



MISSOURI RIVER
BIRD OBSERVATORY

Results of Breeding Bird Surveys
in Southeast Missouri Bottomland Hardwood Forests
Report to the Missouri Department of Conservation
2015



2015 Project Summary



Project Coordinators
Dana Ripper
Ethan Duke

With assistance from:
Veronica Mecko
MRBO Staff Member

Kristina Mitchell
Independent Contractor

- » Despite severe flooding at some study sites during most of the breeding season, MRBO surveyors were able to complete counts at all 85 points on days of ideal conditions.
- » A total of 1,572 bird detections were logged across all study sites, including 533 detections of Lower Mississippi Valley Joint Venture priority species.
- » Several priority species were detected in relatively high numbers, including Acadian Flycatcher ($n = 169$), Yellow-billed Cuckoo ($n = 99$), Prothonotary Warbler ($n = 77$) and Eastern Wood-Pewee ($n = 83$).
- » Density calculations were possible for the aforementioned species and the priority species guild at the Conservation Area (CA) level. In a few cases, estimates were possible at the stand level.
- » Occupancy and relative abundance are presented for all priority species at all sites.
- » 2015 data suggest that Acadian Flycatcher and Yellow-billed Cuckoo populations are relatively high and evenly distributed across sites. Prothonotary Warbler and Eastern Wood-Pewee were abundant at a subset of sites.
- » At this time, no significant difference was documented for priority species between control and treatment sites. When data from all species at all CAs are taken into account, there is a significantly higher (0.10 level) density of birds in general in treatment stands.

**This report is presented
in partial fulfillment of
Cooperative Agreement
#329**



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 20th 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 20th century. Other formerly common bottomland dwellers such as Cerulean 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. Similar to the forest management practices, point counts were conducted using LMVJV monitoring protocol. This protocol is designed to test bird response to stand improvement activities and provide guidance for adaptive management over time. In addition to informing management specific to the MDC in the Missouri Bootheel, survey data are also incorporated into the larger LMVJV modeling effort to contribute to regional conservation plans.

Bachman's Warbler, a former inhabitant of bottomland hardwood forests. This species was last sighted in 1988 in South Carolina.



Methods

Study areas for 2015 forest bird surveys were selected stands within Duck Creek, Donaldson Point, Black Island, Hornersville Swamp, Coon Island and Wilhelmina CAs. MDC Resource Foresters selected stands based on their status as control or recent treatment. MDC generated a series of random points within each stand. Points were at least 250m apart following LMVJV design protocol (Wilson and Twedt 2007). Depending upon size, each stand contained between one and six points. 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 the iGIS Collector application (Geometry 2013) 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 morning.

Point count surveys were conducted by trained observers during the period of May 22 – June 12, 2015. 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 marked upon a surveyor’s approach to a point in addition to the official point-count duration

The timestamp associated with each detection in the iGIS application, along with exact spatial placement of birds within distance bands, facilitated ease of Distance analysis. Bird data collected within the allotted point-count duration (as opposed to bird detections collected upon approach) were imported into Program Distance (Buckland et al. 2001). Forest habitat data received from Mr. Pelton and Mr. Glenn were also imported into Distance for analysis of covariates. Most habitat assessment data were simple categorical (e.g., vine density) or linear (e.g. number of stems) data, but dbh data (diameter of tree at 4.5 feet above ground) necessitated

a conversion in to classes as typical dbh measurements were not taken. We performed this conversion by taking the median value of each dbh class (e.g., 25 cm for the 20-30 cm class), multiplying this by the number of stems in that class, and generating a mean-median dbh for each plot. These data were then grouped into dbh categories of 1 (mean <14 cm), 2 (14-17 cm), 3 (17-20 cm) and 4 (>20 cm). Additionally, we generated Shannon-Weiner Diversity Indices for tree genera within each plot (Gilliam et al. 1995) to assess whether bird density shows significant variation between diversity classes. Resulting Shannon Weiner Diversity Indices were also grouped into ascending categories 1-4.

Data analysis focused on the suite of LMVJV priority species (Table 1). While the monitoring guidelines indicate that analysis be conducted only for species with detections >50 within each stand, this was not possible with the sample sizes obtained in 2015. For this preliminary year of analysis, we generated density estimates for species where we had >30 detections at the Conservation Area level (Table 3), and >10 detections at the individual stand or habitat category level (e.g., Tables 4a-c). While this certainly results in higher margins of error in density estimates, offset somewhat by the use of a global detection function, we wanted to provide at least rudimentary density results for the 2015 season. The sample size issue can best be addressed with additional surveys in future breeding seasons. Additionally, with submission of the Missouri data to the larger LMVJV dataset, our data can be analyzed with a broader variety of methods as conducted by the Joint Venture itself (Wilson and Twedt 2007).

Priority Species	LMVJV Score	Breeding Habitat Preference ¹
Prothonotary Warbler	20	flooded bottomland hardwood
Swainson’s Warbler	20	various forest types with dense, non-herbaceous understory ²
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 mxed 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

Table 1. Lower Mississippi Valley Joint Venture priority bird species and their relative rank.

¹*Summary of basic habitat preference reported in Birds of North America species accounts. bna.birds.cornell.edu*

²please see Appendix A for detailed information.

Results

All 85 points generated under LMJVJ study design guidelines were surveyed in 2015. This included 20 points each at Donaldson Point, Coon Island and Duck Creek CAs, 10 points at Wilhelmina CA, and five points each at Hornersville Swamp and Black Island CAs. Across the study sites, 1,572 birds were documented during point counts including 533 individuals of priority species. Of the 16 species included on the LMJVJ priority list, we documented 12 (Table 2); 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 CA. Other species occurred but in far 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, for which a total of four individuals were documented at Donaldson Point CA.

The most notable data trends included the relatively even distribution of Acadian Flycatcher and Yellow-billed Cuckoo across study areas. Acadian Flycatcher detections peaked at Duck Creek CA ($n = 62$). Though detected in far lower numbers, Kentucky Warbler was also documented across all sites with the exception of Hornersville Swamp CA. Northern Parula detections were highest at Donaldson Point ($n = 13$) and Duck Creek ($n = 11$), and Donaldson Point contained the highest number of White-eyed Vireo ($n = 17$; other sites had zero to two). While in most covariate analyses differences in density were not statistically significant, we note that the density of Prothonotary Warbler at Hornersville Swamp was significantly higher than any other CA. This species also had high relative abundance at Coon Island CA.

Few statistically significant patterns emerged in terms of priority species preference for particular stands, control or treatment status, or plot-level habitat characteristics, but we suspect that this is due to a relatively low sample size. Though more than 500 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 in each category that elucidating meaningful trends was not possible at this time.

In the following pages, data are presented for the priority species occupancy and relative abundance in plots and results for the suite of habitat covariates and stand status as control or treatment. Data are then presented for each of the six study sites where data were not pooled between areas. Priority species that were documented in small numbers (Table 2), are still included wherever appropriate in further data analysis and presentation. Where no individuals of a priority species were detected on any study site, that species was removed from further presentation in tabular and chart data (i.e., Swallow-tailed Kite, Cerulean Warbler, Orchard Oriole and Yellow-breasted Chat).

Table 3. Density (D; birds/acre) and associated Coefficient of Variance (CV) for priority species within surveyed stands at each of six Conservation Area study sites in 2015. Raw number of detections (n) reported where $n < 30$ and density calculations were not performed.

	Black Island - Wolf Bayou		Black Island - Meredith Tract		Coon Island		Donaldson Point		Duck Creek		Hornersville		Wilhelmina	
	n or D	CV	n or D	CV	n or D	CV	n or D	CV	n or D	CV	n or D	CV	n or D	CV
Prothonotary Warbler	1	-	0	-	0.19	0.29	0.12	0.37	0.12	0.33	0.38	0.19	0.19	0.25
Swainson's Warbler	0	-	0	-	0	-	1	-	0	-	0	-	0	-
Mississippi Kite	0	-	0	-	0	-	1	-	0	-	0	-	0	-
Northern Parula	3	-	0	-	2	-	0.21	0.45	0.18	0.43	3	-	4	-
Wood Thrush	0	-	5	-	3	-	4	-	0	-	0	-	0	-
Yellow-billed Cuckoo	3	-	1	-	0.16	0.30	0.16	0.31	0.21	0.27	0.34	0.23	0.26	0.23
White-eyed Vireo	0	-	0	-	2	-	0.44	0.33	2	-	1	-	1	-
Kentucky Warbler	4	-	0	-	5	-	7	-	7	-	0	-	1	-
Eastern Wood-Pewee	3	-	0	-	0.13	0.21	0.06	0.37	0.20	0.19	8	-	7	-
Acadian Flycatcher	2	-	3	-	0.85	0.24	0.71	0.24	1.46	0.19	0.89	0.22	0.80	0.22
Yellow-throated Warbler	1	-	1	-	1	-	1	-	0	-	3	-	0	-
Hooded Warbler	0	-	0	-	0	-	1	-	0	-	0	-	0	-
Priority Species Guild	17	-	10	-	1.99	0.14	2.12	0.13	2.77	0.11	2.70	0.13	2.01	0.14
All Species	7.45	0.09	22	-	6.67	0.08	5.96	0.07	9.00	0.06	9.68	0.06	7.84	0.07

Priority Species	Total detected during 2015 point counts
Prothonotary Warbler	77
Swainson's Warbler	1
Cerulean Warbler	0
Swallow-tailed Kite	0
Mississippi Kite	1
Orchard Oriole	0
Northern Parula	36
Wood Thrush	12
Yellow-billed Cuckoo	99
White-eyed Vireo	23
Yellow-breasted Chat	0
Kentucky Warbler	24
Eastern Wood-Pewee	83
Acadian Flycatcher	169
Yellow-throated Warbler	7
Hooded Warbler	1
Total Priority Species Guild	533

Table 2. Total detections of Lower Mississippi Joint Venture priority species on 2015 point counts. Individuals detected outside of official point-count survey duration not reported in this count.

Results: Plot Occupancy and Relative Abundance

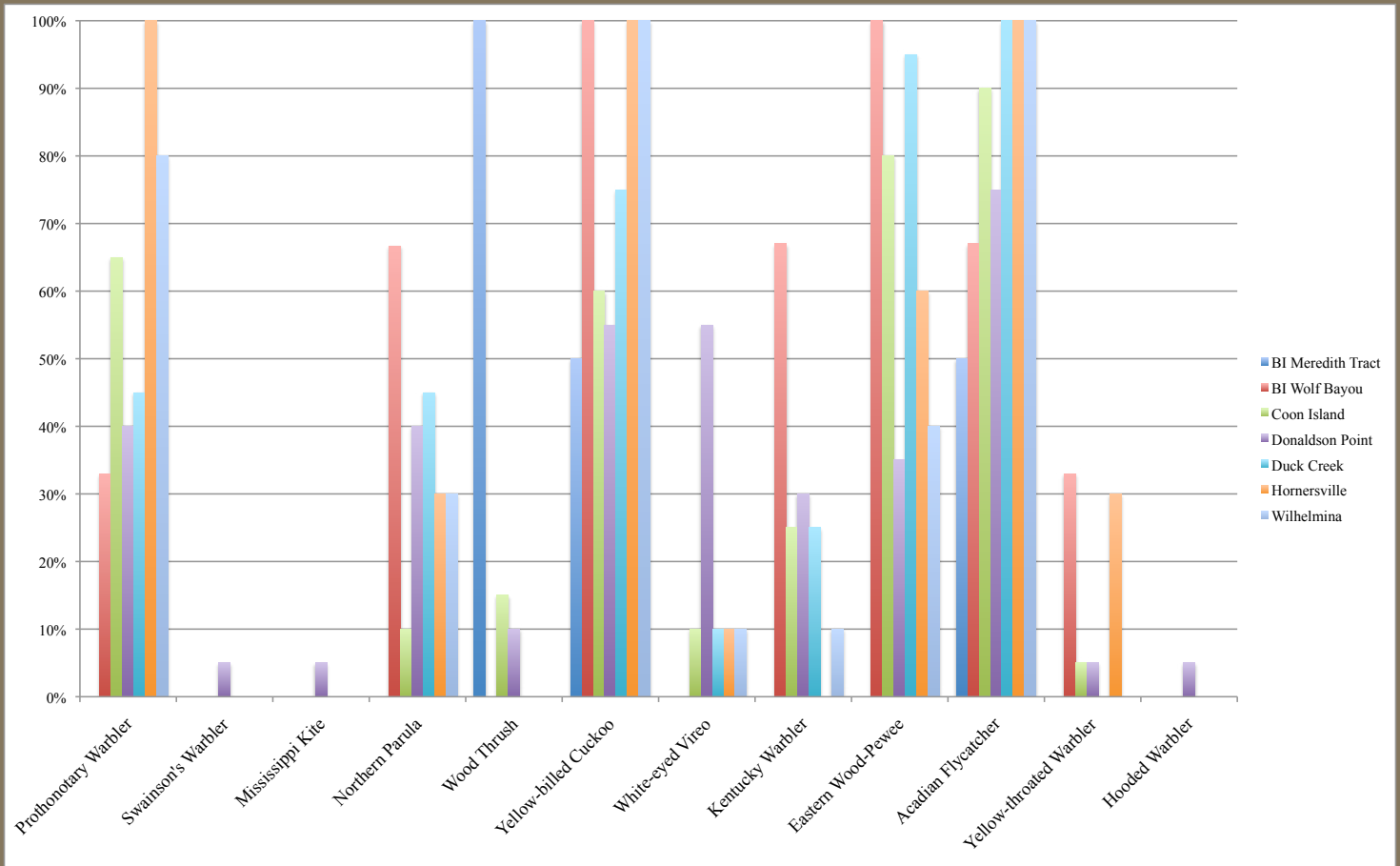
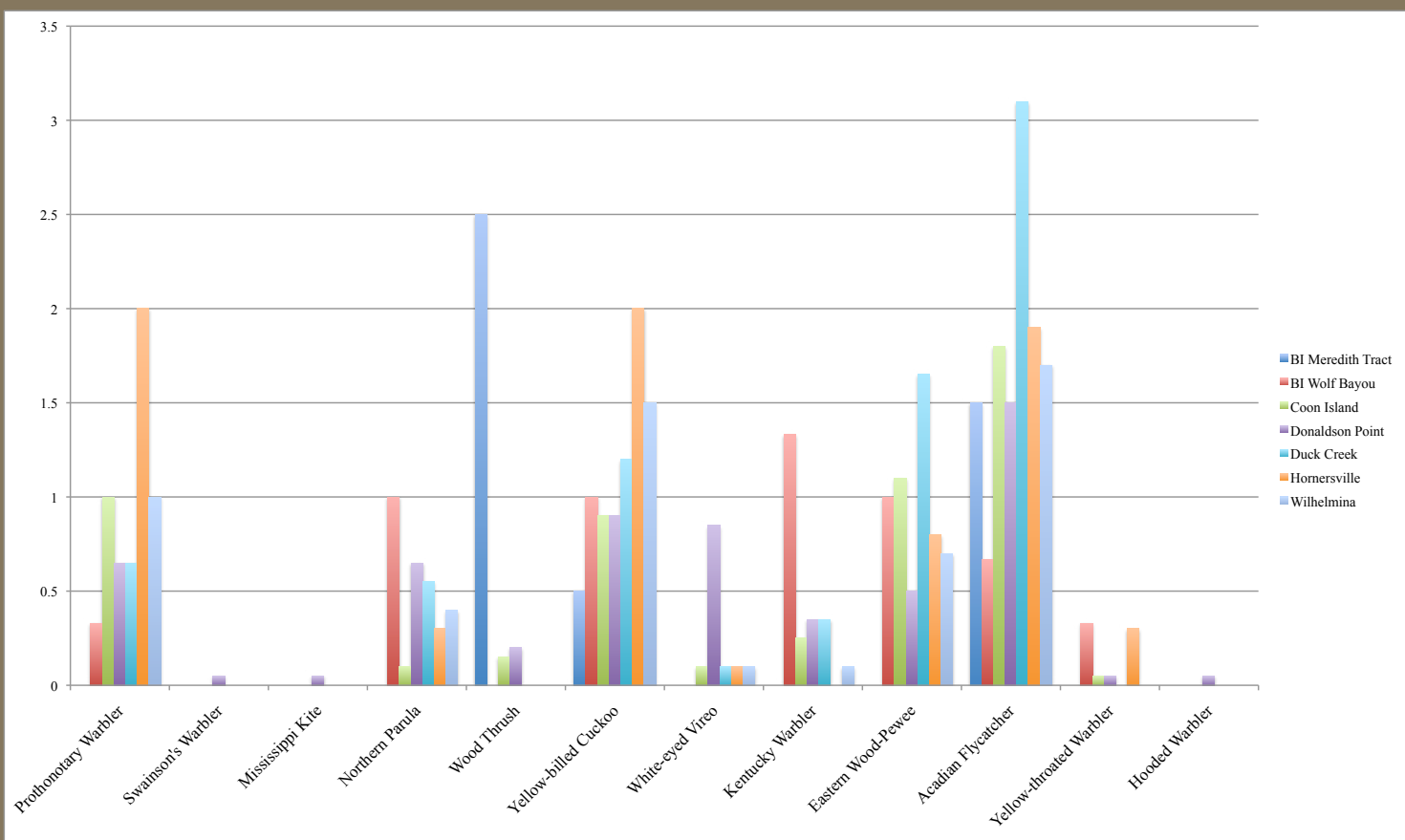


Figure 1 (above): Percentage of plots (point-count radii) occupied by priority species in each Conservation Area study site.
 Figure 2 (below): Mean number of detections at point-count stations for priority species at each Conservation Area study site.



Results: Priority Species Density & Forest Characteristics

Tables 4a,b,c: Density (D; birds/acre) of priority species within vegetation-variable categories collected as part of forest plot data. Vine, Cane, Over-, Mid- and Understory categories are expressed as 1 = None, 2 = Sparse (<25% cover), 3 = Moderate (25-50%), 4 = Heavy (>50%). 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. Data were pooled across all six Conservation Area study sites and global detection probabilities used within post-stratification.

	Vines				Cane			
	1	2	3	4	1	2	3	4
# Point-count stations within each category	<i>n = 28</i>	<i>n = 38</i>	<i>n = 14</i>	<i>n = 5</i>	<i>n = 66</i>	<i>n = 7</i>	<i>n = 4</i>	<i>n = 8</i>
Prothonotary Warbler	0.18	0.19	0.16	<i>1</i>	0.18	<i>5</i>	<i>4</i>	<i>6</i>
Northern Parula	0.12	0.11	<i>8</i>	<i>4</i>	0.10	<i>5</i>	<i>4</i>	<i>6</i>
Yellow-billed Cuckoo	0.23	0.21	0.27	<i>3</i>	0.24	<i>3</i>	<i>5</i>	<i>7</i>
White-eyed Vireo	<i>4</i>	0.14	<i>8</i>	<i>1</i>	<i>8</i>	<i>3</i>	<i>4</i>	<i>8</i>
Kentucky Warbler	<i>8</i>	<i>6</i>	<i>5</i>	<i>5</i>	0.06	<i>2</i>	<i>0</i>	<i>6</i>
Eastern Wood-Pewee	0.15	0.12	<i>6</i>	<i>4</i>	0.13	<i>3</i>	<i>2</i>	<i>4</i>
Acadian Flycatcher	1.27	0.95	0.82	<i>3</i>	1.05	1.07	<i>5</i>	0.62
Priority Species Guild	2.53	2.18	2.37	1.53	2.31	2.03	2.19	2.37
All Species	7.80	7.98	6.39	5.61	7.80	6.21	6.61	6.76

	Overstory				Mid-Story				Understory			
	1	2	3	4	1	2	3	4	1	2	3	4
# Point-count stations within each category	<i>n = 1</i>	<i>n = 9</i>	<i>n = 48</i>	<i>n = 27</i>	<i>n = 0</i>	<i>n = 10</i>	<i>n = 61</i>	<i>n = 14</i>	<i>n = 0</i>	<i>n = 42</i>	<i>n = 39</i>	<i>n = 4</i>
Prothonotary Warbler	<i>0</i>	<i>3</i>	0.162	0.23	-	<i>3</i>	0.19	0.16	-	0.22	0.14	<i>0</i>
Northern Parula	<i>0</i>	<i>8</i>	0.12	0.13	-	<i>6</i>	0.13	<i>5</i>	-	0.13	0.15	<i>1</i>
Yellow-billed Cuckoo	<i>1</i>	<i>8</i>	0.24	0.21	-	0.19	0.22	0.26	-	0.23	0.23	<i>2</i>
White-eyed Vireo	<i>0</i>	<i>4</i>	0.12	<i>8</i>	-	<i>3</i>	0.14	<i>3</i>	-	0.14	0.13	<i>2</i>
Kentucky Warbler	<i>0</i>	<i>4</i>	0.09	<i>2</i>	-	<i>1</i>	0.08	<i>3</i>	-	<i>8</i>	0.11	<i>0</i>
Eastern Wood-Pewee	<i>0</i>	<i>7</i>	0.11	0.14	-	<i>8</i>	0.13	0.09	-	0.10	0.14	<i>2</i>
Acadian Flycatcher	<i>0</i>	0.72	0.87	1.33	-	1.00	0.96	1.14	-	1.08	0.93	0.62
Priority Species Guild	<i>5</i>	2.15	2.15	2.59	-	1.97	2.30	2.45	-	2.36	2.29	1.46
All Species	4.06	6.41	7.49	8.05	-	7.68	7.47	7.57	-	7.65	7.50	6.30

	Tree Diversity				DBH Class			
	1	2	3	4	1	2	3	4
# Point-count stations within each category	<i>n = 12</i>	<i>n = 28</i>	<i>n = 37</i>	<i>n = 8</i>	<i>n = 20</i>	<i>n = 21</i>	<i>n = 19</i>	<i>n = 25</i>
Prothonotary Warbler	<i>4</i>	0.20	0.19	<i>6</i>	0.17	0.26	0.18	0.14
Northern Parula	<i>5</i>	0.16	0.14	<i>1</i>	<i>8</i>	<i>6</i>	0.21	0.13
Yellow-billed Cuckoo	0.24	0.26	0.19	0.24	0.27	0.24	0.23	0.17
White-eyed Vireo	<i>1</i>	<i>6</i>	0.18	<i>3</i>	<i>2</i>	<i>4</i>	<i>7</i>	0.21
Kentucky Warbler	<i>7</i>	<i>5</i>	<i>9</i>	<i>3</i>	<i>3</i>	0.13	<i>5</i>	<i>5</i>
Eastern Wood-Pewee	0.16	0.11	0.12	<i>4</i>	0.11	0.14	0.11	0.11
Acadian Flycatcher	1.08	1.14	0.91	0.75	0.95	0.88	1.18	0.98
Priority Species Guild	2.37	2.48	2.23	1.78	2.28	2.41	2.49	2.03
All Species	7.72	7.59	7.50	7.01	7.70	7.96	7.55	6.97

Results: Priority Species Abundance & Forest Characteristics

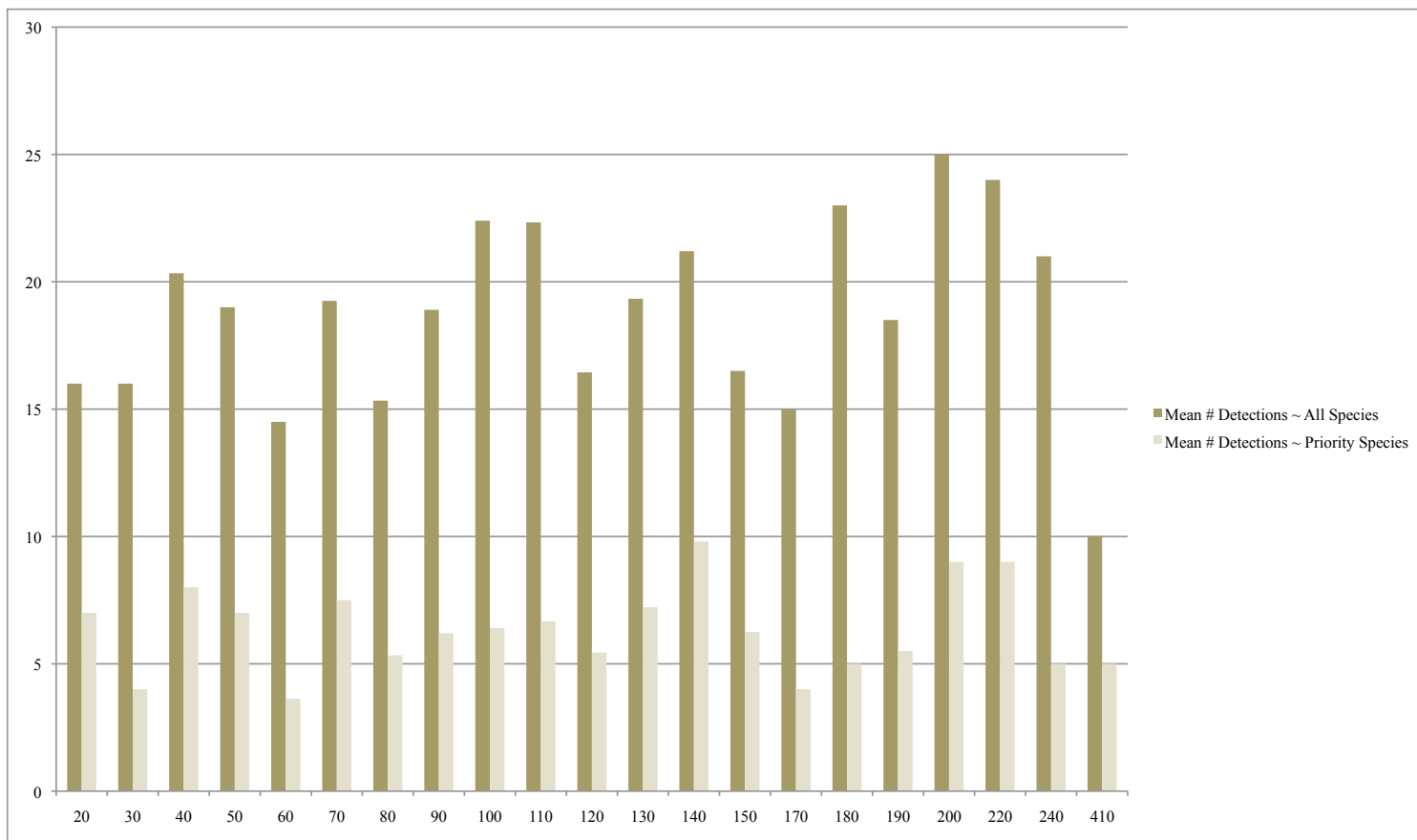
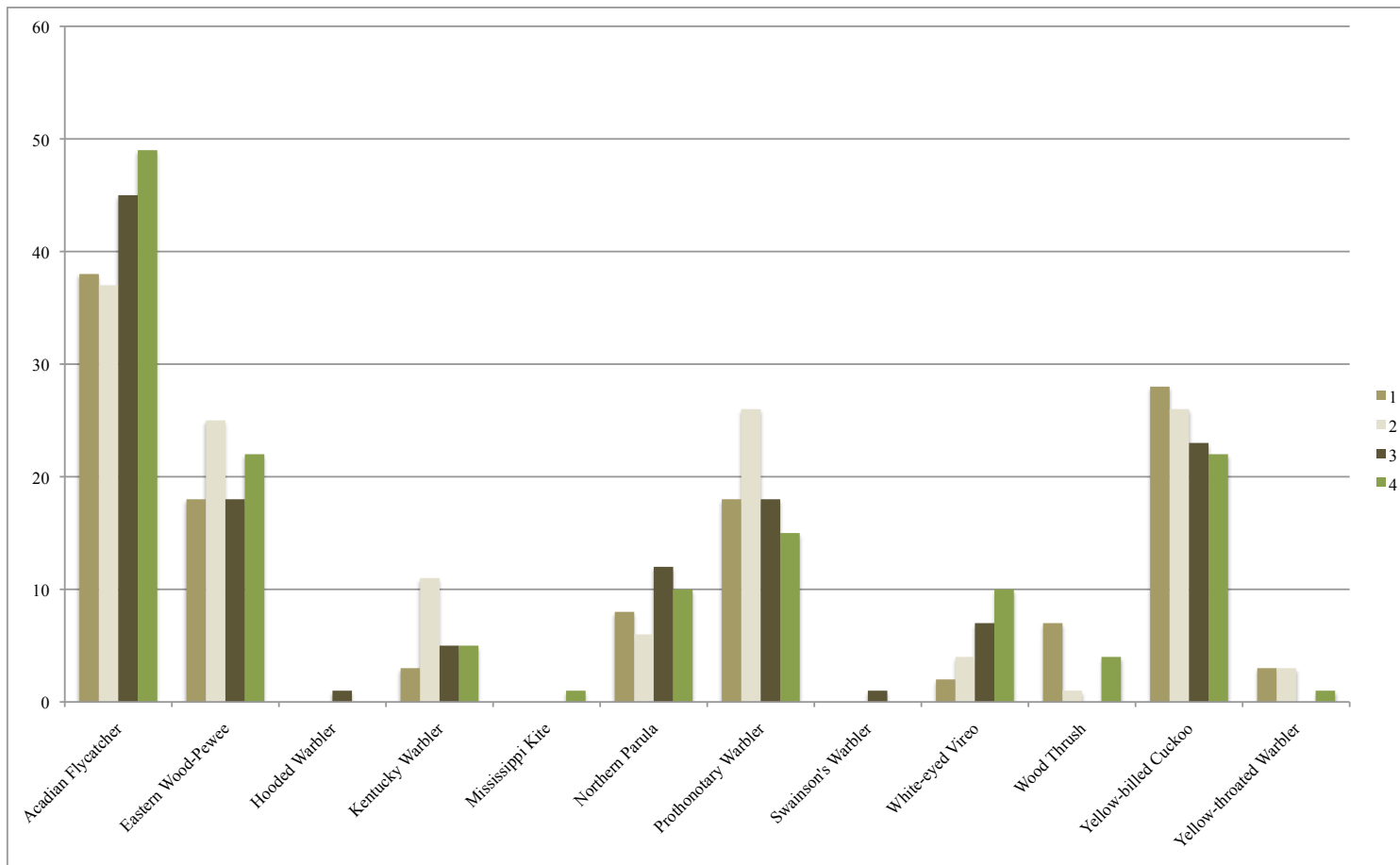


Figure 3 (above): Mean number of individual detections for priority species and all bird species plotted against basal area (ft²/ac).

Figure 4 (below): Total number of detections of priority species in each dbh class. Data for both figures pooled across Conservation Area study sites.



Results: Priority Species in Control and Treatment Stands

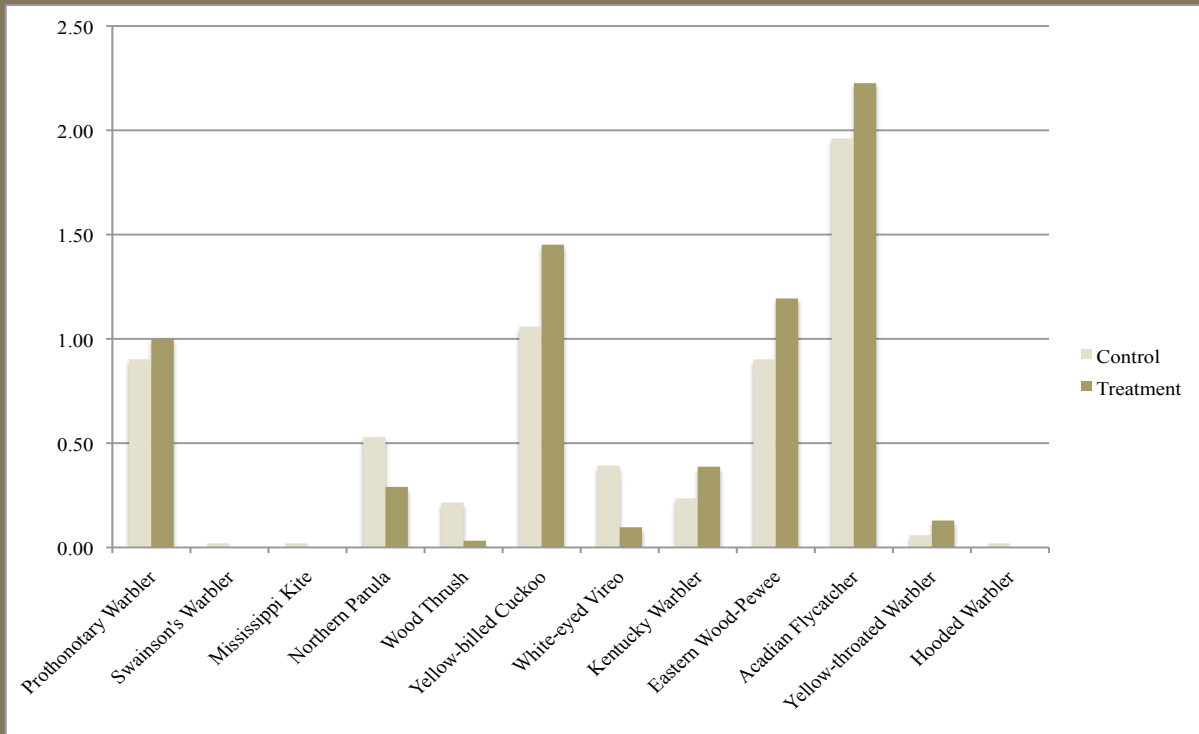


Figure 5: Density (birds/acre) of priority species in Control and Treatment Stands. Data were pooled across all six Conservation Area study sites and global detection probabilities used despite post-stratification of data by category.

Table 5. Density (D) of priority species within Control and Treatment stands. 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. Data were pooled across all six Conservation Area study sites and global detection probabilities used despite post-stratification of data by stand type.

	All CAs combined		Black Island - Wolf Bayou	Black Island - Meredith Tract		Coon Island	
	Control	Treatment	Control only	Control	Treatment	Control	Treatment
# Point-count stations in control or treatment stands	<i>n = 51</i>	<i>n = 34</i>	<i>n = 3</i>	<i>n = 1</i>	<i>n = 1</i>	<i>n = 9</i>	<i>n = 11</i>
Prothonotary Warbler	0.22	0.23	<i>1</i>	<i>0</i>	<i>0</i>	<i>13</i>	<i>7</i>
Northern Parula	0.17	<i>9</i>	<i>3</i>	<i>0</i>	<i>0</i>	<i>1</i>	<i>1</i>
Yellow-billed Cuckoo	0.20	0.25	<i>3</i>	<i>1</i>	<i>0</i>	<i>8</i>	<i>10</i>
White-eyed Vireo	0.20	<i>3</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>2</i>	<i>0</i>
Kentucky Warbler	0.06	0.09	<i>4</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>5</i>
Eastern Wood-Pewee	0.11	0.13	<i>3</i>	<i>0</i>	<i>0</i>	0.35	0.29
Acadian Flycatcher	0.98	1.01	<i>2</i>	<i>0</i>	<i>3</i>	2.13	1.56
Priority Species Guild	2.30	2.26	1.58	<i>5</i>	<i>5</i>	3.43	2.47
All Species	6.98	8.32	6.62	2.06	2.47	12.40	12.64

	Donaldson Point	Duck Creek		Hornersville	Wilhelmina	
	Control Only	Control	Treatment	Treatment Only	Control	Treatment
# Point-count stations in control or treatment stands	<i>n = 20</i>	<i>n = 10</i>	<i>n = 10</i>	<i>n = 10</i>	<i>n = 8</i>	<i>n = 2</i>
Prothonotary Warbler	0.48	0.06	<i>3</i>	<i>1</i>	<i>9</i>	<i>1</i>
Northern Parula	0.25	<i>6</i>	<i>5</i>	<i>3</i>	<i>4</i>	<i>0</i>
Yellow-billed Cuckoo	<i>0.47</i>	0.07	0.07	0.17	0.11	<i>3</i>
White-eyed Vireo	0.53	<i>0</i>	<i>2</i>	<i>1</i>	<i>1</i>	<i>0</i>
Kentucky Warbler	<i>7</i>	<i>1</i>	<i>6</i>	<i>0</i>	<i>0</i>	<i>1</i>
Eastern Wood-Pewee	0.14	0.10	0.09	<i>8</i>	<i>5</i>	<i>2</i>
Acadian Flycatcher	1.29	0.66	0.51	0.36	0.51	<i>3</i>
Priority Species Guild	4.34	0.89	0.78	0.79	1.03	0.91
All Species	12.23	2.99	3.14	4.10	7.62	7.23

Black Island Conservation Area

Species	Wolf Bayou			Meredith Tract		
	mean det./point	SEM	% points present	mean det./point	SEM	% points present
Priority Species						
Prothonotary Warbler	0.33	0.33	33%			0
Swainson's Warbler			0			0
Mississippi Kite			0			0
Northern Parula	1	0.58	67%			0
Wood Thrush			0	2.5	1.5	100%
Yellow-billed Cuckoo	1	0	100%	0.5	0.5	50%
White-eyed Vireo			0			0
Kentucky Warbler	1.33	0.88	67%			0
Eastern Wood-Pewee	1	0	100%			0
Acadian Flycatcher	0.67	0.33	67%	1.5	1.5	50%
Yellow-throated Warbler	0.33	0.33	33%			0
Hooded Warbler			0			0

Species	Number Detected	
	Wolf Bayou	Meredith Tract
Acadian Flycatcher	2	3
Baltimore Oriole	1	
Blue-grey Gnatcatcher	3	
Brown-headed Cowbird	2	
Blue Jay	1	
Carolina Chickadee	2	1
Carolina Wren	2	
Downy Woodpecker	1	
Eastern Towhee		1
Eastern Wood-Pewee	3	
Great-crested Flycatcher	3	
Indigo Bunting	9	4
Kentucky Warbler	4	
Northern Cardinal	6	6
Northern Parula	3	
Pileated Woodpecker	1	
Prothonotary Warbler	1	
Red-bellied Woodpecker	3	
Tufted Titmouse	2	
Wood Duck	1	
Wood Thrush		5
Yellow-billed Cuckoo	3	1
Yellow-throated Vireo	1	
Yellow-throated Warbler	1	1
Grand Total	55	22

Table 6 (above left): mean number of detections per point, associated standard error around mean (SEM) and percentage of points occupied by priority species at Black Island. Table 7 (above right): number of individuals detected during point counts for all species at Black Island. Table 8 (below): number of individuals detected (*n*) or density (*D*) of species or guild in surveyed stands at Black Island. *n* presented with *D* where appropriate for comparison purposes.

	Wolf Bayou	Wolf Bayou	Meredith Tract	Meredith Tract
	Stand 2	Stand 6	North	South
	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>
Prothonotary Warbler	1	0	0	0
Swainson's Warbler	0	0	0	0
Mississippi Kite	0	0	0	0
Northern Parula	3	0	0	0
Wood Thrush	0	0	4	1
Yellow-billed Cuckoo	2	1	1	0
White-eyed Vireo	0	0	0	0
Kentucky Warbler	1	3	0	0
Eastern Wood-Pewee	2	1	0	0
Acadian Flycatcher	1	1	0	3
Yellow-throated Warbler	1	0	0	1
Hooded Warbler	0	0	0	0
Priority Species Guild	2.01 (<i>II</i>)	6	5	5
All Species	6.91	8.54	4.07	4.88

Coon Island Conservation Area

	mean det./ point	SEM	% points present
Priority Species			
Prothonotary Warbler	1	0.27	65%
Swainson's Warbler			0
Mississippi Kite			0
Northern Parula	0.1	0.07	10%
Wood Thrush	0.15	0.09	15%
Yellow-billed Cuckoo	0.9	0.21	60%
White-eyed Vireo	0.1	0.07	10%
Kentucky Warbler	0.25	0.1	25%
Eastern Wood-Pewee	1.1	0.16	80%
Acadian Flycatcher	1.8	0.28	90%
Yellow-throated Warbler	0.05	0.05	5%
Hooded Warbler			0

Species	Number Detected	Species	Number Detected
Acadian Flycatcher	36	Northern Parula	2
American Crow	12	Pileated Woodpecker	4
American Goldfinch	1	Prothonotary Warbler	20
Blue-grey Gnatcatcher	28	Red-bellied Woodpecker	19
Brown-headed Cowbird	6	Red-eyed Vireo	8
Carolina Chickadee	9	Ruby-throated Hummingbird	7
Carolina Wren	22	Red-winged Blackbird	5
Crow Spp.	1	Summer Tanager	5
Downy Woodpecker	6	Tufted Titmouse	23
Eastern Wood-Pewee	22	White-breasted Nuthatch	9
Fish Crow	6	White-eyed Vireo	2
Flycatcher Spp.	1	Woodpecker Spp.	1
Great-crested Flycatcher	12	Wood Thrush	3
Indigo Bunting	15	Yellow-billed Cuckoo	18
Kentucky Warbler	5	Yellow-throated Vireo	1
Mourning Dove	5	Yellow-throated Warbler	1
Northern Cardinal	13	Grand Total	328

Table 9 (above left): mean number of detections per point, associated standard error around mean (SEM) and percentage of points occupied by priority species at Coon Island. Table 10 (above right): number of individuals detected during point counts for all species at Coon Island. Table 11 (below): number of individuals detected (*n*) or density (*D*) of species or guild in surveyed stands at Coon Island. *n* presented with *D* where appropriate for comparison purposes.

Stand (all Compartment 1)	2	3	5	6	7	8
	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>
Prothonotary Warbler	2	0	2	3	9	4
Swainson's Warbler	0	0	0	0	0	0
Mississippi Kite	0	0	0	0	0	0
Northern Parula	0	1	0	0	0	1
Wood Thrush	0	0	0	0	1	2
Yellow-billed Cuckoo	2	3	2	3	6	2
White-eyed Vireo	0	0	0	0	2	0
Kentucky Warbler	2	0	1	2	0	0
Eastern Wood-Pewee	3	2	3	3	6	5
Acadian Flycatcher	5	2	5	5	1.10 (11)	8
Yellow-throated Warbler	0	0	0	0	0	1
Hooded Warbler	0	0	0	0	0	0
Priority Species Guild	1.70 (8	2.37 (13)	1.95 (16)	2.55 (35)	2.10 (
All Species	7.72	3.52	8.53	7.72	6.83	6.30

Donaldson Point Conservation Area

Species	Number Detected
Acadian Flycatcher	30
American Crow	6
Blue-grey Gnatcatcher	14
Brown-headed Cowbird	8
Blue Jay	4
Carolina Chickadee	11
Carolina Wren	6
Common Grackle	1
Downy Woodpecker	2
Eastern Wood-Pewee	10
Great-crested Flycatcher	9
Hooded Warbler	1
Indigo Bunting	34
Kentucky Warbler	7
Mississippi Kite	1
Mourning Dove	2
Northern Cardinal	40
Northern Parula	13
Pileated Woodpecker	2
Prothonotary Warbler	13
Red-bellied Woodpecker	10
Red-eyed Vireo	9
Summer Tanager	6
Swainson's Warbler	1
Tufted Titmouse	11

Species	Number Detected
White-eyed Vireo	17
Woodpecker Spp.	2
Wood Thrush	4
Yellow-billed Cuckoo	18
Yellow-throated Warbler	1
Grand Total	293

	mean det./ point	SEM	% points present
Priority Species			
Prothonotary Warbler	0.65	0.22	40%
Swainson's Warbler	0.05	0.05	5%
Mississippi Kite	0.05	0.05	5%
Northern Parula	0.65	0.19	40%
Wood Thrush	0.2	0.16	10%
Yellow-billed Cuckoo	0.9	0.22	55%
White-eyed Vireo	0.85	0.21	55%
Kentucky Warbler	0.35	0.13	30%
Eastern Wood-Pewee	0.5	0.17	35%
Acadian Flycatcher	1.5	0.23	75%
Yellow-throated Warbler	0.05	0.05	5%
Hooded Warbler	0.05	0.05	5%



Table 12 (above left): number of individuals detected during point counts for all species at Donaldson Point. Table 13 (above center): mean number of detections per point, associated standard error around mean (SEM) and percentage of points occupied by priority species at Donaldson Point. Table 14 (below): number of individuals detected (*n*) or density (*D*) of species or guild in surveyed stands at Hornersville *n* presented with *D* where appropriate for comparison. Figure 6 (above right): locations of Swainson's Warblers detected at Donaldson Point, compartment 3, during and outside of point count surveys.

Compartment	1	5	NA2	NA3	NA5	NA6						
Stand	1	4	9	11	5	2	7	10	2	1	2	4
	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>
Prothonotary Warbler	0	0	0	0	5	0	0	5	0	1	0	2
Swainson's Warbler	0	0	0	0	0	0	1	0	0	0	0	0
Mississippi Kite	0	0	0	1	0	0	0	0	0	0	0	0
Northern Parula	2	0	0	0	0	2	2	4	0	0	1	2
Wood Thrush	0	0	0	1	0	0	0	3	0	0	0	0
Yellow-billed Cuckoo	5	1	0	2	3	1	0	2	1	3	0	0
White-eyed Vireo	0	1	0	0	2	1	5	4	1	0	1	2
Kentucky Warbler	1	2	0	0	3	0	1	0	0	0	0	0
Eastern Wood-Pewee	1	1	0	0	2	0	0	3	2	0	0	1
Acadian Flycatcher	5	0	1	2	5	2	2	4	1	2	3	3
Yellow-throated Warbler	0	0	0	0	0	0	0	0	0	0	1	0
Hooded Warbler	1	0	0	0	0	0	0	0	0	0	0	0
Priority Species Guild	1.82 (15)	5	1	6	3.65 (20)	6	2.01 (11)	3.04 (25)	5	6	6	1.82 (10)
All Species	5.56	3.86	5.28	4.06	7.11	6.50	4.88	6.76	6.50	7.32	8.13	6.30

Duck Creek Conservation Area

	mean det./ point	SEM	% points present
Priority Species			
Prothonotary Warbler	0.65	0.19	45%
Swainson's Warbler			0
Mississippi Kite			0
Northern Parula	0.55	0.15	45%
Wood Thrush			0
Yellow-billed Cuckoo	1.2	0.21	75%
White-eyed Vireo	0.1	0.07	10%
Kentucky Warbler	0.35	0.15	25%
Eastern Wood-Pewee	1.65	0.18	95%
Acadian Flycatcher	3.1	0.2	100%
Yellow-throated Warbler			0
Hooded Warbler			0

Species	Number Detected	Species	Number Detected
Acadian Flycatcher	62	Mourning Dove	4
American Crow	16	Northern Cardinal	18
American Goldfinch	1	Northern Parula	11
Baltimore Oriole	1	Pileated Woodpecker	6
Blue-grey Gnatcatcher	32	Prothonotary Warbler	13
Brown-headed Cowbird	16	Red-bellied Woodpecker	22
Blue Jay	5	Red-eyed Vireo	14
Carolina Chickadee	15	Ruby-throated Hummingbird	6
Carolina Wren	12	Red-winged Blackbird	5
Downy Woodpecker	20	Summer Tanager	4
Eastern Wood-Pewee	33	Tufted Titmouse	49
Fish Crow	4	White-breasted Nuthatch	7
Great-crested Flycatcher	15	White-eyed Vireo	2
Hairy Woodpecker	3	Yellow-billed Cuckoo	24
Indigo Bunting	13	Yellow-throated Vireo	3
Kentucky Warbler	7	Grand Total	443

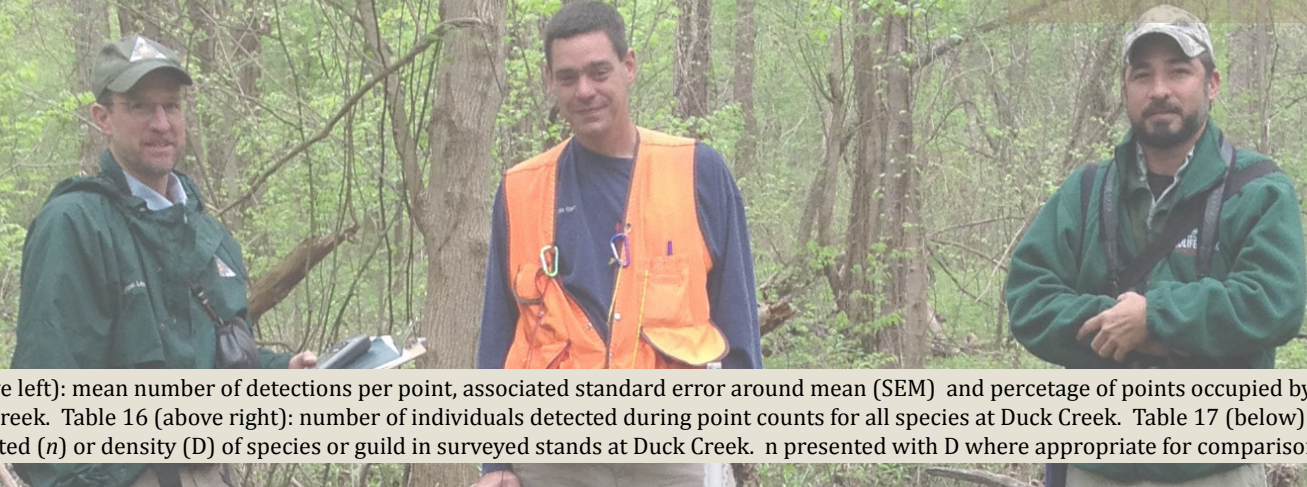


Table 15 (above left): mean number of detections per point, associated standard error around mean (SEM) and percentage of points occupied by priority species at Duck Creek. Table 16 (above right): number of individuals detected during point counts for all species at Duck Creek. Table 17 (below): number of individuals detected (*n*) or density (*D*) of species or guild in surveyed stands at Duck Creek. *n* presented with *D* where appropriate for comparison purposes.

Compartment	5				Pool 2						Pool 3					
	Stand	1	2	8	9	2	3	4	6	8	9	1	2	5	7	9
	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>
Prothonotary Warbler	0	0	0	0	3	2	0	0	1	0	2	1	2	2	0	
Swainson's Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mississippi Kite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Parula	1	1	0	0	2	0	0	0	1	1	2	0	2	0	1	
Wood Thrush	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow-billed Cuckoo	0	1	0	1	1	6	1	1	2	1	1	2	4	2	1	
White-eyed Vireo	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	
Kentucky Warbler	0	2	0	0	0	1	0	1	0	0	2	1	0	0	0	
Eastern Wood-Pewee	2	2	2	1	1	3	2	2	0	3	3	3	2	4	3	
Acadian Flycatcher	4	2	5	3	3	5	2	3	4	3	7	2	8	7	4	
Yellow-throated Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Hooded Warbler	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Priority Species Guild	7	9	7	5	3.65 (10)	3.10 (17)	5	7	8	8	3.10 (17)	3.65 (10)	3.28 (18)	2.74 (15)	9	
All Species	9.35	10.16	10.36	8.94	9.35	7.93	8.13	8.13	9.35	8.54	9.76	9.35	8.13	8.54	9.35	

Hornersville Swamp Conservation Area

	mean det./ point	SEM	% points present
Priority Species			
Prothonotary Warbler	2	0.26	100%
Swainson's Warbler			0
Mississippi Kite			0
Northern Parula	0.3	0.15	30%
Wood Thrush			0
Yellow-billed Cuckoo	2	0.26	100%
White-eyed Vireo	0.1	0.1	10%
Kentucky Warbler			0
Eastern Wood-Pewee	0.8	0.29	60%
Acadian Flycatcher	1.9	0.23	100%
Yellow-throated Warbler	0.3	0.15	30%
Hooded Warbler			0

Species	Number Detected
Acadian Flycatcher	19
American Crow	1
Blue-grey Gnatcatcher	20
Brown-headed Cowbird	10
Carolina Chickadee	10
Carolina Wren	2
Downy Woodpecker	9
Eastern Wood-Pewee	8
Great-crested Flycatcher	5
Indigo Bunting	18
Mourning Dove	1
Northern Cardinal	19
Northern Parula	3
Ovenbird	1
Pileated Woodpecker	3
Prothonotary Warbler	20
Red-bellied Woodpecker	17
Red-eyed Vireo	11
Red-headed Woodpecker	1
Ruby-throated Hummingbird	6
Red-winged Blackbird	4
Summer Tanager	5
Tufted Titmouse	19
White-breasted Nuthatch	2
White-eyed Vireo	1
Yellow-billed Cuckoo	20
Yellow-throated Warbler	3
Grand Total	238

Table 18 (above left): mean number of detections per point, associated standard error around mean (SEM) and percentage of points occupied by priority species at Hornersville. Table 19 (above right): number of individuals detected during point counts for all species at Hornersville. Table 20 (below): number of individuals detected (*n*) or density (*D*) of species or guild in surveyed stands at Hornersville. *n* presented with *D* where appropriate for comparison.

	Stand	
	(both Compartment 3)	
	5	6
	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>
Prothonotary Warbler	0.41 (13)	7
Swainson's Warbler	0	0
Mississippi Kite	0	0
Northern Parula	2	1
Wood Thrush	0	0
Yellow-billed Cuckoo	0.41 (13)	7
White-eyed Vireo	1	0
Kentucky Warbler	0	0
Eastern Wood-Pewee	2	6
Acadian Flycatcher	0.96 (11)	8
Yellow-throated Warbler	0	3
Hooded Warbler	0	0
Priority Species Guild	2.55 (42)	2.92 (32)
All Species	9.48	9.96

Wilhelmina Conservation Area

	mean det./ point	SEM	% points present
Priority Species			
Prothonotary Warbler	1	0.21	80%
Swainson's Warbler			0
Mississippi Kite			0
Northern Parula	0.4	0.22	30%
Wood Thrush			0
Yellow-billed Cuckoo	1.5	0.17	100%
White-eyed Vireo	0.1	0.1	10%
Kentucky Warbler	0.1	0.1	10%
Eastern Wood-Pewee	0.7	0.3	40%
Acadian Flycatcher	1.7	0.21	100%
Yellow-throated Warbler			0
Hooded Warbler			0

Species	Number Detected
Acadian Flycatcher	17
American Crow	6
Blue-grey Gnatcatcher	15
Brown-headed Cowbird	6
Blue Jay	1
Carolina Chickadee	6
Carolina Wren	7
Downy Woodpecker	4
Eastern Wood-Pewee	7
Great-crested Flycatcher	2
Hairy Woodpecker	3
Indigo Bunting	6
Kentucky Warbler	1
Northern Cardinal	22
Northern Parula	4
Pileated Woodpecker	1
Prothonotary Warbler	10
Red-bellied Woodpecker	11
Red-eyed Vireo	14
Red-shouldered Hawk	1
Ruby-throated Hummingbird	7
Red-winged Blackbird	8
Summer Tanager	8
Tufted Titmouse	10
White-eyed Vireo	1
Yellow-billed Cuckoo	15
Grand Total	193

Table 21 (above left): mean number of detections per point, associated standard error around mean (SEM) and percentage of points occupied by priority species at Wilhelmina. Table 22 (above right): number of individuals detected during point counts for all species at Wilhelmina. Table 23 (below): number of individuals detected (*n*) or density (*D*) of species or guild in surveyed stands at Wilhelmina. *n* presented with *D* where appropriate for comparison.

Compartment	2				3		
	Stand	5	6	7	8	1	3
	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>	<i>n</i> or <i>D</i>
Prothonotary Warbler	0	1	1	2	1	5	
Swainson's Warbler	0	0	0	0	0	0	
Mississippi Kite	0	0	0	0	0	0	
Northern Parula	1	0	0	0	0	3	
Wood Thrush	0	0	0	0	0	0	
Yellow-billed Cuckoo	2	1	1	4	3	4	
White-eyed Vireo	0	0	0	1	0	0	
Kentucky Warbler	0	0	0	0	1	0	
Eastern Wood-Pewee	0	0	1	4	2	0	
Acadian Flycatcher	1	2	1	5	3	5	
Yellow-throated Warbler	0	0	0	0	0	0	
Hooded Warbler	0	0	0	0	0	0	
Priority Species Guild	4	4	4	2.92 (16)	1.82 (10)	2.07 (17)	
All Species	6.09	6.50	9.76	9.15	7.52	7.59	

Discussion

While the number of stands included in this study reached the recommended threshold of 15-20 stands suggested by the LMVJV, in many cases stands were too small to contain the recommended six point count stations (Wilson and Twedt 2007). This resulted in a small sample size of individual birds at the stand level even for species for which overall counts were high (e.g., Acadian Flycatcher, $n = 169$ throughout all study areas). We suggest that additional point-count surveys be conducted in 2016 to bolster sample sizes, that additional treatment stands be included, and that stands be selected based on representation of stand-level variables (e.g., include more stands with category 1 overstory and/or category 4 understory). Additionally, where possible, selecting larger stands would allow a higher number of point-count stations and potentially more meaningful stand-level results.

For priority species for which few or no individuals were documented, in some 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, and is generally associated with successional shrub encroachment of prairies as well as shrubby upland forest edges (Ripper et al. 2014; pers. obs. by MRBO staff). 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) and the detection of only one individual on survey may be more representative of the survey protocol than low numbers on study sites.

The relatively low numbers of Kentucky Warbler, White-eyed Vireo and Hooded Warbler may not be surprising based on their habitat affinity, the study site composition, and the seasonal conditions of 2015. 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 the flooding at most study sites during spring and early summer may have reduced the understory on most plots to a level unacceptable to this species. While sample sizes were relatively low, Kentucky Warbler detections were highest at Duck Creek and Donaldson Point, sites where much of the interior was not flooded for extended periods this year. 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 absence of Cerulean Warbler and the low number of Swainson's Warbler. Cerulean Warbler was historically abundant in the bottomland forests of the MAV (BNA No. 511). This species' absence may be a function of its forest area requirements in the MAV region, which some studies have suggested is as high as 4,000 acres of unbroken habitat. 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 most sites is indicative of high-quality habitat coupled with ideal hydrological conditions and, presumably, ample cavity nest sites.

Literature Cited

BIRDS OF NORTH AMERICA ONLINE (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: <http://bna.birds.cornell.edu/bna/>. ***Species accounts retrieved for all Lower Mississippi Valley Joint Venture priority species.***

BUCKLAND, S.T., D.R. ANDERSON, K.P. BURNHAM, J.L. LAKE, D.L. BORCHERS, AND L. THOMAS. 2001. Introduction to distance sampling: estimating abundance of biological populations. Oxford: New York, USA.

GEOMETRY, INC. 2013. iGIS mobile application. <http://www.geometryit.com>

GILLIAM, F.S., N.L. TURRILL, AND M.B. ADAMS. 1995. Herbaceous-layer and overstory species in clear-cut and mature central Appalachian hardwood forests. *Ecological Applications* 5(4): 947-955.

GUILFOYLE, M. P. 2001. Management of bottomland hardwood forests for non-game bird communities on Corps of Engineers projects. *EMRRP Technical Notes Collection* (ERDC TN-EMRRP-SI-21), U.S. Army Engineer Research and Development Center, Vicksburg, MS. www.wes.army.mil/el/emrrp

RIPPER D., AND E.C. DUKE. 2014. Breeding bird surveys on Missouri's focal grassland landscapes. Missouri River Bird Observatory report to the Missouri Department of Conservation. www.mrbo.org/mrbo-reports/

WILSON, R. AND D. TWEDT. 2007. Assessing forest breeding bird response to forest management. In LMVJV Forest Resource Conservation Working Group. 2007. Restoration, Management, and Monitoring of Forest Resources in the Mississippi Alluvial Valley: Recommendations for Enhancing Wildlife Habitat. (R. Wilson, K. Ribbeck, S. King, and D. Twedt, Eds.).



Appendix A: Swainson's Warbler Habitat Information

Excerpted from *The Birds of North America* Species Account No. 126

Anich, Nicholas M., Thomas J. Benson, Jeremy D. Brown, Carolina Roa, James C. Bednarz, R. E. Brown and J. G. Dickson. 2010. Swainson's Warbler (*Limnothlypis swainsonii*), *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: <http://bna.birds.cornell.edu/bna/species/126>

Breeding Habitat

Variety of habitats including bottomland hardwood forests, mixed mesophytic montane forests, and early-seral pine stands. Species typically found in areas with shaded and dense understory, abundant leaf litter, and little herbaceous ground cover. Generally found in large contiguous forests, but within these can occupy different age classes of habitat provided the appropriate structure exists (Mitchell et al. 2001). In bottomland forest, uses moist but not inundated areas, but may occasionally forage along wet areas (Meanley 1969). Currently and historically, most Swainson's Warbler habitat has existed in relatively high-elevation and infrequently flooded bottomland hardwood forests. Species can withstand short-duration floods (Anich and Reiley 2010), but significant flooding can decrease habitat suitability and lead to local population declines (Benson and Bednarz 2010b). Stands of cane, dwarf palmetto (*Sabal minor*), sweet pepperbush (*Clethra alnifolia*), or spicebush (*Lindera benzoin*) are commonly occupied vegetation types, and these areas often have a significant vine component, especially greenbrier (*Smilax* spp.) and grape (*Vitis* spp.; Meanley 1969; Graves 2001, 2002; Henry 2004; Benson et al. 2009; Brown et al. 2009). Similarly, stands with understories dominated by vines, particularly greenbrier, are commonly occupied by Swainson's Warblers in some areas (Peters et al. 2005, Anich et al. 2010, Benson and Bednarz 2010a).

Overall, key components of Swainson's warbler breeding habitat include dense canopy cover with occasional disturbance gaps that function to maintain dense shrub-level vegetation for nesting, abundant leaf litter, sparse herbaceous vegetation, moist soils, appropriate hydrologic regimes, and substantial forest cover at the landscape scale (Meanley 1971b; Eddleman 1978; Thomas et al. 1996; Graves 1998, 2001, 2002; Wright 2002; Bednarz et al. 2005; Benson et al. 2009; Brown et al. 2009; Anich et al. 2010).

Conservation & Management

The demise of once vast canebrakes has undoubtedly harmed this species. Cane removal in a Missouri forest that previously supported several breeding pairs eliminated all but 1 territorial male (Easterla 1975). Residential development in the Appalachians of West Virginia has rendered formerly prime mountain habitat unsuitable for Swainson's Warblers (Hall 1983). Fragmentation of bottomland hardwood forests and elimination of canebrakes have been proposed as possible causes for the demise of Bachman's Warbler (*Vermivora bachmanii*) (Meanley 1972, Remsen 1986), and these factors may also prove detrimental to Swainson's Warbler, which is generally found in heavily forested landscapes (Mitchell et al. 2001). Additionally, fragmentation of bottomland forests, and cane habitat specifically, may attract predators, lead to decreased reproductive success, and therefore decrease habitat quality for Swainson's Warblers (Benson et al. 2010a, b). Most remaining bottomland forests are at relatively low elevations and therefore prone to frequent and prolonged flooding, whereas higher elevation sites on which optimal Swainson's Warbler habitat may exist have been converted to agriculture or are highly fragmented (Rudis 1995, Twedt and Loesch 1999).

Measures may vary by region and specific habitat type but, in general, creating dense understory vegetation within forests should benefit Swainson's Warbler (see: Habitat). Habitat characteristics needed to encourage nesting and feeding success regardless of forest age include a well-developed leaf litter layer with sparse herbaceous cover and well-developed forest mid-story and/or overstory. The presence of "understory thickets" — areas with dense vine tangles, cane patches or shrubs with a range of stem densities between 30,000–50,000 stems/ha — exemplifies the habitat requirements of Swainson's Warblers (Graves 2002, Somershoe et al. 2003, Henry 2004, Thompson 2005, Gerwin 2006, Brown 2008). Where available, palmetto fronds should be conserved as they are selected at the nest patch scale in both pine and hardwood forests (Henry 2004, Gerwin 2006).

Helpful management practices include conserving a mosaic of mature bottomland forests, especially relatively high-elevation sites not prone to frequent flooding, and also young forest stands (Dickson et al. 1993). Protecting and restoring relatively large bottomland-hardwood forest tracts is also recommended for this species, as forests larger than 300 ha may be preferred (Eddleman 1978, Rich et al. 2004). As Swainson's Warblers are less abundant in wet forests prone to leaf-litter submergence, efforts should focus on the conservation of higher, drier areas within large bottomland forests and on providing habitat heterogeneity in these forests (Twedt and Loesch 1999, Twedt et al. 2006, Twedt and Somershoe 2009).

Many bottomland forests throughout the Southeast are relatively even-aged forests dominated by homogeneous, closed canopies, and have little vertical or horizontal diversity (Twedt and Wilson 2007, Twedt and Somershoe 2009). These forests provide relatively poor Swainson's Warbler habitat, and human disturbances, especially silviculture, could mimic natural disturbances and provide the heterogeneity to these forests that Swainson's Warblers prefer (Twedt and Wilson 2007, Twedt and Somershoe 2009).

Pashley and Barrow (1993) suggested selective cutting operations that mimic tree falls and increase intensity of light reaching the forest floor while maintaining a relatively closed canopy would help Swainson's Warbler, but thought that larger group selection cuts might not be beneficial. However, group selection and shelterwood cuts may provide suitable habitat; research in Louisiana has demonstrated that variable-

Appendix A continued

retention, clustered-thinning methods with or without embedded patch cuts may be beneficial for Swainson's Warblers (Twedt and Somershoe 2009). Single-tree selection is likely not ideal for Swainson's Warblers, as it may not create large-enough gaps to stimulate understory growth. (D. Twedt, pers. comm.).

As Swainson's Warblers require canopy or subcanopy cover, large clearcuts might not be ideal given that all vegetation is removed, which makes stands unsuitable for at least 5 years after the cut. Clearcuts may provide suitable habitat after trees begin to form a closed canopy and provide shade for a well-developed layer of leaf litter and dense understory, especially if other suitable forest stands are present on the landscape during this regeneration period. Indeed, Swainson's Warblers can be abundant in intensively managed forested landscapes, including those managed primarily for timber production, provided that a sufficient range of stand ages is present and they are relatively free from the adverse effects of flooding. With all of these silvicultural options, allowing natural regeneration of the vegetation after cutting, rather than using treatments such as shearing, is likely most beneficial (Peters 1999).

To create future breeding habitat by promoting cane regeneration, Eddleman et al. (1980) proposed creating forest openings (maximum 4 ha) by clear-cutting areas without cane but adjacent to stands of cane. To manage current habitat, they suggested selective cutting of mature trees in males' territories during the non-breeding season to increase cane production and longevity. Additionally, to manage cane in bottomland hardwood forests, Gagnon (2006) proposed a combination of disturbances including prescribed burns every 7 to 10 years and overstory thinning to maximize cane vigor and stand density.

Effectiveness Of Measures: The Species' Response

Although measures have not been implemented specifically to assess management effects on Swainson's Warblers, several studies have demonstrated that this species routinely occupies intensively managed forests (Henry 2004, Peters et al. 2005, and Thompson 2005, Bassett-Touchell and Stouffer 2006, Benson 2008, Benson and Bednarz 2010a).

Swainson's Warblers may respond to forest restoration as soon as 5–9 years after restoration, depending on restoration method (Twedt et al. 2002). However, responses to silvicultural treatments and restoration are likely most pronounced after 10 years, possibly peaking 15–20 years post-treatment, and then gradually declining until another treatment is applied (Heltzel and Leberg 2006, Twedt and Wilson 2007, Twedt and Somershoe 2009). Indeed, Swainson's Warbler densities in Louisiana forests treated with variable-retention, clustered-thinning methods increased from 5 years post-treatment to the conclusion of the study at 13 years post-treatment (Twedt and Somershoe 2009) and selectively harvested stands that were 12–18 years post-harvest had much greater warbler densities than stands that were 1–5 or >30 years post-harvest (Heltzel and Leberg 2006). In pine plantations, inclusion of some hardwood species could be beneficial as this provides a combination of pine and hardwood leaf-litter.

Graves (2002) recommended forests should be managed every 15–25 years to maintain Swainson's Warbler populations. However, Twedt and Somershoe (2009) suggest longer intervals (25–30 years) would likely be beneficial, as they found Swainson's Warbler densities remained high in 28-year-old forests. Similarly, Roa Vásquez (2010) found high Swainson's Warbler abundances in stands that were last harvested more than 40 years ago in se. Arkansas. Therefore, it would seem appropriate to define the frequency at which a forest should be managed based on the unique characteristics of each site and local Swainson's Warbler population estimates.

Although large-scale timber harvests could provide suitable habitat several years later, they should not take place in areas currently occupied by Swainson's Warblers; clear-cutting forest stands occupied by Swainson's Warblers caused the disappearance of local populations in Illinois (S. Bailey, pers. comm.). Additional controlled studies with long-term monitoring that evaluates multiple silvicultural treatments are ultimately needed to determine the best way to manage for Swainson's Warbler. Moreover, the effects of timber management on Swainson's Warbler reproductive success remain unknown, yet are necessary for determining successful long-term management for this species.



Photo: US Fish and Wildlife Service.