



# Results of Breeding Bird Surveys in Southeast Missouri Bottomland Hardwood Forests 2015-2017

Report to the Missouri Department of Conservation







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# Project Summary

- » The Missouri River Bird Observatory (MRBO) entered into an agreement with the MDC's Wildlife Division to conduct 85 single-visit point-counts at seven Conservation Areas in the Missouri Bootheel in 2015. MRBO was able to complete the 2015 work and use remaining funds to conduct 53 point counts at three additional sites in 2016 and 28 point counts at five additional sites in 2017. Data collection followed Lower Mississippi Valley Joint Venture (LJVJV) protocol.
- » A total of 3,090 bird detections were documented across all study sites. Of these, 2,877 were collected during the official survey period while on point counts, including 988 priority species detections.
- » Several priority species were detected in relatively high numbers, including Acadian Flycatcher ( $n = 321$ ), Yellow-billed Cuckoo ( $n = 157$ ), Prothonotary Warbler ( $n = 170$ ) and Eastern Wood-Pewee ( $n = 167$ ).
- » Occupancy (i.e., percentage of point-count plots occupied) and relative abundance (i.e., mean number of detections per point) are presented for priority species at all sites.
- » Density calculations were performed for the priority species for which sample sizes were large enough and for the priority species as a guild at the Conservation Area (CA) level and Control vs. Treatment stand level. Where sample size allowed, densities were also calculated for species in the context of Treatment Type (i.e., Harvest vs. TSI), time since treatment, and LMVJV stand characteristic categories (e.g., canopy cover).
- » Overall, few significant differences were found in bird occupancy or density between treatment and control stands, between treatment types, and within stand characteristics. While in some cases this may be an artifact of sample size, there were only a few species for which significant differences in density occurred. Yellow-billed Cuckoo had a significantly higher density in Control stands while Acadian Flycatcher and Eastern Wood-Pewee had significantly higher densities in Treatment stands. Within the Treatment classification, both of these species had higher densities in the TSI category than Harvest. The priority species guild showed very similar rates of occupancy, relative abundance and density across all variables.
- » As appendices to this report, all survey data are provided to the MDC in an itemized Excel workbook as well as in an ArcGIS Online spatially-explicit format.

## Introduction

The bottomland hardwood forests of the Mississippi Alluvial Valley (MAV) have undergone a loss of more than 80% over the past 150 years. Most losses occurred within the 20<sup>th</sup> century and were driven by a variety of human land-use factors including conversion to agriculture and urban development (Guilfoyle 2001). Bottomland hardwood forest-dependent bird species have undergone associated steep declines. Two, the Ivory-billed Woodpecker and the Bachman's Warbler, became extinct in the 20<sup>th</sup> century. Other formerly widespread bottomland dwellers such as Swainson's Warbler and Swallow-tailed Kite have been largely or entirely extirpated from Missouri's bottomland hardwood forests. Some species (e.g. Eastern Wood-Pewee) with distributions that include the northern or eastern U.S. also inhabit other forest types, such as upland, high-elevation and/or mixed coniferous-deciduous forests. In many cases, however, those habitat types have also been largely converted and the conservation of the MAV bottomland hardwood forest provides an important contribution to the persistence of many species.

To restore and improve the remaining bottomland forest habitat in Missouri's Bootheel, the Missouri Department of Conservation (MDC) Forestry Division has adopted the forest management protocol of the Lower Mississippi Valley Joint Venture (LMVJV). This protocol specifies stand management activities that result in a wide variety of canopy stratification, understory condition, and other microhabitat characteristics that provide habitat for the full suite of bottomland hardwood forest birds. Recent implementation of these practices has created a more heterogeneous forest habitat in several Conservation Areas (CAs) in the Bootheel.

In order to assess the preliminary response by breeding forest birds to management, the MDC contracted the Missouri River Bird Observatory (MRBO) to conduct point-count surveys in 2015; funding allowed for further surveys in 2016 and 2017. Similar to the aforementioned forest management practices, point counts were conducted using LMVJV monitoring protocol. This protocol involves documenting all species detected by sight and sound while focusing on a suite of priority species scored by their conservation concern status and habitat specificity (Table 1). The LMVJV protocol is designed to test bird response to stand improvement activities and provide guidance for adaptive management over time.



# Methods

Study areas (Figure 1) were selected by MDC Natural Areas Coordinator Mike Leahy along with regional MDC and US Fish and Wildlife Service Foresters. Mr. Leahy generated a series of random points within each selected forest stand following LMVJV design protocol (Wilson and Twedt 2007). Foresters Mark Pelton and Ross Glenn and their teams performed habitat assessments in visible plots surrounding each bird survey point following LMVJV habitat assessment protocol, using data sheets provided in the Wilson and Twedt (2007) monitoring guidelines.

Breeding bird survey methodology also followed LMVJV protocol (Wilson and Twedt 2007), with the modification of entering survey data directly into ArcGIS Collector on iPads in place of using LMVJV data sheets. Using this application, each bird detection was placed directly on an overlay of aerial imagery and the point-count boundaries. Drop-down menus allowed observers to indicate detection type (e.g., visual or song) and detections were given a unique timestamp. Spatial locations of each bird and associated time, distance, and detection-type data were directly uploaded to ArcGIS after each survey.

Point count surveys were conducted by trained observers during the period of May 22 – June 12, 2015, May 23 – May 30, 2016 and June 3 – June 15, 2017. All surveys were conducted between 0530h and 0930h, and on mornings with no precipitation and wind <8 mph. Based on point location within stands and ease of traversing the understory, surveyors were able to complete between two and six points each morning. Birds were mapped upon a surveyor’s approach to a point in addition to the official point-count timeframe.

Bird data collected within the point-count timeframe were imported into Program Distance (Buckland et al. 2001) along with forest habitat data received from Mr. Pelton and Mr. Glenn. Most habitat assessment data were simple categorical variables with four potential classes (e.g., vine density with categories none, sparse, moderate or thick). We generated mean diameter at breast height (DBH) values based on the provided stand data along with Shannon-Weiner Diversity Indices for tree genera within each plot (Gilliam et al. 1995). Mean DBH and Diversity Indices were then also binned into four categories (in ascending DBH and diversity) to remain consistent with other stand data. Stands were designated as Control if no management activities had occurred there for >15 years, and Treatment if harvest or timber stand improvement (TSI) had taken place within the past 15 years. Data compilation and Distance analyses focused on the suite of LMVJV priority species (Table 1).

Table 1. Lower Mississippi Valley Joint Venture priority bird species and their relative rank. <sup>1</sup>Summary of basic habitat preference reported in Birds of North America species accounts. [bna.birds.cornell.edu](http://bna.birds.cornell.edu)

Priority Species	LMVJV Score	Breeding Habitat Preference <sup>1</sup>
Prothonotary Warbler	20	flooded bottomland hardwood
Swainson’s Warbler	20	various forest types with dense, non-herbaceous understory
Cerulean Warbler	19	riparian bottomlands or upper mesic slopes and dry mountain ridgetops
Swallow-tailed Kite	18	various forest types with easily-accessible canopy trees
Mississippi Kite	18	mixed-species riparian woodland with nearby open area
Orchard Oriole	18	open, park-like woodlands, especially on riparian borders
Northern Parula	16	upper canopy of deciduous forests
Wood Thrush	16	under- and mid-story of deciduous and mixed forests, typically upland mesic
Yellow-billed Cuckoo	15	dense thickets along streams and marshes; open woodland with dense understory
White-eyed Vireo	15	secondary deciduous scrub, pasture and woodland margins in late succession
Yellow-breasted Chat	15	thickets, often in prairie
Kentucky Warbler	15	bottomland forest and riparian edges with dense understory
Eastern Wood-Pewee	14	various woodland communities; associated with riparian areas and high stem-density woodlands
Acadian Flycatcher	14	undisturbed mature mesic and lowland forest; most abundant in large tracts
Yellow-throated Warbler	14	variety of forest types, including bottomland deciduous and cypress swamp
Hooded Warbler	13	mature forest with significant gaps that facilitate a shrub understory

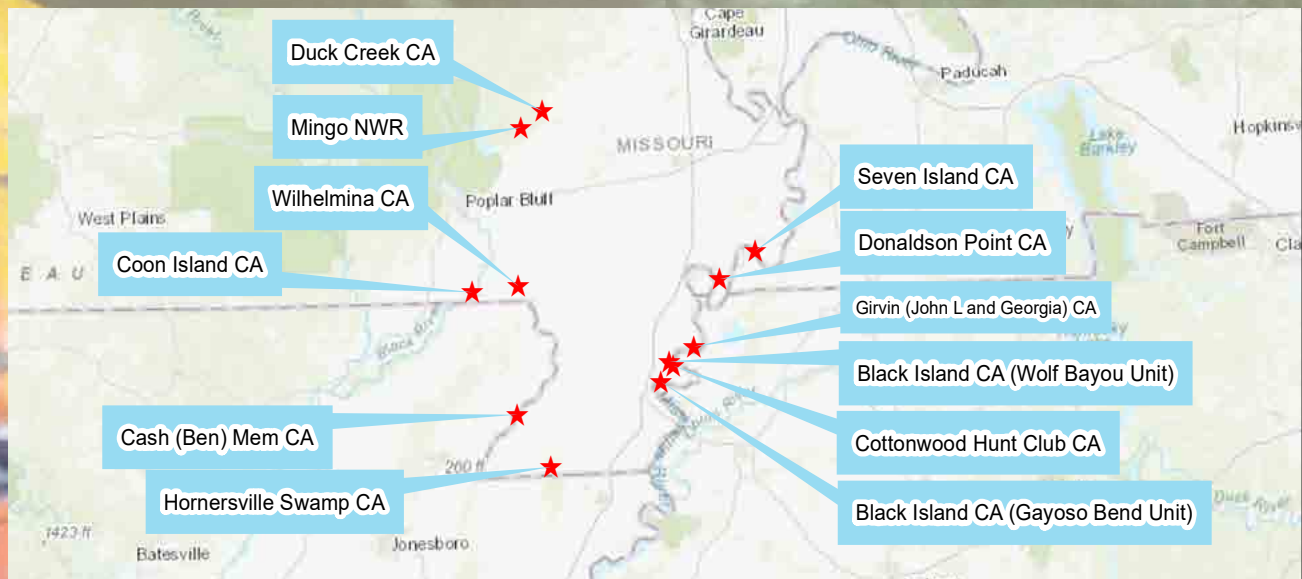


Figure 1. Southeastern Missouri sites at which breeding bird point-count surveys were conducted 2015-2017.



# Study Design

Table 2. Locations and characteristics of 166 bottomland forest bird survey points, 2015-2017.

Sample Year	Site	Treatment Points	Control Points	Total Points
2015	Black Island (Meredith Tract)	1	1	2
	Black Island (Wolf Bayou)	0	3	3
	Coon Island	11	9	20
	Donaldson Point	0	20	20
	Duck Creek	9	11	20
	Hornersville Swamp	0	10	10
	Wilhelmina	0	10	10
<b>2015 Total Points</b>		<b>21</b>	<b>64</b>	<b>85</b>
2016	Cottonwood	0	14	14
	Black Island (Gayoso)	0	3	3
	Mingo	19	17	36
<b>2016 Total Points</b>		<b>19</b>	<b>34</b>	<b>53</b>
2017	Girvin	0	3	3
	Donaldson Point	2	3	5
	Seven Island	0	5	5
	Hornersville Swamp	2	3	5
	Ben Cash	0	10	10
<b>2017 Total Points</b>		<b>4</b>	<b>24</b>	<b>28</b>
<b>Total Points 2015-2017</b>		<b>44</b>	<b>122</b>	<b>166</b>

Table 3. Amount of bird survey points that fell within the various categories of forest stand data collected using LMJVJ protocol.

Category	Time Since Treatment				Treatment Type			DBH Class				Diversity Class			
	1 yr	2-5 yrs	5.1-10 yr	10.1-15 yr	Harvest	TSI	1	2	3	4	1	2	3	4	
# points	10	26	1	7	14	30	45	42	38	41	31	59	64	12	

Category	Vines				Cane				Overstory				Midstory				Understory			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
# points	62	68	19	17	146	8	4	8	2	20	87	57	1	21	122	22	5	91	63	7

## Results

Of 168 survey points generated for this study from 2015-2017, MRBO surveyors were able to access 166 (two points at Girvin Conservation Area were inaccessible due to water levels in 2017). Across all study sites, 2,877 birds were documented during point counts including 988 individuals of priority species. Of the 16 species included on the LMJVJ priority list, we documented 12 (Table 4); all priority species except Yellow-breasted Chat, Orchard Oriole, Cerulean Warbler and Swallow-tailed Kite were represented.



Several species were detected in high numbers, including Acadian Flycatcher, Eastern Wood-Pewee, Prothonotary Warbler and Yellow-billed Cuckoo. These species were detected on every Conservation Area and within Mingo National Wildlife Refuge (Tables 4 and 5). Other priority species occurred but in lower numbers, such as Kentucky Warbler, Yellow-throated Warbler, White-eyed Vireo, and Northern Parula. In a few cases, only one individual was documented during the point-count survey but others were detected upon approaching the survey point or while traversing between points. This is the case with Swainson's Warbler and Mississippi Kite.

In the following pages, data are presented on priority species' occupancy (Table 5) and relative abundance (Figure 2) in plots as well as density estimates for each study site, for habitat covariates and within treatment vs. control stands (Tables 6-8; Figure 3). Priority species that were documented in small numbers are still included in the priority species guild dataset wherever appropriate in further data analysis and presentation.

Table 4. Total on-point detections of Lower Mississippi Valley Joint Venture priority species on 2015-2017 point counts. Species are listed in descending order of their LMJVJ conservation score.

<i>Priority Species</i>	2015	2016	2017	Total
Prothonotary Warbler	77	53	40	170
Swainson's Warbler	1	0	0	1
Cerulean Warbler	0	0	0	0
Swallow-tailed Kite	0	0	0	0
Mississippi Kite	1	0	0	1
Orchard Oriole	0	0	0	0
Northern Parula	36	22	11	69
Wood Thrush	12	2	3	17
Yellow-billed Cuckoo	99	26	32	157
White-eyed Vireo	23	3	9	35
Yellow-breasted Chat	0	0	0	0
Kentucky Warbler	24	9	2	35
Eastern Wood-Pewee	83	68	16	167
Acadian Flycatcher	169	107	45	321
Yellow-throated Warbler	7	4	1	12
Hooded Warbler	1	2	0	3
Total	533	296	159	988

## Occupancy and Relative Abundance on Point-Count Plots

Table 5. Percentage of plots (point-count circles) occupied by priority species in each Conservation Area study site. Species are listed in descending order of their LMJVJ conservation score.

Site/Year	Ben Cash	Black Island - Gayoso	Black Island - Meredith	Black Island - Wolf Bayou	Coon Island	Cottonwood	Donaldson Point	Duck Creek	Girvin	Hornersville	Mingo	Seven Island	Wilhelmina
Priority Species	2017	2016	2015	2015	2015	2016	2015/2017	2015	2017	2015/2017	2016	2017	2015
Prothonotary Warbler	90%	100%	0%	33%	65%	43%	36%	45%	33%	80%	53%	40%	80%
Swainson's Warbler	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%
Mississippi Kite	0%	0%	0%	0%	0%	0%	4%	0%	0%	0%	0%	0%	0%
Northern Parula	10%	33%	0%	33%	10%	14%	40%	45%	33%	33%	39%	80%	30%
Wood Thrush	0%	0%	100%	0%	15%	0%	12%	0%	0%	0%	3%	0%	0%
Yellow-billed Cuckoo	80%	100%	50%	100%	60%	79%	64%	75%	67%	80%	17%	80%	100%
White-eyed Vireo	0%	0%	0%	0%	10%	7%	52%	10%	0%	20%	3%	40%	10%
Kentucky Warbler	10%	0%	0%	67%	25%	14%	24%	25%	0%	0%	8%	0%	10%
Eastern Wood-Pewee	60%	0%	0%	100%	80%	36%	32%	95%	33%	60%	92%	20%	40%
Acadian Flycatcher	80%	100%	50%	67%	90%	21%	72%	100%	100%	100%	94%	80%	100%
Yellow-throated Warbler	10%	0%	50%	33%	5%	0%	4%	0%	0%	20%	11%	0%	0%
Hooded Warbler	0%	0%	0%	0%	0%	7%	4%	0%	0%	0%	3%	0%	0%

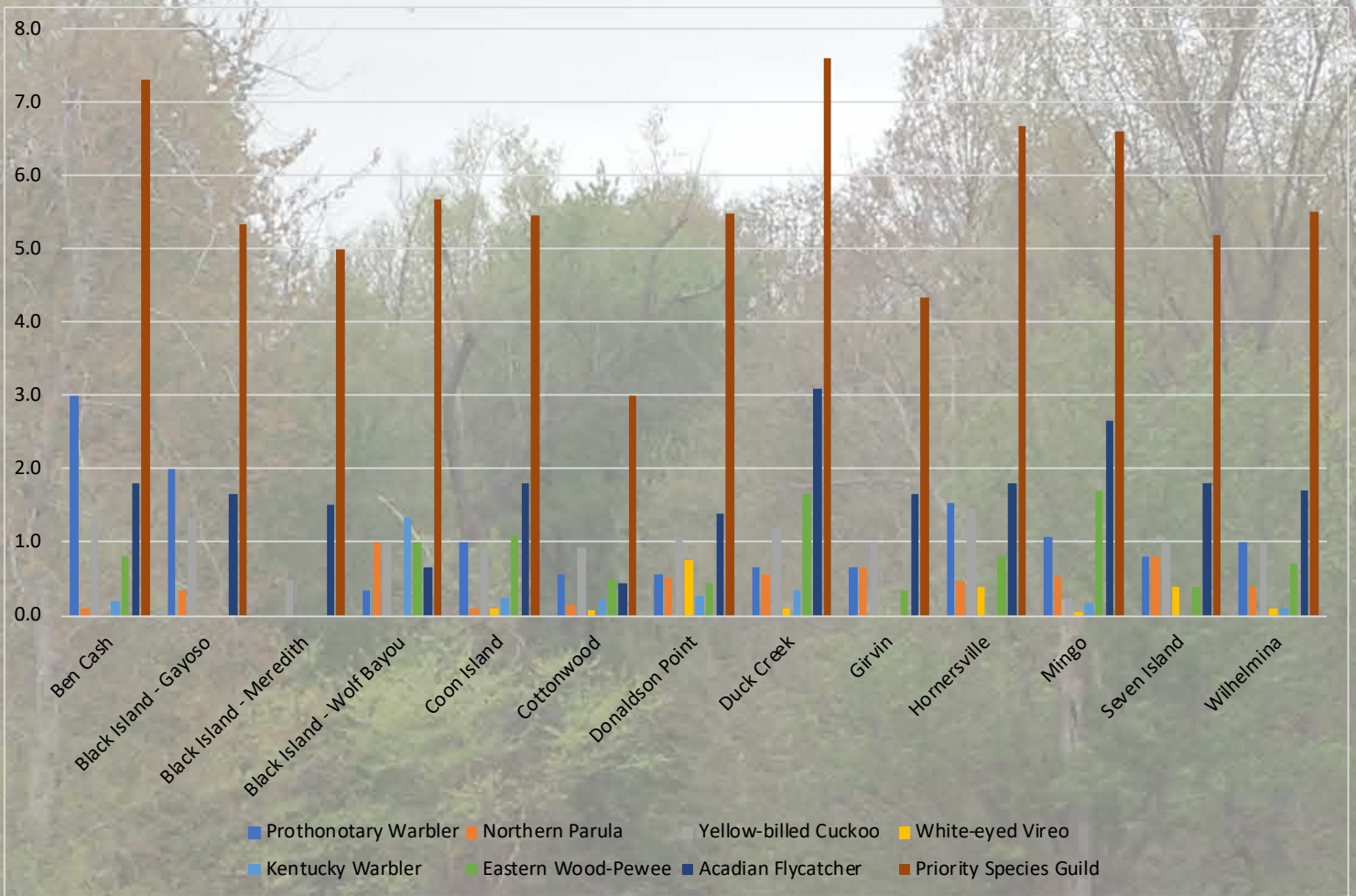


Figure 2. Mean number of detections per point on all study areas for the priority species guild as a whole and for individual species where total detections were >30 across all study areas.

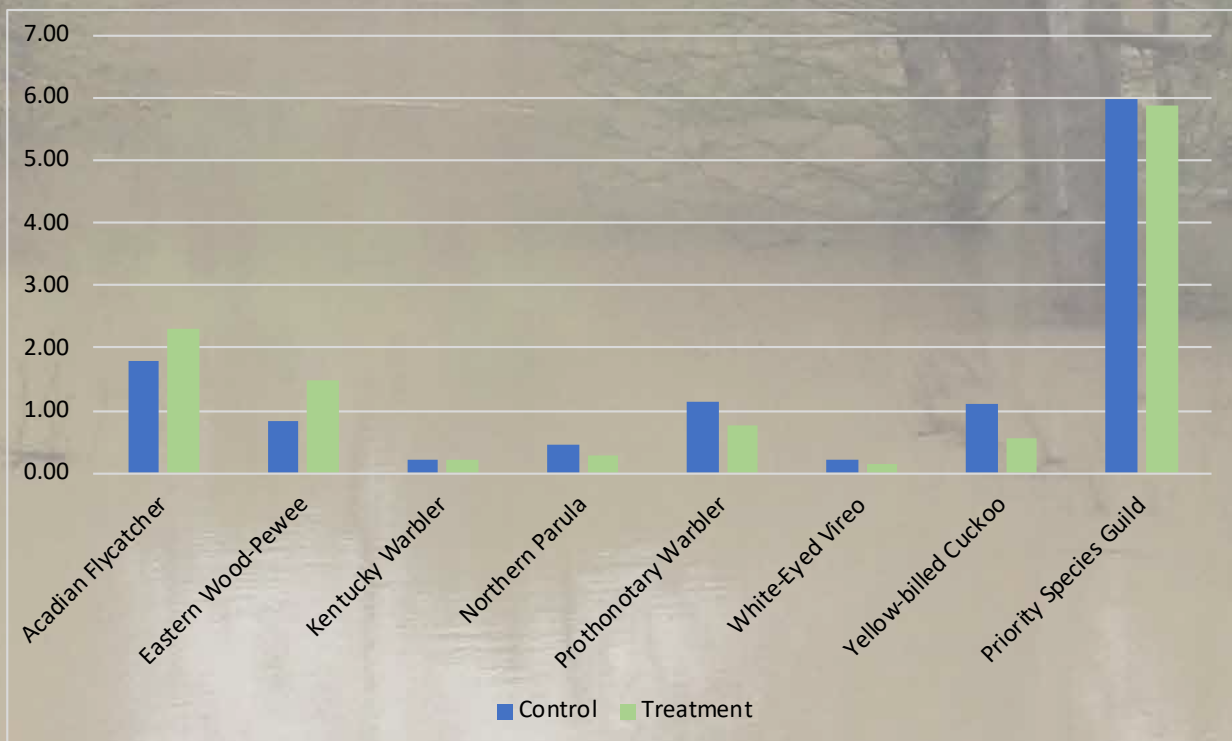


Figure 3. Mean number of detections per point in Control and Treatment categories for the priority species guild as a whole and for individual species where total detections were >30 across all study areas.



# Priority Species Density: Conservation Areas and Treatments

Table 6. Density (D; birds/acre) of all species, the priority species guild, and individual priority species within all study sites. Raw number of detections (*italicized* within species results) reported where number of detections is <10 within the stand type and density calculations were not performed.

	Ben Cash	Black Island - Gayoso	Black Island - Meredith	Black Island - Wolf Bayou	Coon Island	Cottonwood	Donaldson Point	Duck Creek	Girvin	Hornersville	Mingo	Seven Island	Wilhelmina
All Species	4.85	3.82	2.93	4.88	4.37	3.12	3.75	5.89	4.35	5.84	4.34	6.18	5.14
Priority Species Guild	2.19	1.60	1.50	1.70	1.63	0.90	1.58	2.28	1.30	2.00	2.03	1.56	1.65
Prothonotary Warbler	0.68	<i>6</i>	<i>0</i>	<i>1</i>	0.23	8	0.12	0.15	2	0.35	<i>0.24</i>	4	0.22
Swainson's Warbler	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
Mississippi Kite	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>
Northern Parula	<i>1</i>	<i>1</i>	<i>0</i>	3	2	2	0.09	0.1	2	7	0.09	4	4
Wood Thrush	<i>0</i>	<i>0</i>	5	<i>0</i>	3	<i>1</i>	7	<i>0</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>0</i>	<i>0</i>
Yellow-billed Cuckoo	0.20	<i>4</i>	<i>1</i>	3	0.14	0.14	0.16	0.18	3	0.22	9	5	0.23
White-eyed Vireo	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	2	<i>1</i>	0.41	2	<i>0</i>	6	2	2	<i>1</i>
Kentucky Warbler	2	<i>0</i>	<i>0</i>	4	5	3	7	7	<i>0</i>	<i>0</i>	6	<i>0</i>	<i>1</i>
Eastern Wood-Pewee	8	<i>0</i>	<i>0</i>	3	0.18	7	0.07	0.27	<i>1</i>	0.13	0.27	2	7
Acadian Flycatcher	0.88	5	3	2	0.88	6	0.66	1.52	5	0.88	1.31	9	0.84
Yellow-throated Warbler	<i>1</i>	<i>0</i>	<i>1</i>	<i>1</i>	<i>1</i>	<i>0</i>	<i>1</i>	<i>0</i>	<i>0</i>	3	4	<i>0</i>	<i>0</i>
Hooded Warbler	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>0</i>	<i>0</i>

Table 7. Density (D; birds/acre) of priority species within Control and Treatment stands, within treatment types and within time since treatment categories. Raw number of detections (*italicized* within species results) reported where number of detections is <10 within the stand type and density calculations were not performed.

	Treatment Type				Time Since Treatment			
	Control	Treatment	Harvest	TSI	1 yr	2-5 yrs	5.1-10 yr	10.1-15 yr
All Species	4.60	4.55	4.55	4.54	3.11	4.56	4.26	5.13
Priority Species Guild	1.78	1.78	1.48	1.93*	9	1.82	9	1.88
Prothonotary Warbler	0.25	0.17	8	0.19	<i>1</i>	0.18	<i>1</i>	4
Northern Parula	0.08	0.05	3	0.06	<i>0</i>	0.06	<i>1</i>	<i>1</i>
Yellow-billed Cuckoo	0.16*	0.08	0.12	0.06	2	0.06	2	6
White-eyed Vireo	0.13	7	5	2	<i>0</i>	<i>1</i>	<i>0</i>	6
Eastern Wood-Pewee	0.13	0.24*	0.16	0.28*	2	0.25	1	11
Acadian Flycatcher	0.88	1.13*	0.74	1.31*	3	1.21	4	3

\*significantly higher density,  $p = 0.05$

# Priority Species Density: Forest Characteristics

Table 8. Density (D; birds/acre) of priority species within vegetation-variable categories collected as part of forest plot data. Vine, Over-, Mid- and Understory categories are expressed as 1 = None, 2 = Sparse (<25% cover), 3 = Moderate (25-50%), 4 = Heavy (>50%). Results for cane are not presented here as sample sizes outside the "1" category were too small for robust analyses.

Tree diversity classes expressed as 1 = Shannon-Weiner value <0.5, 2 = 0.51-1.0, 3 = 1.01 - 1.5, 4 = >1.5. DBH classes expressed as 1 = mean dbh <14 cm, 2 = 14-17 cm, 3 = 17-20 cm, 4 = >20 cm.

Raw number of detections (*italicized* within bird data) reported where number of detections is <10 within a category and density calculations were not performed. Priority species with <10 observations in all categories are excluded from these tables.



	Vines				Overstory				Mid-Story				Understory			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
All Species	4.68	4.94	4.10	3.39	3.46	4.14	4.60	4.77	4.26	5.02	4.53	4.52	5.01	4.61	4.65	3.35
Priority Species Guild	1.98	1.82	1.66	1.08	1.65	1.50	1.69	2.04	<i>6</i>	1.66	1.80	1.82	1.56	1.80	1.87	0.94
Prothonotary Warbler	0.22	0.28	0.16	<i>9</i>	<i>1</i>	<i>7</i>	0.21	0.32	<i>1</i>	0.17	0.25	0.19	<i>5</i>	0.24	0.23	<i>1</i>
Northern Parula	0.08	0.06	0.09	<i>6</i>	<i>0</i>	0.13	0.06	0.07	<i>0</i>	<i>9</i>	0.07	<i>9</i>	<i>1</i>	0.08	0.07	<i>2</i>
Yellow-billed Cuckoo	0.13	0.15	0.18	0.13	<i>2</i>	0.14	0.15	0.13	<i>1</i>	0.14	0.14	0.16	<i>8</i>	0.13	0.16	<i>4</i>
White-eyed Vireo	<i>4</i>	0.15	0.28	<i>3</i>	<i>1</i>	<i>7</i>	0.12	<i>8</i>	<i>1</i>	<i>3</i>	0.11	<i>6</i>	<i>1</i>	0.11	0.13	<i>2</i>
Eastern Wood-Pewee	0.23	0.15	<i>7</i>	<i>9</i>	<i>0</i>	0.12	0.16	0.18	<i>0</i>	0.17	0.17	0.13	<i>3</i>	0.17	0.17	<i>2</i>
Acadian Flycatcher	1.17	0.97	0.78	<i>7</i>	<i>0</i>	0.66	0.84	1.24	<i>0</i>	0.96	0.93	1.03	<i>5</i>	1.04	0.90	<i>6</i>

	Tree Diversity				DBH Class			
	1	2	3	4	1	2	3	4
All Species	4.28	4.65	4.69	4.62	4.25	4.80	4.73	4.60
Priority Species Guild	1.62	1.96	1.73	1.61	1.47	1.98	2.01	1.71
Prothonotary Warbler	0.16	0.27	0.23	0.22	0.16	0.30	0.25	0.21
Northern Parula	<i>7</i>	0.09	0.08	<i>3</i>	0.05	0.06	0.11	0.08
Yellow-billed Cuckoo	0.17	0.14	0.12	0.16	0.17	0.14	0.14	0.11
White-eyed Vireo	<i>4</i>	0.13	0.13	<i>3</i>	<i>7</i>	<i>7</i>	0.14	0.15
Eastern Wood-Pewee	0.17	0.16	0.17	<i>6</i>	0.13	0.19	0.17	0.17
Acadian Flycatcher	0.73	1.12	0.89	0.89	0.69	1.03	1.12	0.97



# Spatially-explicit Data Available in ArcGIS Online

All spatially-explicit data from bottomland forest bird surveys conducted by MRBO are available at [mrbo.maps.arcgis.com](http://mrbo.maps.arcgis.com) in the “Bottomland Forest Bird Data” Group. Data are formatted for analysis in Program Distance and/or other statistical programs. Further instructions with example decision support tools as well as extensive feature service details are available. To request additional access, contact [ethan.duke@mrbo.org](mailto:ethan.duke@mrbo.org).

**Bottomland Forest Bird Data** Overview

Edit Thumbnail

**Bottomland Bird Data**  
This group houses bottomland forest bird data, and study design. See description for additional products that are available.  
owned by [ethanduke](#)

Description

Additionally, select species profiles with heatmaps are available as templates. These maps can be recreated for any species across survey years using the "All Bottomland Bird Detections" and "Bottomland Forest Study Design 2015-2017" feature services in this group. For permissions and questions please contact MRBO.

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All Bottomland Bird Detections 2015-2018	ethanduke	Jan 18, 2019	Jan 18, 2019	1
Prothonotary Warbler	ethanduke	Nov 17, 2015	Jun 27, 2016	97
Bottomland Forest Kentucky Warbler	ethanduke	Nov 17, 2015	Jun 27, 2016	97
Bottomland Forest Acadian Flycatcher	ethanduke	Nov 17, 2015	Jun 27, 2016	146
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Overview of all Birds	ethanduke	Nov 17, 2015	Jun 27, 2016	87

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Figure 4. A screenshot of the “Bottomland Forest Bird Data” Group. Feature services, maps, and example web apps are available within this group.



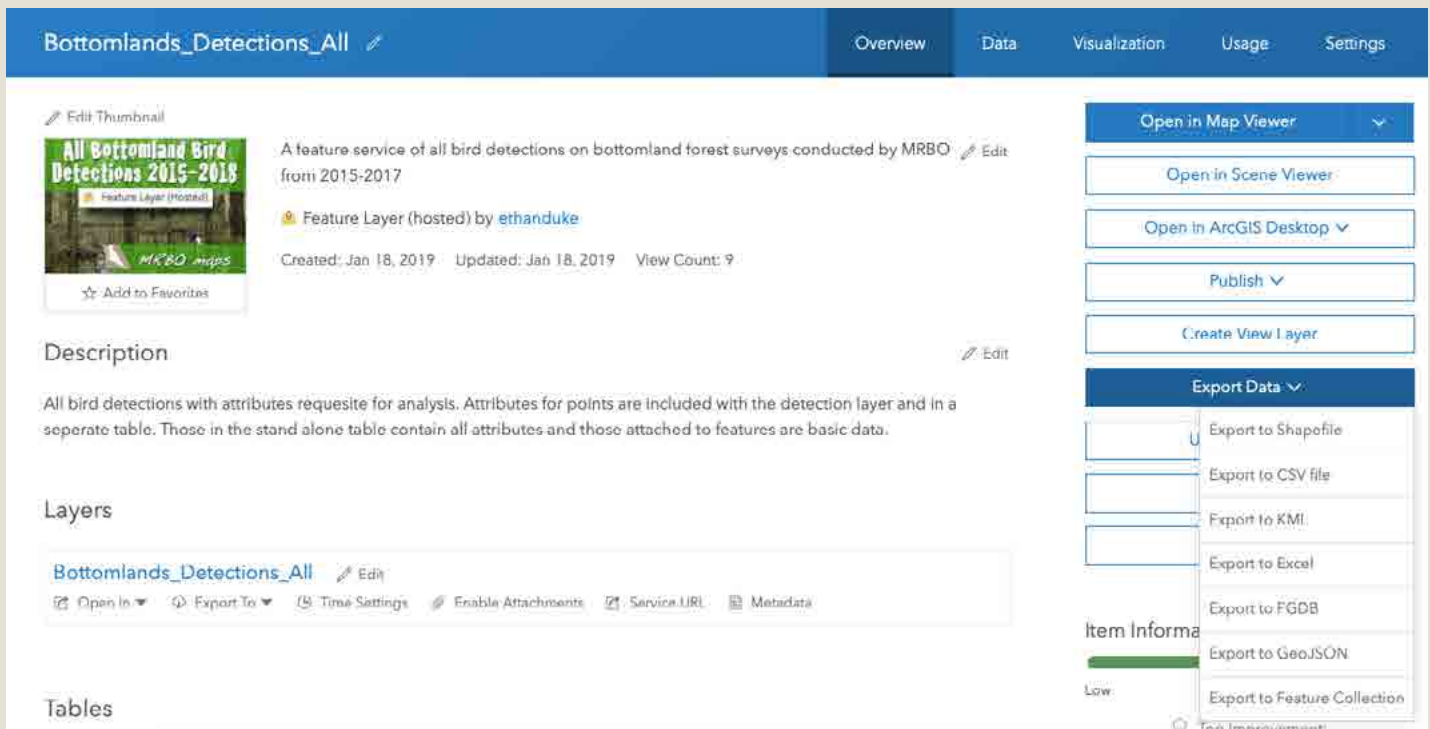


Figure 5. A screenshot of the “Bottomlands\_Detections\_All” feature service which contains all spatially-explicit bird detections with attributes for analysis. These data can be downloaded in a variety of formats and/or added to any maps and web apps.

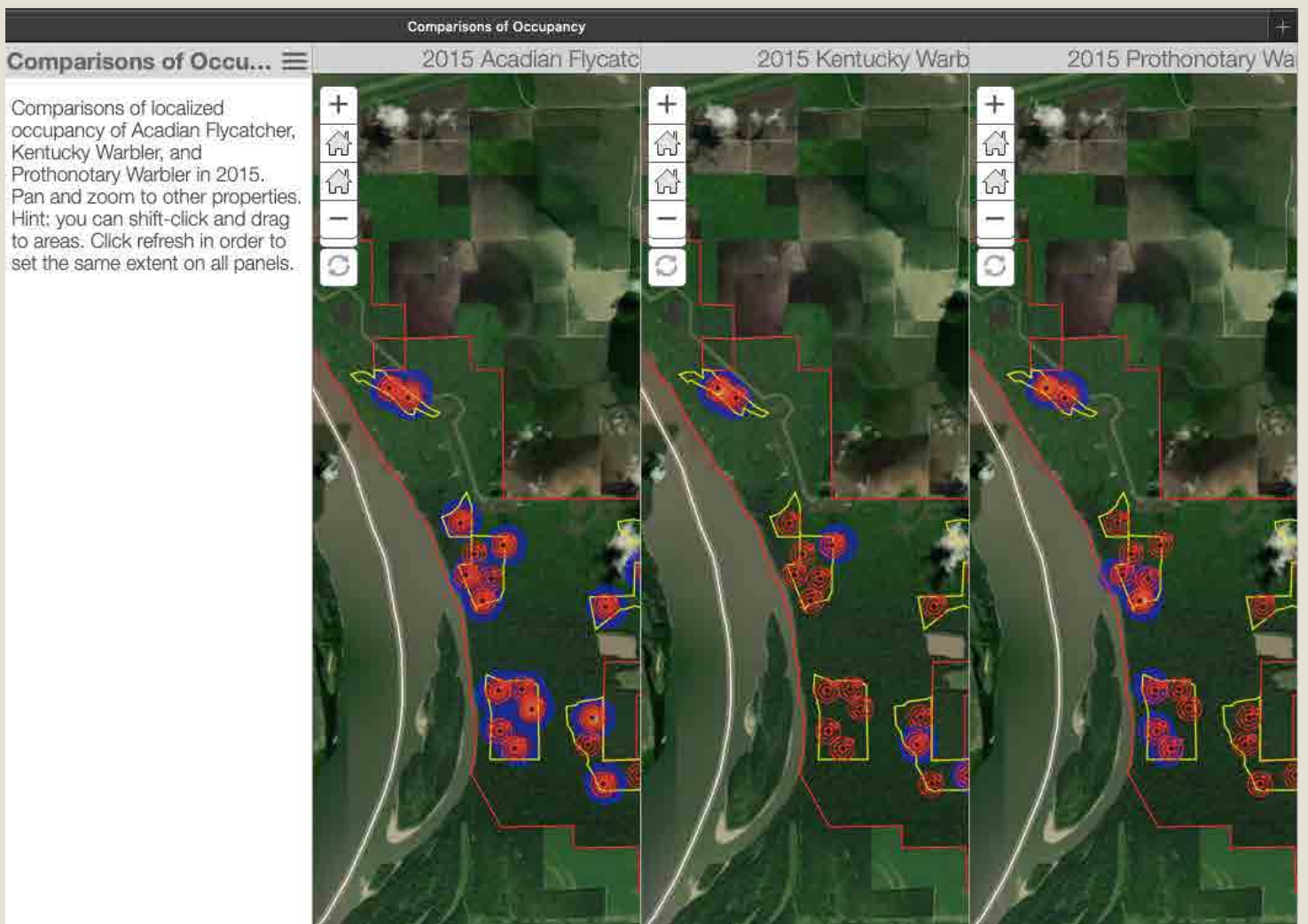


Figure 6. A screenshot showing just one example of a web app illustrating detection heatmaps of three different species. Many iterations of this app can be made to illustrate species distribution across years on all sites surveyed.



# Discussion

Few statistically significant patterns emerged in terms of priority species preference for particular stands, control or treatment status, or vegetative characteristics as measured by LMVJV protocol. Notable exceptions to this include higher densities of Acadian Flycatcher and Eastern Wood-Pewee in treatment stands, and within the TSI category as compared to harvest. Yellow-billed Cuckoo diverged from this pattern by having a significantly higher density in control stands. The priority species guild as a whole displayed a higher density in TSI stands, though the guild's density was identical in control and treatment stands.

We note that the three aforementioned species had the highest sample sizes of all species. This suggests that trends do exist in priority species' preference for certain stand types but larger sample sizes are required to identify significant differences. When all data from 2015-2017 are combined, we had far more points located in control ( $n = 122$  points) than in treatment stands ( $n = 44$  points). There were also far more points in the 2-5 years since treatment category ( $n = 26$  points) than in the <1 yr ( $n = 10$  points), 5.1-10 yr ( $n = 1$  point) and 10.1-15 yr ( $n = 7$  points). Though almost 1,000 detections of priority species were compiled across the suite of study sites, once data were parsed out by stand, vegetation categories, or treatment, for most species  $n$  was low enough for most categorical variables that elucidating meaningful trends was only possible for a few species. Spatial data as presented on the previous two pages may be of greater use to Missouri Department of Conservation staff for examining "hotspots" of priority species occurrence and, within this context, gauging local-scale management success.

For priority species for which few or no individuals were documented, in most cases this is not surprising. Swallow-tailed Kite, for example, historically occurred in Missouri but the species' current distribution does not include this state (BNA No. 138). Yellow-breasted Chat is relatively common in some areas of Missouri but is generally associated with successional shrub encroachment on prairies as well as shrubby upland forest edges (Ripper et al. 2014). Orchard Oriole tends to be more of a savanna species, inhabiting groves within or adjacent to pasture and other upland habitat, often near riparian areas and draws. Finally, while Mississippi Kite populations are higher in the Bootheel forests than anywhere else in Missouri, this species is not well-documented by single point-counts (BNA No. 402).

The relatively low numbers of Kentucky Warbler, White-eyed Vireo and Hooded Warbler may not be surprising based on their habitat affinity and study site composition. White-eyed Vireo is more of a successional-shrub and woodland edge species, a habitat not well represented in our point-count sample. Kentucky Warbler requires a dense understory for nesting and foraging, and regular seasonal flooding at most study sites may have reduced the understory on most plots to a level unacceptable to this species. The Hooded Warbler has similar habitat preferences to the Kentucky, and requires a shrub understory for nesting. Continued application of LMVJV forest management guidelines that create canopy gaps and a shifting mosaic of shrub understory may facilitate increased nesting by Kentucky and Hooded Warbler in the future. Based on these species' current distribution and population levels (BNA Nos. 324, 110), it is likely that Kentucky Warbler will remain the more common of the two.

Of particular concern is the low number of Swainson's Warbler. Swainson's Warbler populations in Missouri were probably not high historically, but current forest management practices have the potential to sustain a stable population in the Bootheel. This species occurs in areas where flooding is less frequent, maintaining the dense thicket and/or cane understory selected for nesting (BNA No. 126). This makes areas such as Donaldson Point CA, with its less-frequent and shorter-duration flood cycles, more potentially suitable for Swainson's Warbler than regularly flooded areas like Hornersville Swamp. The presence of cane thickets in many areas where Swainson's Warbler is absent may indicate inadequate dispersal corridors between areas (e.g., individuals do not disperse from Donaldson Point to Coon Island).

Relatively high numbers of Acadian Flycatcher, Eastern Wood-Pewee, and Yellow-billed Cuckoo throughout the study sites suggests that high-quality bottomland forest habitat is being provided for the more generalist bottomland species. Further LMVJV-directed forest management targeted towards more selective species will improve habitat conditions for specialists while maintaining good generalist habitat. Finally, we suggest that the relatively high numbers of Prothonotary Warbler, a high-ranking priority species, at many sites is indicative of high-quality habitat coupled with ideal hydrological conditions and, presumably, ample cavity nest sites.

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