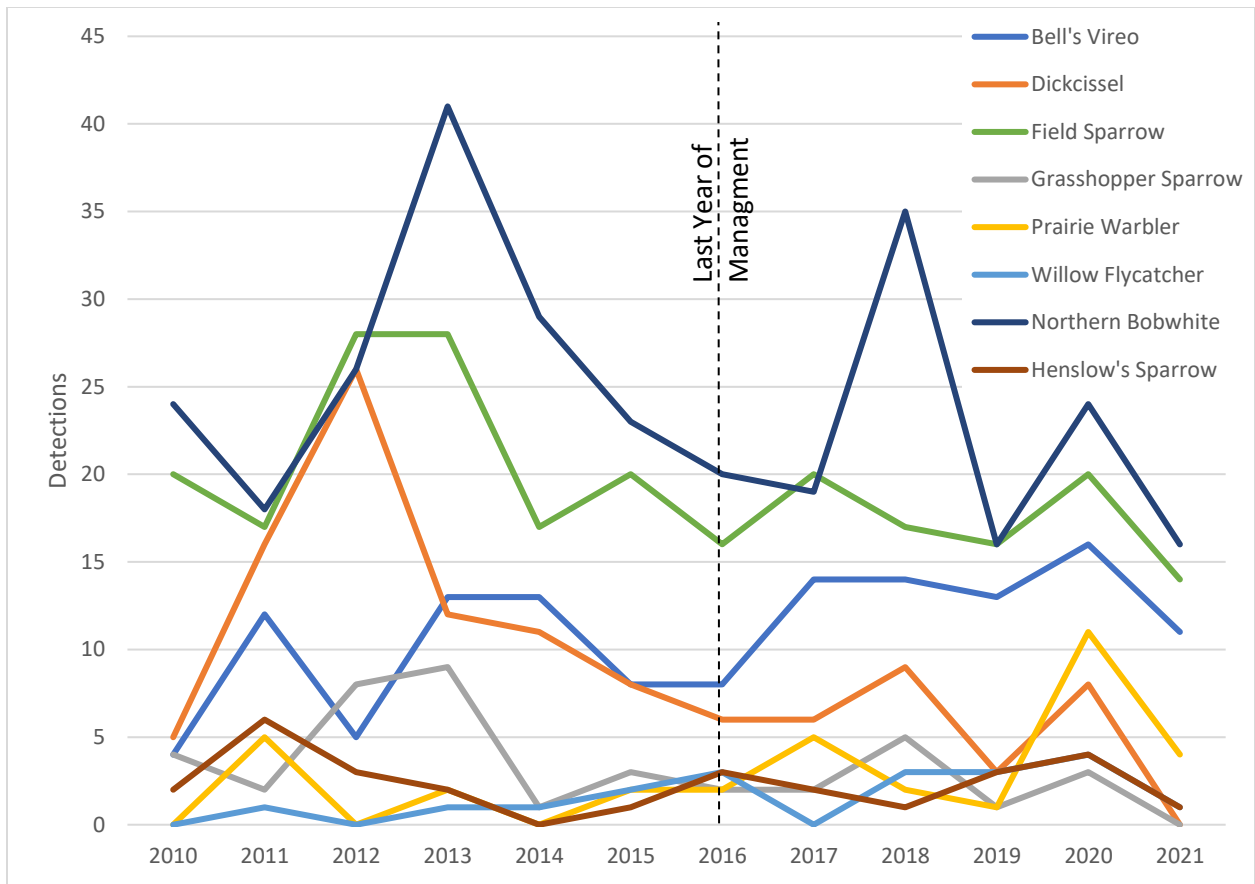


Figure 15. The raw detections of selected SGCN and timing of management from 2010–2021 at Peabody WMA.

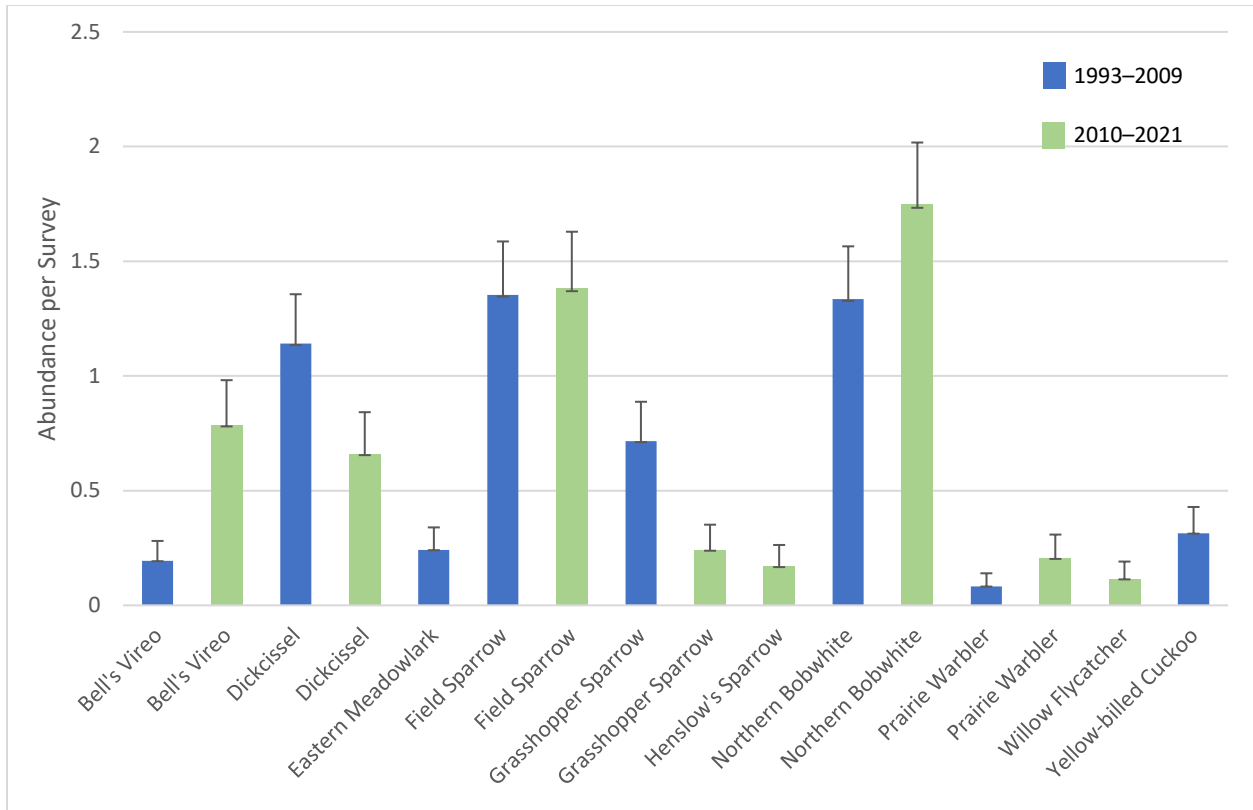


Figure 16. The SGCN abundance at Peabody WMA from 1993–2009 and 2010–2021.

Shaker Village

Shaker Village is a 3,000 acre preserve located in Mercer county. Shaker Village is comprised of native grasslands, shrublands, woodlands, and agricultural plots and is a designated Kentucky Quail Focal Area (Morgan and Robinson 2015). The species with the greatest abundance, in descending order, were the red-winged blackbird, northern bobwhite, indigo bunting, field sparrow, and common yellowthroat. Twelve SGCN have been observed at Shaker Village, but only 8 species were detected frequently enough to calculate abundance (Figure 17, Table 13).

Compared with the 1993–2009 surveys, the 2010–2021 surveys saw a significant decrease in the abundance of the following SGCN: eastern meadowlark, grasshopper sparrow, and Henslow’s sparrow. The following SGCN had a significantly greater abundance during 2010-2021 surveys: dickcissel, field sparrow, northern bobwhite, red-headed woodpecker, and yellow-billed cuckoo (Figure 18).



Dickcissels
Photo by Mark Lowry

Species Richness: 79

Years Surveys were Conducted: 2005–2008, 2010–2019, 2021

Management Practices: Prescribed burns, herbicide application, mowing, and planting/restoration of native grass

Timing of Treatment: 2010–2021

Bird Response to Management: Management occurred too regularly for an analysis of its direct influence on SGCN abundance. The trends of SGCN from 2010–2021 varied with increases and decreases in the majority of SGCN. Henlow’s sparrows, red-headed woodpeckers, yellow-bellied cuckoos had slight trends. Northern bobwhites, dickcissels, grasshopper sparrows, and eastern meadowlarks had notably negative trends during the survey period (Table 10). Despite this declining trend, abundances for northern bobwhite and dickcissel remained high in comparison to other sites and were significantly higher during 2010-2021 than 2005-2009. Declines in eastern meadowlark in response to native grass restoration are not surprising, as this species does tend to be more associated with cool-season grasses in Kentucky (Yeiser *et al.* 2021).

Native warm-season grass restoration peaked, along with raw counts for Northern Bobwhite, at Shaker Village from 2008-2014. Since then, burning has been the main management tactic used to maintain early successional habitat at the site. A majority of the survey points were burned in 2018 and 2019, but succession has progressed in some areas despite burning. The decline of northern bobwhites seen in this dataset is not observed in Quail Focal Area (QFA) count data recorded at the same site during the same time period. Density estimates based on QFA count data have been fairly stable despite a dip after a severe winter weather event, likely causing a high mortality in 2015 (Morgan and Rhoden 2020, Ben Leffew *Personal Communication* 2021). A change in observer at this site in 2014 may have biased Northern Bobwhite count data, exacerbating declining trends. We surmise the northern bobwhite population has probably stabilized at Shaker Village in recent years, but we also recommend more data collection to confirm current trends for this and other grassland species.

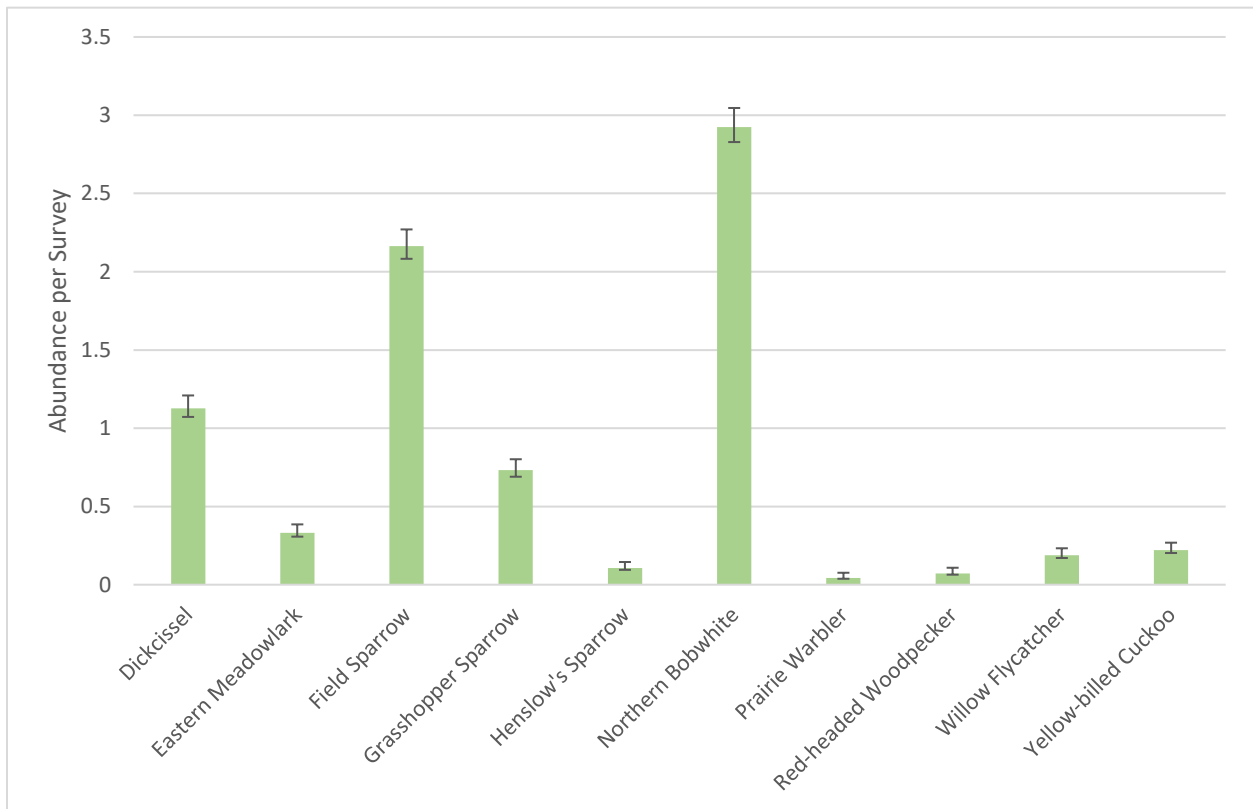


Figure 17. The abundance of SGCN at Shaker Village from 2010–2017, 2019, 2021.

Table 10. The trends of the SGCN at Shaker Village from 2010–2017, 2019, 2021.

Species	Trend	St. Error
Dickcissel	-1.280	0.331
Eastern Meadowlark	-1.041	0.292
Field Sparrow	0.728	1.420
Grasshopper Sparrow	-1.348	0.894
Henslow's Sparrow	0.022	0.417
Northern Bobwhite	-4.495	2.208
Prairie Warbler	0.384	0.085
Red-headed Woodpecker	0.009	0.151
Willow Flycatcher	1.029	0.180
Yellow-billed Cuckoo	-0.007	0.402

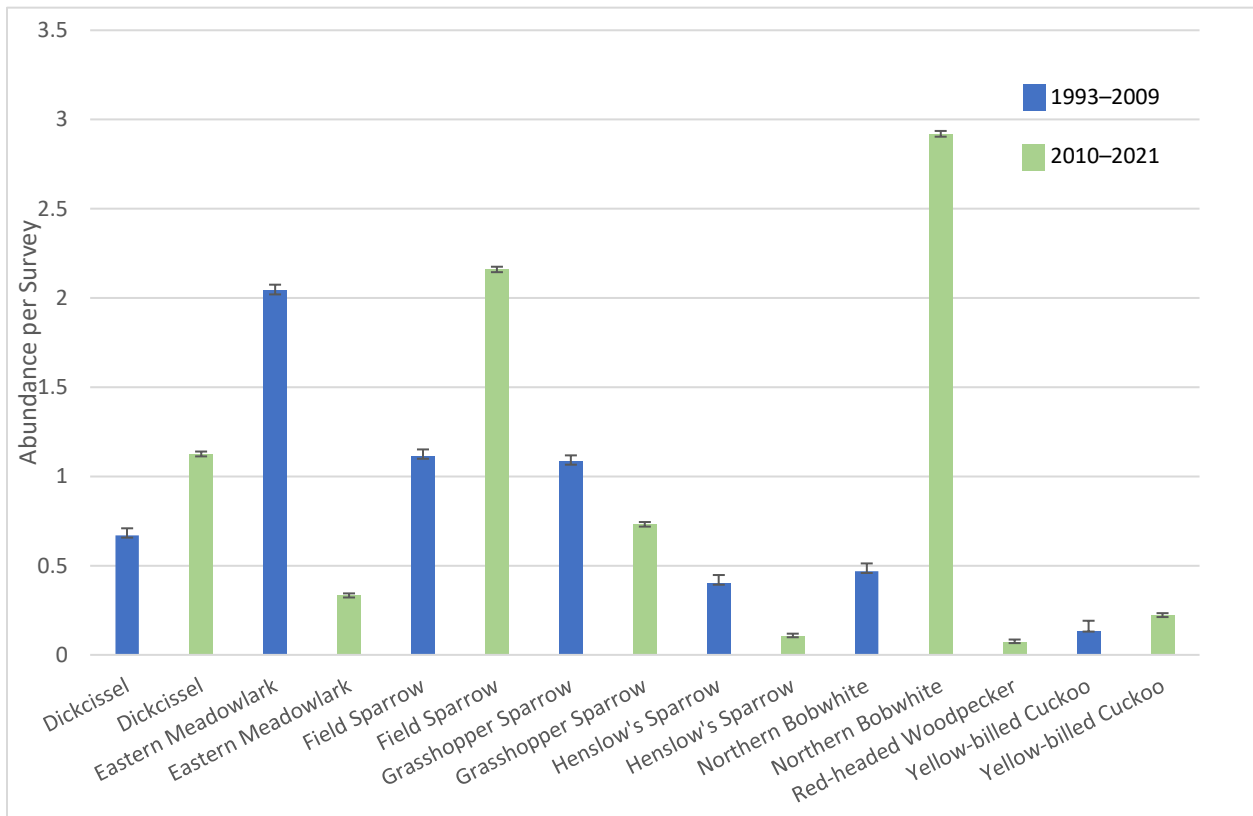


Figure 18. The SGCN abundance at Shaker Village from 1993–2009 and 2010–2021.

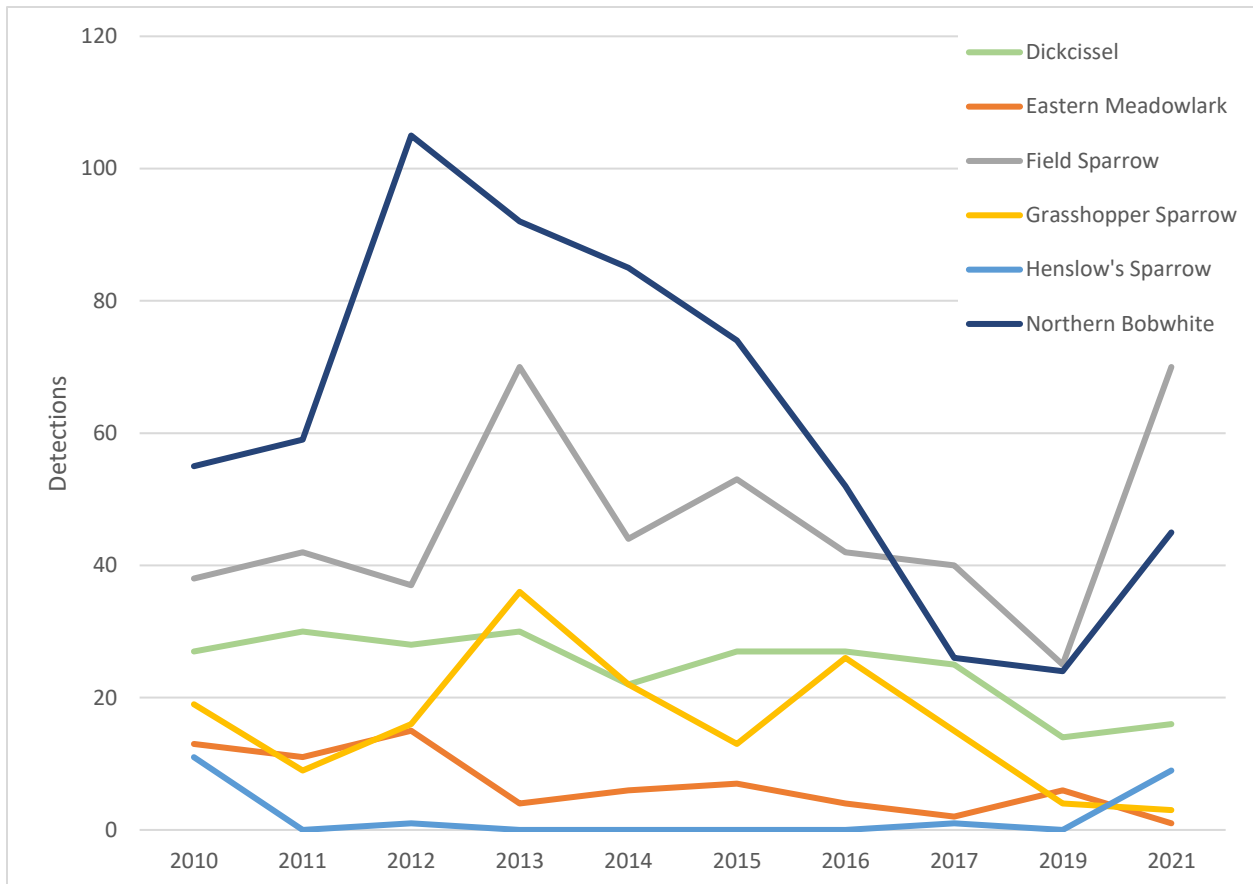


Figure 19. The raw detections of selected SGCN at Shaker Village of Pleasant Hill from 2010–2017, 2019, and 2021.

Shillalah Creek WMA

Shillalah Creek is a 2,640-acre WMA located in Bell and Harlan counties. The landcover at Shillalah consists of mixed deciduous and oak/hickory forests. The most observed species at Shillalah WMA were the ovenbird, red-eyed vireo, black-throated green warbler, hooded warbler, and scarlet tanager. Eight SGCN were detected at Shillalah, but abundance was only able to be calculated for three species (Figure 20, Table 13). Black-throated green warblers and worm-eating warblers had a positive trend and wood thrushes had a negative trend during the surveys (Table 11).

Compared with the 1993–2009 surveys, the 2010–2021 surveys did not see a significant decrease in



Wood Thrush
Photo by Mark Lowry

the abundance of any SGCN. Black-throated green warbler and wood thrush significantly increased in abundance (Figure 21).

Species Richness: 42

Years Surveys were Conducted: 2000–2010, 2012, 2014, 2016–2019, 2021

Management Practices: No management during 2010–2021 surveys

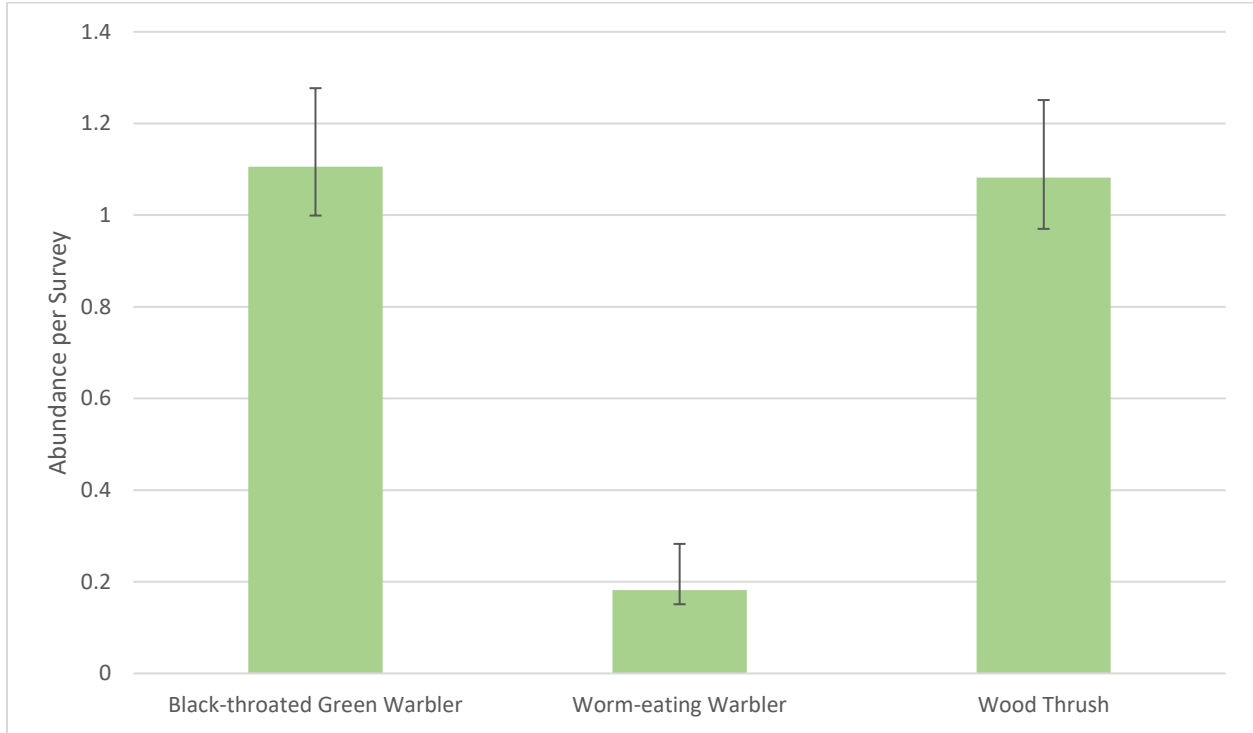


Figure 20. The abundance of SGCN at Shillalah Creek WMA from 2010, 2012, 2014, 2016–2019, 2021.

Table 11. The trends of SGCN at Shillalah Creek WMA from 2010, 2012, 2014, 2016–2019, 2021.

Species	Trend	St. Error
Black-throated Green Warbler	0.204	0.265
Wood Thrush	-0.406	0.361
Worm-eating Warbler	0.183	0.108

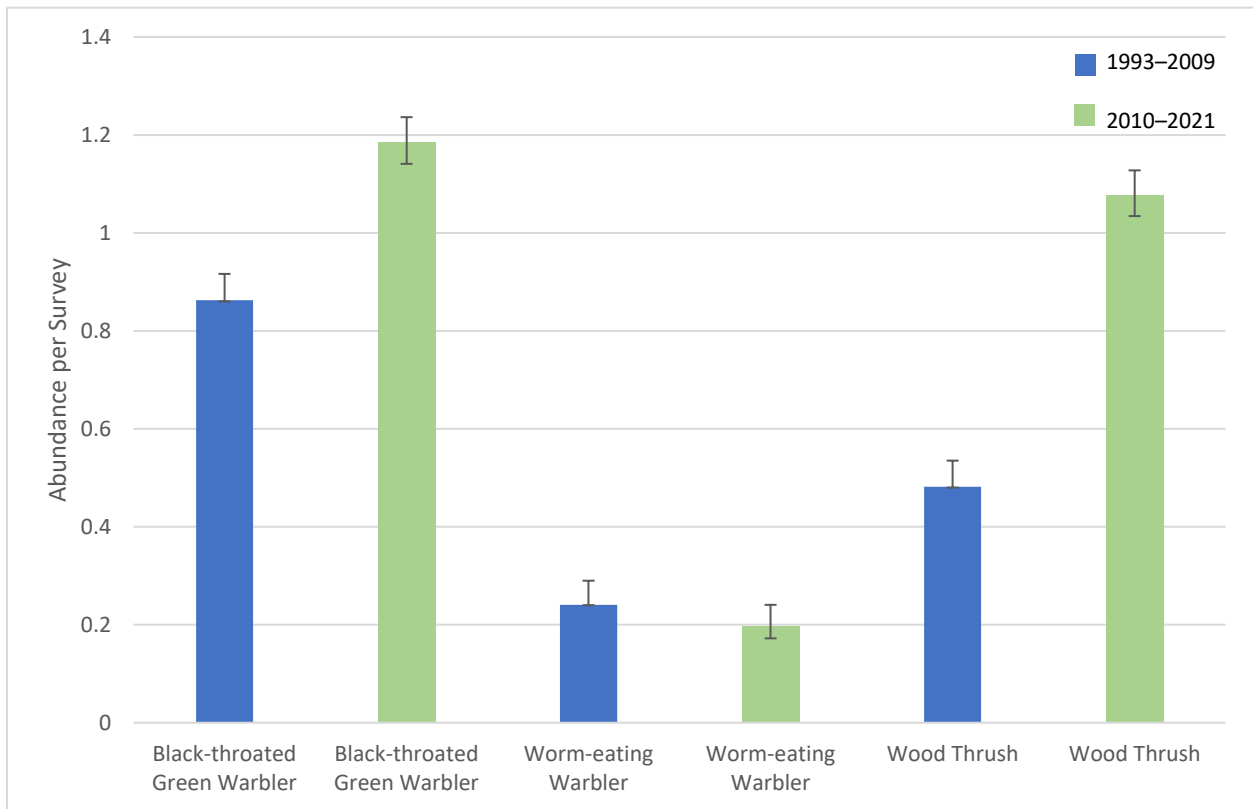


Figure 21. The SGCN abundance at Shillalah WMA from 1993–2009 and 2010–2021.

Starfire Mine

Starfire Mine is located in Perry, Knott, and Breathitt counties. This area was previously a WMA, but is no longer managed by KDFWR. The 16,000 acres of habitat at Starfire consisted mainly of reclaimed mine lands dominated by scrub grassland. The most detected species at Starfire were the European starling, field sparrow, grasshopper sparrow, indigo bunting, and yellow-breasted chat. Seven SGCN were detected during the surveys at Starfire Mine, but abundance was only able to be calculated for five species (Figure 22, Table 13). There were notably declining trends in grasshopper sparrows and field sparrows during the survey. Eastern meadowlarks and prairie warblers had decreasing trends, while northern bobwhites had an increasing trend (Table 12).



Prairie Warbler
Photo by Mark Lowry

Compared with the 1993–2009 surveys, the 2010–2021 surveys saw a significant decrease in the abundance of the following SGCN: blue-winged warblers

and Henslow’s sparrows. The following SGCN significantly increased in abundance: field sparrows and prairie warblers (Figure 23).

Species Richness: 43

Years Surveys were Conducted: 2000–2003, 2005–2013

Management Practices: No management during 2010–2021 surveys

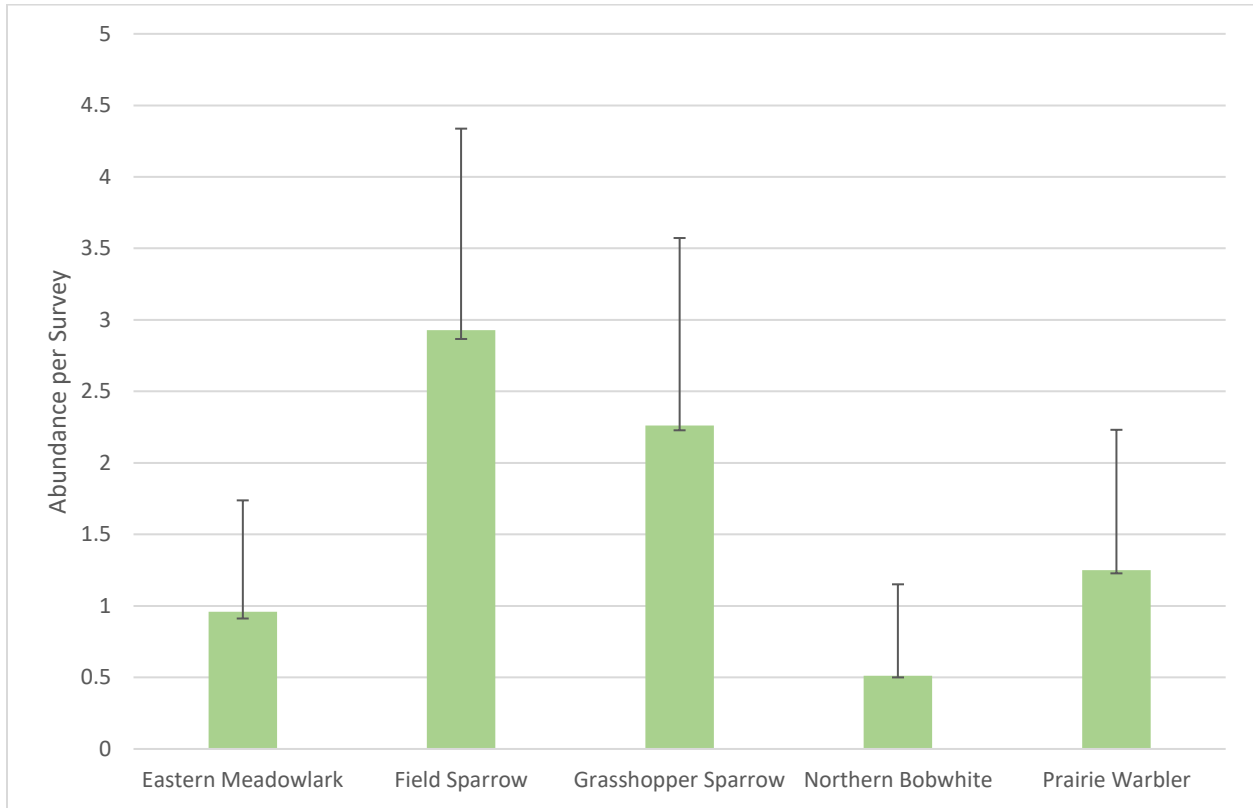


Figure 22. The abundance of SGCN at Starfire Mine from 2010–2013.

Table 12. The trends of SGCN at Starfire Mine from 2010–2013.

Species	Trend	St. Error
Eastern Meadowlark	-1.000	0.949
Field Sparrow	-3.100	1.634
Grasshopper Sparrow	-3.700	0.794
Northern Bobwhite	0.500	0.592
Prairie Warbler	-0.300	0.173

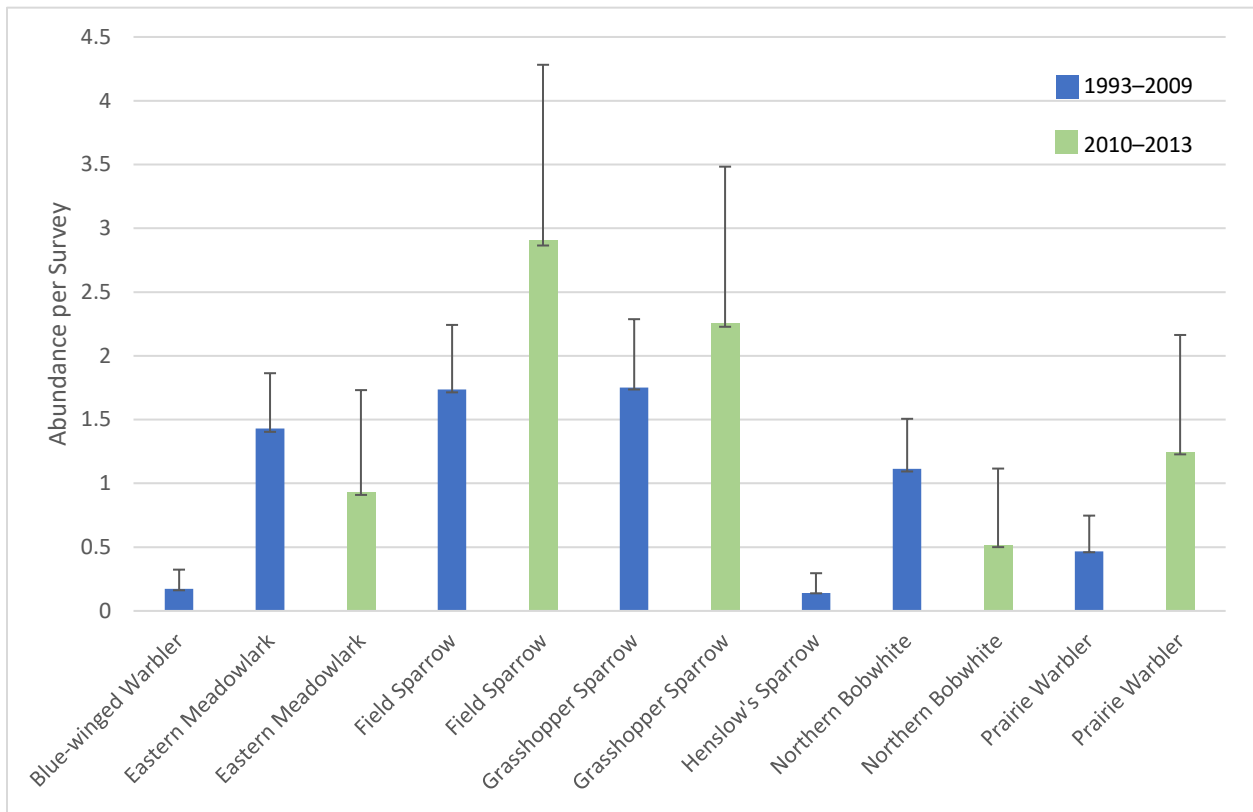


Figure 23. The SGCN abundance at Starfire Strip Mine from 1993–2009 and 2010–2013.

Table 13: The 2010–2021 abundance per survey point of SGCN at surveyed sites. Species in italics were likely observed during migration and are unlikely to breed at the site.

**Species detected at transect, but sample size was not sufficient for an estimate of abundance.

	Ano Strip Mine	Cane Creek	Curd Garden	Fort Campbell	Green River WMA	Jefferson Co. Mem. For.	Otter Creek	Peabody WMA	Shaker Village	Shillalah WMA	Starfire Mine
Bachman's Sparrow	0	0	0	**	0	0	0	0	0	0	0
Bell's Vireo	0	0	0	**	0	0	0	0.780	0	0	0
<i>Blackpoll Warbler</i>	0	0	0	0	0	0	**	0	0	0	0
Black-throated Green Warbler	0	1.499	1.321	0	0	0	**	0	0	1.106	0
Blue-winged Warbler	0	0	0	**	0	0	**	**	0	**	**
<i>Bobolink</i>	0	0	0	**	0	0	0	0	0	0	0
<i>Brown Creeper</i>	0	0	0	0	0	0	**	0	0	0	0
Canada Warbler	0	0	0	0	0	0	0	0	0	**	0
Cerulean Warbler	0	**	**	0	0	0	**	0	0	**	0
Chuck-will's-widow	0	0	0	0	**	0	0	0	0	0	0
Common Raven	0	0	0	0	0	0	0	0	0	**	0
Dickcissel	0	0	0	0.690	0	0	0	0.660	1.082	0	**
Eastern Meadowlark	0	0	0	0.341	0	0	0	**	0.332	0	0.958
Eastern Whip-poor-will	0	0	**	0	0	0	0	0	0	0	0
Field Sparrow	1.238	**	**	0.68	0	0	0.15	1.382	2.163	0	2.929
Grasshopper Sparrow	**	0	0	0.121	0	0	0	0.240	0.703	0	2.441
Henslow's Sparrow	0	0	0	0.080	0	0	0	0.170	0.102	0	**
Kentucky Warbler	0	**	0.075	0.196	**	0.286	0.938	0	**	0	0
<i>Least Flycatcher</i>	0	0	0	0	0	0	0	0	**	0	0
Loggerhead Shrike	0	0	0	0	0	0	0	0	**	0	0
Louisiana Waterthrush	0	0.058	0.131	**	0.129	**	**	0	0	0	0
Northern Bobwhite	**	0	0	1.163	0	0	**	1.749	2.869	0	0.512
Prairie Warbler	1.412	0.122	0.982	0.673	0	0	**	0.205	0.042	0	1.242
Prothonotary Warbler	0	0	0	0.063	0	0	**	0	0	0	0
Red-headed Woodpecker	0	0	0	0.169	0	0	0.219	**	0.074	0	0
<i>Rose-breasted Grosbeak</i>	0	0	0	0	0	0	0	0	0	**	0
<i>Savannah Sparrow</i>	0	0	0	0	0	0	0	0	**	0	0
Willow Flycatcher	0	0	0	**	0	0	0	0.115	0.19	0	0
Wood Thrush	0	0.357	0.374	0.4	1.716	1.611	1.282	0	**	1.082	**
Worm-eating Warbler	0	0.832	0.642	0.188	0.338	0.278	**	0	0	0.182	0
Yellow-billed Cuckoo	**	3.049	1.810	0.987	0.51	**	0.513	**	0.222	**	**

Discussion

The most detected species across all years and survey sites were the red-eyed vireo, American crow, indigo bunting, hooded warbler, and tufted titmouse. These species, except for the hooded warbler, are habitat generalists and are highly detectable. Detection probability has the potential to bias the abundance of species observed during the survey. Analyzing many of these same sites, Buehler and Vorisek found that Henslow's sparrows and prothonotary warblers had relatively low detection probability (2010). While our abundance estimates are corrected for detection probability, our trends are not. Thus, the trends reported should be interpreted with some caution.

Species richness varied greatly between sites with Fort Campbell exhibiting the highest species richness and Ano Strip Mine exhibiting the lowest (Figure 1). Species richness is no doubt influenced by the longevity of the survey, skill level of the observer, and variety of habitats available within the survey route. Thus, it shouldn't be used solely to judge the value of bird populations at the site, but can be an interesting metric and is useful for directing future management and research.

There have been significant changes in SGCN abundance at several sites since the 1993–2009 PIF point count analysis. Many of the changes in SGCN abundance over this near three-decade long survey can be attributed to natural succession. This is especially apparent at Ano Strip Mine and Starfire Mine, where species that prefer more woody plant material in early successional habitats, like field sparrows and prairie warblers, tended to increase in abundance during the 2010–2021 survey block. However, succession also likely drove changes in abundance for forest species at sites like Cane Creek and Green River WMA, where canopy trees were allowed to mature despite prescribed fire in the understory, and increases in mature forest species (e.g. wood thrush) followed.

Any type of habitat management will result in a tradeoff between species that benefit from the management and those that decline because of it. With few exceptions, the management practices at the survey sites generally only affected a portion of points when performed. Even so, the performed management at Cane Creek, Curd Garden, Green River WMA, and Peabody WMA, where it occurred, did seem to influence the abundance or trends of certain SGCN. Several sites went without sufficient breaks in management to allow for an analysis of the effects of management on SGCN abundance. This did not allow for a before-and-after assessment of SGCN abundance, but it was possible to look at the trends of SGCN during the survey window. The trend analysis is less reliable though since it does not account for detection probability or variations in survey effort.

Results for most forest species, including Kentucky warbler, Louisiana waterthrush and wood thrush, varied per site with increases at some areas and decreases at others. However, results for worm-eating warblers were more consistent, showing a declining trend or lower abundance in response to prescribed fire at three sites: Cane Creek, Curd Garden, and Green River WMA. Worm-eating warblers have been previously found to decline after burns, as the leaf litter and understory vegetation they use for nesting and foraging is reduced post-burn (Artman *et al.* 2001, Blake 2004). On the contrary, black-throated green warbler abundance was consistently higher during 2010-2021 than 1993-2009 at all three sites where this species was detected. This is encouraging since there was some concern this species would decline during recent years due to Hemlock Woolly Adelgid's effects on their habitat (KDFWR 2013).

Notably high abundances were observed for forest SGCN at several survey sites. For example, Kentucky warblers showed a high abundance at Otter Creek (although with a decreasing trend). Interestingly, Otter Creek also had the highest abundance for red-headed woodpeckers with an increasing trend. Abundances were low overall for Louisiana waterthrush, but Curd Garden and Green River showed higher abundances than the other sites. Wood thrushes had a high abundance at Green River and Jefferson Memorial Forest. Black-throated green warblers showed high abundance at DBNF surveys (Curd Garden and Cane Creek) and Shillalah. Meanwhile, worm-eating warbler and yellow-billed cuckoo showed higher abundances at the DBNF routes. This data can be important when considering sites for future management and research for these SGCN.

Fort Campbell, Peabody WMA, and Shaker Village all have managed areas for grassland SGCN, and Peabody WMA and Shaker Village are designated as Kentucky Quail Focal Areas. While succession in grasslands can result in rapid changes in species abundance, over the long-term, management has been successful in increasing the abundance of several SGCN at the grassland sites. Specifically, when looking at northern bobwhite abundance, the 2010–2021 surveys reported a significantly higher abundance of the species than the 1993–2009 surveys at all three sites which were also the sites with the highest abundance for northern bobwhite overall (Table 13). Field sparrow and dickcissel abundance was also higher during 2010-2021 than 1993-2009 at Fort Campbell and Shaker Village and field sparrow showed stability between the two periods at Peabody. One of the strong points of this survey effort is its longevity and the resulting ability to assess long-term change as a result of management efforts.

Of some concern is the declining trends/abundance seen in a few grassland SGCN recorded on these surveys, in some cases, despite management intended to benefit them. Declining trends or long-term declines in abundance were seen across several sites for Henslow's sparrow, grasshopper sparrow, and eastern meadowlark. These species tend to prefer grasslands with little to no woody cover and habitat management custom-tailored to their needs will likely be required to increase populations.

Areas with high abundance of grassland and early successional species noted through this project can be utilized to direct future conservation and research. High abundance for prairie warbler was noted at Ano and Starfire, both reclaimed mine sites. Henslow's sparrow abundance was comparatively low where this species was found, but Peabody showed the highest abundance of all the sites. Grasshopper sparrows were most abundant at Starfire, but with a decreasing trend, likely due to succession at this unmanaged site. Bell's vireos were only found at Peabody, but that is not surprising as this species' range only covers a portion of the state.

Many SGCN were not detected in large enough numbers to ascertain abundance. These species included Bachman's sparrow, common raven, and loggerhead shrike. As previously suggested by Buehler and Vorisek (2010), focal surveys for under-detected SGCN are necessary to better assess these populations. This approach has been used by KDFWR for golden-winged warblers, loggerhead shrike, cerulean warblers, and common ravens.

Going forward, it will be worthwhile to continue sampling, especially at managed areas, to further assess the effects of habitat management. We did notice the effects of observer bias at some sites and did our best to work around this (even omitting 2021 data due to staff turnover at some sites). Whenever possible, the same observer should be used between years at each site. However, despite the challenges of working with such data, we do find this dataset useful for documenting long-term changes in the bird communities at these sites.

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