Grassland bird surveys and nest-monitoring in MDC patch-burn graze study units 2015-2019

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Introduction

Patch-burn grazing (PBG) is a widely accepted management tool that is utilized to produce a diversity of vegetative structure, thus increasing both nesting and foraging habitat for a variety of grassland-obligate species (Churchwell et al. 2008, Coppedge et al. 2008, Hovick et al. 2011). To manage for grassland-obligate bird species in the <1% of native prairie remaining in Missouri, a comprehensive management toolbox includes the use of prescribed fire and moderate grazing. The long-term effects of PBG on grassland bird populations and nesting success in Missouri is an important topic for investigation.

In conjunction with the MDC Resource Science Division's (RSD) 15 year patch-burn grazing (PBG) study, the Missouri River Bird Observatory (MRBO) has initiated a parallel study to investigate the effects of PBG treatment on grassland bird densities and nesting success. Study areas include Diamond Grove, Kickapoo, Providence, Wah'Kon-Tah, Taberville, and Hi Lonesome Prairies. Target grassland breeding species include Eastern Meadowlark (*Sturnella magna*), Dickcissel (*Spiza americana*), Field Sparrow (*Spizella pusilla*), Henslow's Sparrow (*Ammodramus henslowii*), Grasshopper Sparrow (*Ammodramus savannarum*), Northern Bobwhite (*Colinus virginianus*), Bell's Vireo (*Vireo bellii*), Loggerhead Shrike (*Lanius ludovicianus*), and Greater Prairie-Chicken (*Tympanuchus cupido*). However, all species detected during surveys are recorded and all species' nests that are found are monitored.

Format of this report

This report presents the results of 2015-2019 transect surveys on PBG study units. Data were combined across years to analyze and present grassland bird densities in grazed and ungrazed units.

Nest-monitoring results are provided in detail for 2019. Where appropriate for comparison purposes, reletvant 2016-2018 data are also included.

More detailed descriptions of survey and nest-monitoring methodolgy are available in previous years' reports or upon request. Densities of grassland obligate species on all MDC properties surveyed in 2019 can be accessed in MRBO's comprehensive report (Duke and Ripper 2019).

Project Summary

- MRBO surveyors located and monitored 206 nests during the 2019 breeding season, bringing the 2016-2019 sample size to 667 nests, 444 of which are grassland target species.
- Nest monitoring data to date suggest that nests in the control units have higher rates of nest survival compared to treatment units, with target species as a guild having the highest survival rate followed by Bell's Vireo and then all species' nests. Bell's Vireo has higher rates of survival in the treatment unit compared to all other groups. Dickcissel nests have the lowest survival rate of all groups of nests analyzed through Logistic Exposure technique.
- Survey data from 2015-2019 on all of the MDC's PBG units indicate that there is some preference for (e.g. higher density in) treatment units by Dickcissel, Eastern Meadowlark, Grasshopper Sparrow, Field Sparrow and Northern Bobwhite, while Bell's Vireo and Henslow's Sparrow show a preference for control units. Taken as a guild, Missouri's grassland obligates do not show significant differences in density between treatment and control units.

Grassland Bird density on PBG Units

The PBG study units are surveyed using the standardized line-transect design that is employed throughout MRBO's surveys of public grasslands throughout Missouri. However, while other grassland survey sites are visited once each breeding season, PBG study units are surveyed twice in order to bolster sample sizes for further analysis.

Line-transect surveys were conducted on the PBG units within the months of May and June. Bird detections were marked with spatially explicit data using ArcGIS Collector and with this information density estimates of grassland-obligate species were made using the program Distance. Density estimates were calculated if the sample size was ≥10 for a unit. Combined density estimates of all grassland obligates from 2015 to 2019 show that there is no significant trend in preference for treatment versus control units (Table 1). Individual species analyses show preferences for treatment or control types, significant preferences include Eastern Meadowlark and Field Sparrow preferring treatment units and Henslow's Sparrow preferring control units (Tables 2 through 8).

Tables 1 - 3: Density of birds on patch-burned graze and ungrazed units on Conservation Areas.
n = total number of observations during transect surveys. D = estimated density in birds/acre generated by Program Distance based on pooled data from all survey years and locations. Density calculated only if n >10 for a property. CV = coefficient of variance. 2019 density values of the entire property are shown for comparison.

indicates treatment unit where density was higher, but not significantly

indicates treatment unit where density was significantly higher (alpha <0.05).

All Grassland Obligates

Table 1 indicates Diamond Grove and Wah'Kon-Tah had significantly higher density values of obligate species in the control unit compared to the treatment unit. For all properties combined, density was not significantly different.

	2015-2019 Treatment			2015-2019 Control			2019 Entire Property
	n	D	CV	n	D	CV	D
Diamond Grove	1111	1.307	0.05	1344	1.517	0.05	1.092
Hi-Lonesome	916	1.349	0.14	1192	1.276	0.08	0.868
Providence (treatment)/Kickapoo (control)	1060	1.417	0.08	583	1.242	0.09	1.285 / 0.749
Taberville	807	1.590	0.07	698	1.530	0.06	1.127
Wah'Kon-Tah	690	1.172	0.07	794	1.679	0.07	1.089
All Properties	4584	6.834	0.04	4611	7.244	0.03	

Table 2 indicates Providence had significantly higher densities of Bell's Vireo than Kickapoo while Wah'Kon-Tah had significantly higher densities in the control unit then the treatment unit. Overall trend shows most control units host higher densities of Bell's Vireo.

	2015-2019 Treatment			2015-2019 Control			2019 Entire Property
	n	D	CV	n	D	CV	D
Diamond Grove	42	0.053	0.26	44	0.053	0.17	0.099
Hi-Lonesome	80	0.125	0.98	120	0.136	0.17	0.116
Providence (treatment)/Kickapoo (control)	99	0.141	0.12	13	0.029	0.34	- / 0.2
Taberville	66	0.138	0.13	76	0.177	0.17	0.15
Wah'Kon-Tah	88	0.159	0.11	129	0.289	0.13	0.204
All Properties	375	0.616	0.06	382	0.684	0.10	

Bell's Vireo

Table 3 indicates most properties had higher densities of Dickcissels in treatment units but only Taberville had significantly higher values than its control unit counterpart. Wah'Kon-Tah had significantly higher densities in the control unit compared to the treatment unit.

	2015-2019 Treatment			2015-2019 Control			2019 Entire Property
	n	D	CV	n	D	CV	D
Diamond Grove	588	0.749	0.07	654	0.692	0.07	0.684
Hi-Lonesome	234	0.373	0.11	227	0.350	0.09	0.320
Providence (treatment)/Kickapoo (control)	632	0.915	0.10	390	0.779	0.11	0.726 / 0.500
Taberville	356	0.760	0.10	304	0.625	0.07	0.524
Wah'Kon-Tah	138	0.254	0.13	229	0.454	0.13	0.430
All Properties	1948	3.052	0.05	1926	2.899	0.06	

Dickcissel

Tables 4 - 6: Density of birds on patch-burned graze and ungrazed units on Conservation Areas.
n = total number of observations during transect surveys. D = estimated density in birds/acre generated by Program Distance based on pooled data from all survey years and locations. Density calculated only if n >10 for a property. CV = coefficient of variance. 2019 density values of the entire property are shown for comparison.

indicates treatment unit where density was higher, but not significantly

indicates treatment unit where density was significantly higher (alpha <0.05).

Table 4 indicates all properties combined as well as most PBG sites individually had significantly greater densities of Eastern Meadowlark in the treatment units. Wah'Kon-Tah had the opposite with significantly greater values in the control unit compared to the treatment unit.

	2015-2019 Treatment			2015-2019 Control			2019 Entire Property
	n	D	CV	n	D	CV	D
Diamond Grove	240	0.232	0.08	296	0.228	0.09	0.223
Hi-Lonesome	194	0.235	0.28	184	0.134	0.08	0.112
Providence (treatment)/Kickapoo (control)	133	0.146	0.11	57	0.083	0.16	0.137 / -
Taberville	125	0.203	0.12	88	0.132	0.09	0.096
Wah'Kon-Tah	86	0.120	0.15	113	0.163	0.09	0.086
All Properties	778	1.066	0.08	738	0.740	0.05	

Eastern Meadowlark

Table 5 indicates Field Sparrow densities were significantly greater in the treatment units of Hi-Lonesome, Taberville, Wah'Kon-Tah, and all properties combined. Kickapoo showed greater densities compared to Providence but they are not significant. Diamond Grove had an insufficient sample size for comparison.

	2015-2019 Treatment			2015-2019 Control			2019 Entire Property
	n	D	CV	n	D	CV	D
Diamond Grove	8	-	-	13	0.012	0.33	-
Hi-Lonesome	103	0.168	0.19	108	0.092	0.28	0.123
Providence (treatment)/Kickapoo (control)	32	0.047	0.22	33	0.056	0.22	-
Taberville	60	0.131	0.15	50	0.087	0.17	0.123
Wah'Kon-Tah	75	0.141	0.16	49	0.082	0.22	0.141
All Properties	278	0.497	0.09	253	0.328	0.14	

Field Sparrow

Table 6 indicates Grasshopper Sparrow densities were greater in the treatment units of Diamond Grove, Hi-Lonesome, Wah'Kon-Tah, and all properties combined. Only Wah'Kon-Tah's treatment unit densities were significantly greater than its control unit. Kickapoo had significantly greater densities than Providence. Taberville had insufficient sample sizes for densities to be calculated

	2015-2019 Treatment			2015-2019 Control			2019 Entire Property
	n	D	CV	n	D	CV	D
Diamond Grove	101	0.151	0.15	123	0.147	0.15	0.044
Hi-Lonesome	88	0.165	0.46	65	0.074	0.64	0.082
Providence (treatment)/Kickapoo (control)	12	0.020	0.47	21	0.047	0.30	-
Taberville	3	-	-	7	-	-	-
Wah'Kon-Tah	57	0.123	0.19	27	0.060	0.26	0.020
All Properties	261	0.468	0.18	243	0.344	0.18	

Grasshopper Sparrow

Tables 7 - 8: Density of birds on patch-burned graze and ungrazed units on Conservation Areas.
n = total number of observations during transect surveys. D = estimated density in birds/acre generated by Program Distance based on pooled data from all survey years and locations. Density calculated only if n >10 for a property. CV = coefficient of variance. 2019 density values of the entire property are shown for comparison.

indicates treatment unit where density was higher, but not significantly

indicates treatment unit where density was significantly higher (alpha <0.05).

Table7 indicates Henslow's Sparrow densities were greater in control units than treatment units with Diamond Grove, Hi-Lonesome and all properties combined having signficantly greater densities and Taberville and Wah'Kon-Tah having insignificant differences. Providence and Kickapoo had similar densities.

	2015-2019 Treatment			2015-2019 Control			2019 Entire Property
	n	D	CV	n	D	CV	D
Diamond Grove	104	0.149	0.17	177	0.256	0.14	0.214
Hi-Lonesome	127	0.227	0.16	223	0.305	0.14	0.050
Providence (treatment)/Kickapoo (control)	90	0.146	0.21	53	0.144	0.26	-
Taberville	159	0.381	0.12	139	0.390	0.17	0.185
Wah'Kon-Tah	209	0.431	0.13	0	0.522	0.11	0.134
All Properties	689	1.334	0.07	785	1.617	0.08	

Henslow's Sparrow

Table 8 indicates Northern Bobwhite density differences were only signficant between Wah'Kon-Tah units with the control having higher densities than the treatment. All properties combined, higher densities were in the treatment unit but differences are not significant. Kickapoo had insufficient sample sizes for comparison with Providence.

	2015-2019 Treatment			2015-2019 Control			2019 Entire Property
	n	D	CV	n	D	CV	D
Diamond Grove	22	0.016	0.25	33	0.020	0.22	-
Hi-Lonesome	65	0.061	0.19	109	0.061	0.14	0.048
Providence (treatment)/Kickapoo (control)	61	0.052	0.16	9	-	-	-
Taberville	35	0.044	0.24	30	0.035	0.26	0.043
Wah'Kon-Tah	37	0.040	0.22	53	0.059	0.18	0.057
All Properties	220	0.212	0.13	234	0.185	0.11	

Northern Bobwhite

Wah'Kon-Tah Prairie Control Unit

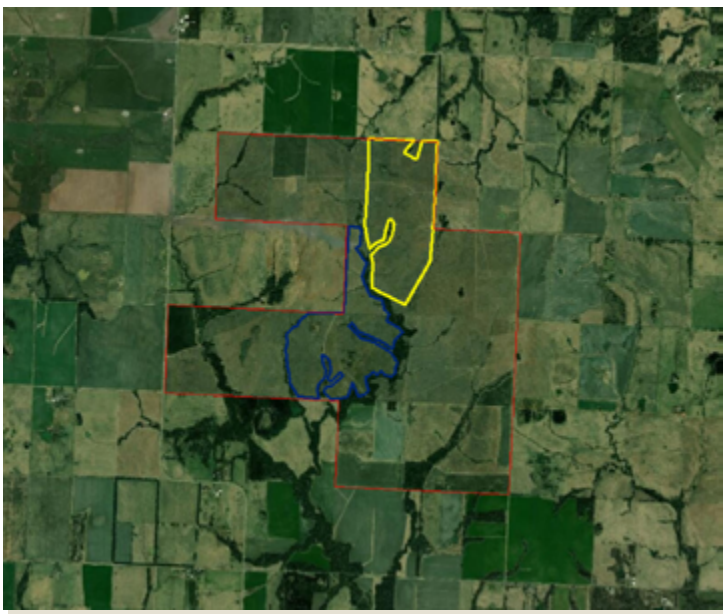

Figure 1. Taberville Prairie and the PBG study units: treatment (yellow) and control (blue).

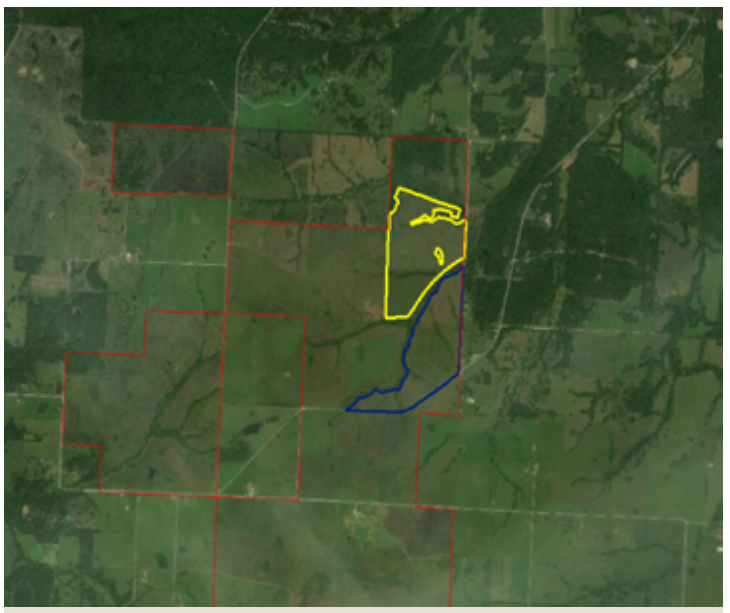

Figure 2. Wah'Kon-Tah Prairie and the PBG study units: treatment (yellow) and control (blue).

Since 2016, MRBO has been conducting a nest-monitoring study on the Taberville (2016, 2018, 2019) and Wah'Kon-Tah (2017, 2019) Prairies patch-burn grazing study units. The goal of the study is to measure the effects of patch-burn grazing management practices on nest success. There are two types of units in this study, a treatment unit and a control unit. The treatment unit typically has grazers present during the season while the control unit does not have grazers present. In addition, each unit typically has approximately one-third of its area burned every year. Therefore, for the purpose of this study, nests are categorized as either being in the treatment or control unit.

2019 Study Area Characteristics. Taberville Prairie (Figure 1) is a 1,360-acre remnant prairie located in the Upper Osage Grasslands Priority Geography and is characterized largely by native prairie (2,700 acres). Other components include warm season grass plantings, crop fields, prairie restoration, woodlots, and old fields. The PBG study area falls on the eastern side of the property and the treatment unit is approximately 199 acres while the control unit is approximately 195 acres. Wah'Kon-Tah Prairie (Figure 2) is a 3,030-acre parcel also located in the Upper Osage Grasslands Priority Geography and has other components including warm season grass plantings and wooded areas. The PBG study area falls on the northeastern side of Wah'Kon-Tah. The treatment unit is approximately 154 acres and the control unit is approximately 138 acres. All four units searched this year had ~one-third of its area burned prior to the start of the 2019 breeding season and both treatment areas had grazers present for most the searching and monitoring season.

Methods. MRBO observers conducted nest searches at Taberville Prairie Conservation Area from the end of May until mid-July, 2016 and at Wah'Kon-Tah Prairie from mid-May until the end of July in 2017. In 2018, nest-searching went on from late-May until late-July at Taberville Conservation Area. In 2019, both Taberville Conservation Area and Wah'Kon-Tah Prairie were searched from early-May to late-July. We note that four observers were employed on the project in 2016, two in 2017, and three in 2018.

Observers tried to spend equal time nest-searching in the treatment and control units, with the number of searchers in each unit varying per day to ensure search times were equal. Each unit was traversed by foot and observers focused on cues such as flushing adults, short flights, chipping adults, or adults with food or nesting material. Upon flushing a bird, observers immediately searched the area for a maximum of ten minutes to minimize disturbance. If the nest was not found during that time period, observers knelt in a concealed location to watch for returning parents. Technicians primarily searched independent from one another but would occasionally search together, especially when implementing the rope-dragging technique. For this method, searchers held opposite ends of a rope that had cans dangling from portions of the rope and walked along the prairie while the rope dragged across the tops of the vegetation and the cans clanking against each other. This created disturbances that were very likely to cause any ground-nesting bird to flush from their nest when walking near them. Rope-dragging was used mainly in areas that had few sumac and other woody growth since this hardy vegetation caused the rope to snag often.

After a nest was found, they were marked electronically with spatially explicit information and marked physically by administering black, electrical tape on nearby vegetation. Photos and descriptions of nest locations were also recorded for reference. Nests were checked every 3 days but during the early stages of the nesting cycle (e.g. laying or incubation) nests were checked less frequently to minimize disturbance. During late stages of the nesting cycle, nests were checked more frequently in order to maximize accuracy of nest-fate classifications.

Nests were documented as successful (fledging at least one young), failed, or unknown (in a few cases). Observers attempted to determine the cause of nest failure, classified as predation (mammalian or reptile) or other (e.g. weather damage, human disturbance or other cause) based on the state of the failed nest.

Photos are taken near nest locations to help relocate nests during monitoring

Data analysis. R-Studio with packages library(lme4) and library(MASS) was employed to perform a Logistic Exposure analysis using PBG treatments units as covariates (Shaffer 2004). Required attribute data consisted of nest ID, status of the nest ('1' when the nest was active or fledged and '0' if the nest failed), the intervals between each day the nest was checked, and the nest's management unit. Logistic Exposure analysis provides daily, weekly and full-cycle nest survival rates.

Results. In 2019, MRBO observers spent 208 hours in the Wah'Kon-Tah control unit and 103 hours in the Taberville control unit. Observers spent 207 hours in the Wah'Kon-Tah treatment unit and 98 hours in the Taberville treatment unit. All searching took place from May 8th to July 30th. On Taberville, 47 nests were found in the control unit and 45 nests found in treatment unit. On Wah'Kon-Tah, 54 nests were found in the control unit and 59 nests found in the treatment unit, totaling to 206 nests found and monitored in 2019 (Table 9).

Of the total 206 nests monitored, 76 of them succeeded in producing at least one fledgling, 2 were still active at the end of the project, 12 had fates that could not be determined, and 116 of the nests failed. Of the 116 nests that failed, 7 of them had failed from causes other than predation. Of the 206 nests monitored, 107 were target species' nests and 40 of these nests were successful in producing at least one fledgling, 61 had failed, 1 was still active at the end of the project, and 5 had unknown fates (Table 10). In total, with 4 years of nest searching data, MRBO has monitored 444 target species' nests within the PBG boundaries.

Sample size to date has been sufficient ($n > 50$ per treatment) to allow logistic exposure analyses comparing nest survival by management unit on the target species guild, all species, and Dickcissel using all combined years data (Table 12). Sample size was high enough to analyze all species and target species using only 2019 data as well. Although not meeting the standard of having a sample size of at least 50 nests, combined years of Bell's Vireo sizes are close to that margin and so logistic regression analyses were run on these species as well (Table 12). Results from the Logistic Exposure analyses show that in every grouping of nests, full-cycle nest survival was higher in the control unit than in the treatment unit (Figure 3).

Target Species' nests distance to woody edge was explored as a variable affecting nest success. Using supervised classification techniques in ArcMap: Edges with mature trees surrounding the units, shrubby thicket islands within the units, and large riparian draws with substantial woody vegetation were classified as woody edges. Using the Near geoprocessing tool in ArcMap, the closest distance a nest was from a woody edge was obtained. The average distance to woody edge of failed and successful nests of target species over the years 2016-2019 are shown in Figure 4. The results are using apparent nest fates, but suggest that most target species' nest failures are closer to woody edges than their nest successes. Outliers from this trend are Bell's Vireo; which often prefer to nest near woody edges, and Dickcissel.

For all nests monitored from 2016-2019, cowbird parasitism was documented and rates of brood parasitism by Brown-headed Cowbirds are shown in Table 13. Out of 667 nests monitored, 19% of them have been parasitized. Of the grassland-obligate species, Bell's Vireo had the highest rate of parasitism with 39% of nests being parasitized. Dickcissel, Field Sparrow, and Henslow's Sparrow had lower parasitism rates while Eastern Meadowlark had no parasitism. Grasshopper Sparrow and Northern Bobwhite also had no parasitism but our sample size for those species was very small.

DISCUSSION. This analysis was the first time that management units were classified as either treatment or control, rather than the four management types that previous years had followed. Classifying nests in this simpler way allows for sample sizes to be larger and data analysis more robust. Despite reclassifying nests from previous years into these two categories, sample sizes are still lacking for rigorous analysis of a few of the target species. After the 2019 season, with these simpler classifications, nest survival was higher in the control unit for all analysis group. 2019 seemed to be a really good year for Bell's Vireo because in 2019 we found the most Bell's Vireo nests of any year so far and in the control units 17 of 27 Bell's Vireo nests monitored, succeeded. This high percentage of Bell's Vireo nest success is likely to blame for the large discrepancy in nest survival rates between treatment and control units. This high survival rate of Bell's Vireo is most likely causing the same skew in the analysis of all years combined Bell's Vireo nest survival between treatment and control units.

Logistic Exposure analysis of target species in relation to distance to woody edge will be a test we hope to run after the season in 2020. We had intended to run this analysis after this season but a large percentage of our target species' nests belong to Bell's Vireo and Field Sparrow. Bell's Vireo and Field Sparrow nests should be excluded from the analysis because of their tendencies to nest in these woodier areas, however, after removing these nests, sample sizes of the remaining grassland-obligate species were insufficient to run Logistic Exposure analyses adequately.

Brood parasitism rates of Missouri grassland species have been linked to distance to woody edges (Winter et al. 2000). Considering how Bell's Vireo nests monitored have the highest parasitism rate of nests thus far in the study, it would be interesting to see how distance to woody edge has affected Bell's Vireo nest parasitism rates. Our current rate of nest parasitism for Bell's Vireo is similar to past research (Budnik et al. 2000) but our Dickcissel rate of parasitism is higher than past research in southwestern Missouri (Winter 1999). Although nest sample size of other grassland-obligate species is relatively low to make any conclusions about brood parasitism rates, is appears as though observed brood parasitism of Eastern Meadowlarks is low (Patten et al. 2006).

In 2019, compared to previous years, both Taberville and Wah'Kon-Tah PBG study sites were monitored. It is of note to mention that although searchers spent twice as much time in 2019 at Wah'Kon-Tah than at Taberville, only a few more target species' nests were found at Wah'Kon-Tah. The greater area size of PBG units at Taberville might be responsible. From a searcher's perspective, the more area we can search, the greater chance of flushing up nesting birds. Therefore, if we have the manpower, searching and monitoring at both sites might

Table 9. All nests monitored in 2019

	Taberville		Wah'Kon-Tah		
Species	Control	Treatment	Control	Treatment	**Total**
American Goldfinch	3				**3**
American Robin			1		**1**
Bell's Vireo	16	5	11	10	**42**
Blue-winged Warbler				1	**1**
Brown Thrasher	2	11	8	9	**30**
Common Yellowthroat	1	3	1		**5**
Dickcissel	9	7	4		**20**
Eastern Meadowlark		3		2	**5**
Eastern Towhee		1		1	**2**
Field Sparrow	8	2	4	16	**30**
Gray Catbird		4	10	8	**22**
Henslow's Sparrow		2	1	6	**9**
Horned Lark		1			**1**
Indigo Bunting	1	1			**2**
Mourning Dove		5	1	1	**7**
Northern Bobwhite				1	**1**
Northern Cardinal	2	1			**3**
Red-winged Blackbird			6		**6**
Wild Turkey	1				**1**
Yellow-breasted Chat	4		7	4	**15**
Total	**47**	**46**	**54**	**59**	**206**

be advantageous in subsequent years. One repercussion of monitoring over a larger area is the greater amount of time it takes to travel between nests. To date, MRBO has monitored non-target species' nests found but after this season, it is evident that too much time is being spent on the monitoring of non-target species. In 2020, we will plan on excluding the monitoring of non-target species so that more time can be spent searching for target species' nests.

Table 10. Fate of all species nests in 2019

	Control				Treatment			
Species	**Active**	**Failure**	**Success**	**Unknown**	**Active**	**Failure**	**Success**	**Unknown**
American Goldfinch		1		2				
American Robin			1					
Bell's Vireo		10	17			10	5	
Blue-winged Warbler						1		
Brown Thrasher		7	3			11	9	
Common Yellowthroat		1		1		1	2	
Dickcissel		7	5	1	1	3	3	
Eastern Meadowlark						3	1	1
Eastern Towhee						2		
Field Sparrow		8	4			13	4	1
Gray Catbird	1	5	4			5	7	
Henslow's Sparrow		1				6	1	1
Horned Lark						1		
Indigo Bunting			1			1		
Mourning Dove			1			5		1
Northern Bobwhite								1
Northern Cardinal		2				1		
Red-winged Blackbird		2	3	1				
Wild Turkey			1					
Yellow-breasted Chat		5	4	2		4		
Total	**1**	**49**	**44**	**7**	**1**	**67**	**32**	**5**

Table 11. Fate of Target Species from 2016-2019

	Control				Treatment			
Species	Active	Failure	Success	Unknown	Active	Failure	Success	Unknown
Ammodramus Sparrow						1		
Bell's Vireo		32	28	1		25	17	4
Dickcissel	1	61	32	4	12	64	37	5
Eastern Meadowlark		2				7	6	2
Field Sparrow		22	6	3		30	12	1
Grasshopper Sparrow						1	2	
Henslow's Sparrow		5	2			12	2	2
Northern Bobwhite							1	1
Total	**1**	**122**	**68**	**8**	**12**	**140**	**77**	**15**

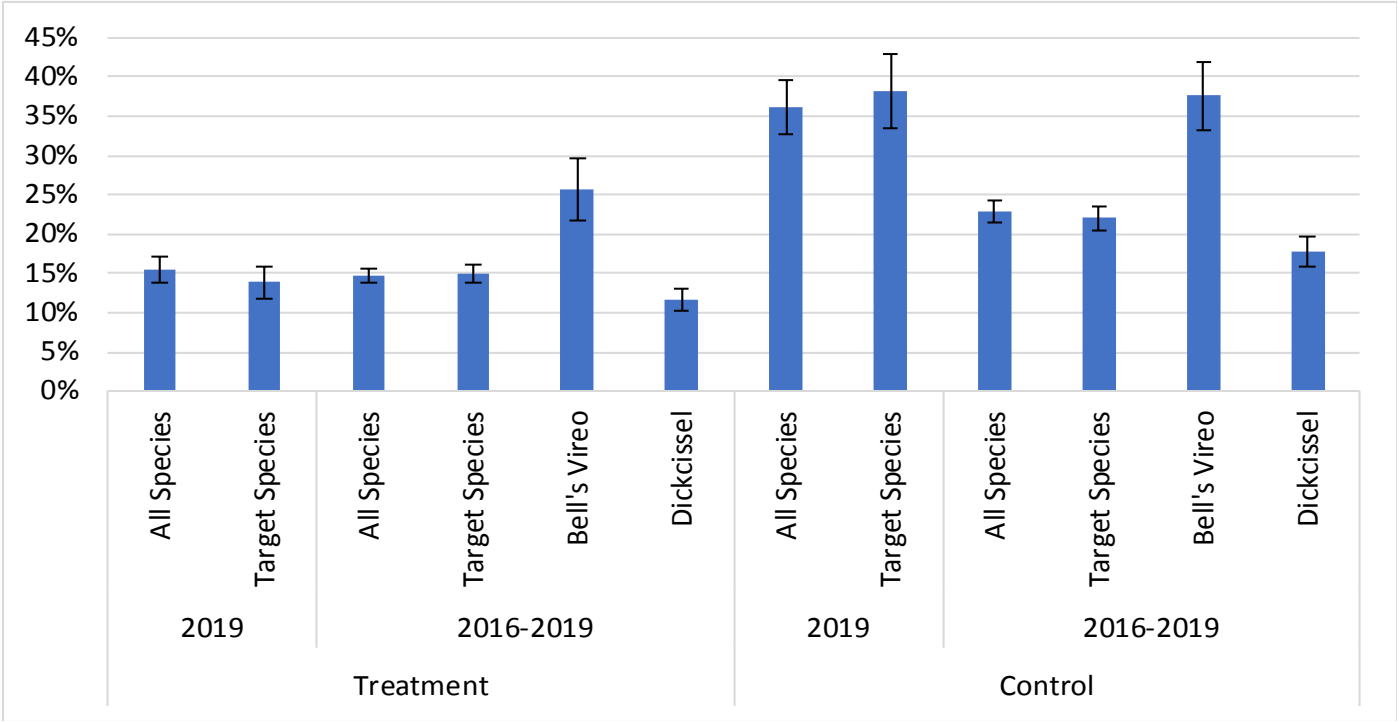

Figure 3. Full-cycle nest survival for all species, target species, Bell's Vireo, and Dickcissel

Table 12. Nest survival for all species, target species, Bell's Vireo, and Dickcissel

	Treatment		Control	
Species/Group	Full Cycle	SE	Full Cycle	SE
All Species 2019	15.4%	0.017	36.2%	0.034
Target Species 2019	13.8%	0.021	38.2%	0.048
All Species 2016-2019	14.7%	0.009	22.9%	0.014
Target Species 2016-2019	15.0%	0.011	22.0%	0.016
Bell's Vireo 2016-2019	25.8%	0.039	37.6%	0.043
Dickcissel 2016-2019	11.6%	0.013	17.8%	0.012

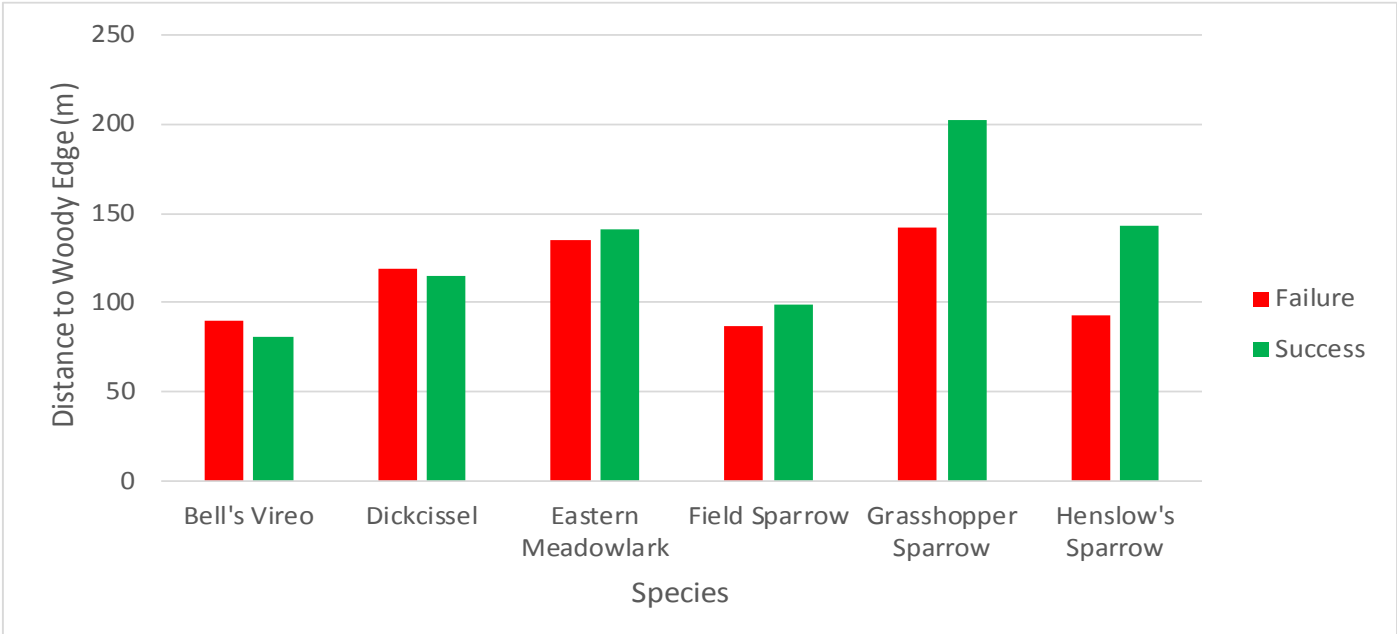

Figure 4. Apparent nest failure and success of target species and their nest's averages distance to woody edges

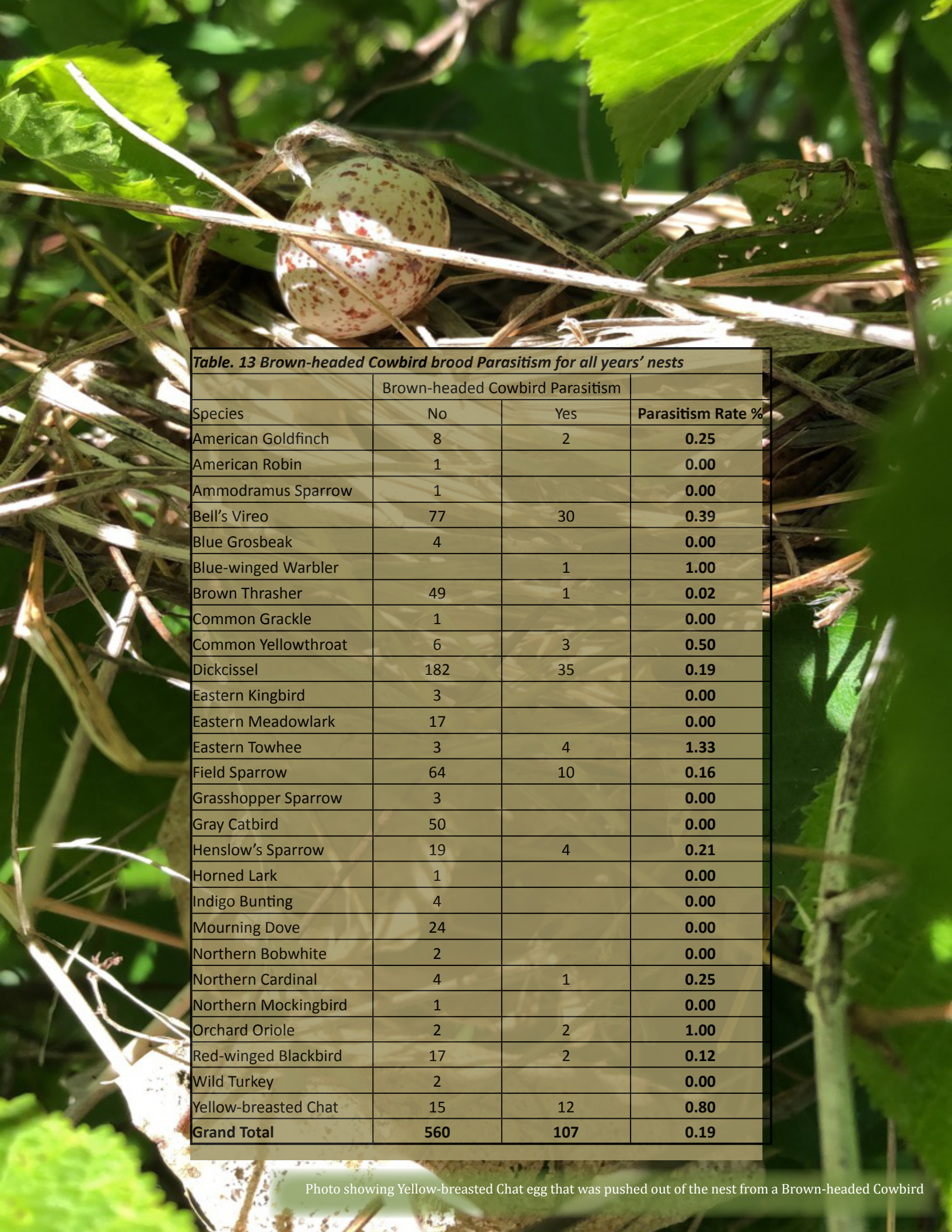

Table. 13 Brown-headed Cowbird brood Parasitism for all years' nests			
	Brown-headed Cowbird Parasitism		
Species	No	Yes	**Parasitism Rate %**
American Goldfinch	8	2	**0.25**
American Robin	1		**0.00**
Ammodramus Sparrow	1		**0.00**
Bell's Vireo	77	30	**0.39**
Blue Grosbeak	4		**0.00**
Blue-winged Warbler		1	**1.00**
Brown Thrasher	49	1	**0.02**
Common Grackle	1		**0.00**
Common Yellowthroat	6	3	**0.50**
Dickcissel	182	35	**0.19**
Eastern Kingbird	3		**0.00**
Eastern Meadowlark	17		**0.00**
Eastern Towhee	3	4	**1.33**
Field Sparrow	64	10	**0.16**
Grasshopper Sparrow	3		**0.00**
Gray Catbird	50		**0.00**
Henslow's Sparrow	19	4	**0.21**
Horned Lark	1		**0.00**
Indigo Bunting	4		**0.00**
Mourning Dove	24		**0.00**
Northern Bobwhite	2		**0.00**
Northern Cardinal	4	1	**0.25**
Northern Mockingbird	1		**0.00**
Orchard Oriole	2	2	**1.00**
Red-winged Blackbird	17	2	**0.12**
Wild Turkey	2		**0.00**
Yellow-breasted Chat	15	12	**0.80**
Grand Total	**560**	**107**	**0.19**

Photo showing Yellow-breasted Chat egg that was pushed out of the nest from a Brown-headed Cowbird

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Photo credits
Bell's Vireo - page 3 by Dr. David Rintoul
All other photos taken by MRBO field staff.
Background this page: Bell's Vireo nest
Back cover: Dickcissel fledgling