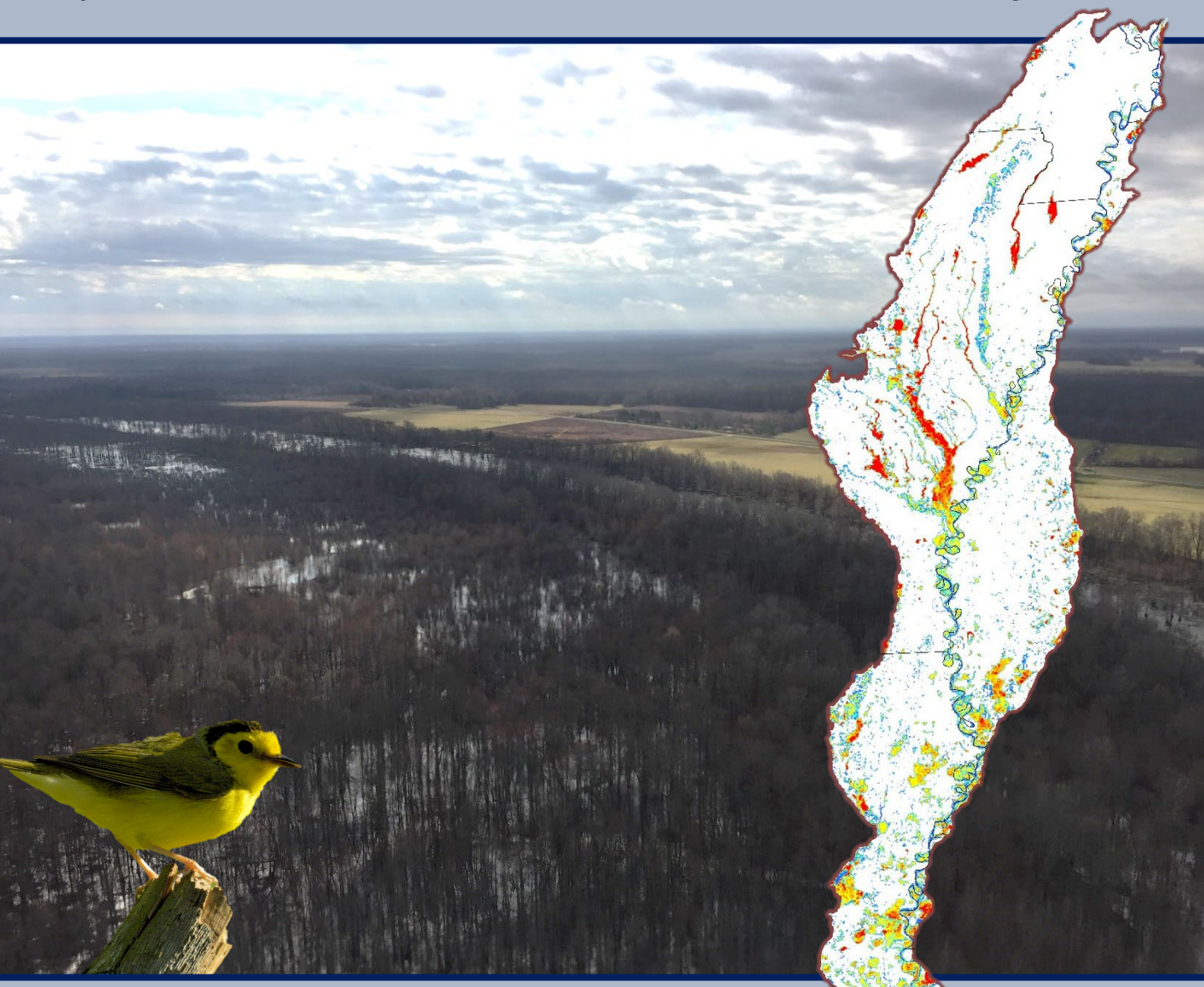
Mississippi Alluvial Valley

Forest-breeding Landbird

Population Goals & Quantitative Habitat Objectives



Lower Mississippi Valley
JOINT VENTURE
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Mississippi Alluvial Valley Forest-breeding Landbird Population Goals and Quantitative Habitat Objectives

Mississippi Alluvial Valley Landbird Team, Lower Mississippi Valley Joint Venture:

Dean Demarest, U.S. Fish and Wildlife Service
Blaine Elliott, Lower Mississippi Valley Joint Venture and U.S. Fish and Wildlife Service
Robert Ford, Partners in Flight and U.S. Fish and Wildlife Service
David Hanni, Tennessee Wildlife Resources Agency
Keith McKnight, Lower Mississippi Valley Joint Venture and U.S. Fish and Wildlife Service
Anne Mini, Lower Mississippi Valley Joint Venture and American Bird Conservancy
Daniel Twedt, Patuxent Wildlife Research Center, U.S. Geological Survey
Randy Wilson, U.S. Fish and Wildlife Service

Introduction

The Mississippi Alluvial Valley (MAV) is a 9 million ha (22-million-acre) floodplain that supports a diverse and ecologically rich bottomland hardwood forest ecosystem – one of the most productive in North America. It extends from roughly Cape Girardeau, Missouri, to the Gulf of Mexico and features a mosaic of ridges, swales, meander belts, and backswamps. Small changes in elevation (<1 foot) in the MAV are associated with large shifts in hydrology, which in turn, strongly affect plant and animal community composition and structure. The resultant diversity contributes to a fertile and productive floodplain. General forest types in the MAV include: Oak-gum-cypress (41%), elm-ash-cottonwood (29%), oak-hickory (17%), and the remainder is other forest types (Oswalt 2013). Within the oak-gum-cypress and elm-ash-cottonwood categories, sugarberry-hackberry-elm-green ash and sweetgum-Nuttall oak-willow oak forest types account for close to one-half of MAV bottomland forest acreage, while baldcypress-tupelo forests are about 16 percent (Oswalt 2013). Although we emphasize bottomland hardwood habitat and associated bird species, this planning effort includes analyses based upon all forest types within the MAV. Hence, the term 'forest' refers to all forest types in the MAV.

Since European colonization, the most significant threat to forest-interior landbirds that breed in the Mississippi Alluvial Valley Bird Conservation Region (BCR 26) has been the loss of bottomland hardwood forest habitat. By the early 1990's, less than 25% of the MAV remained forested, and most of the remaining bottomland hardwood forest occurred on the river side of the mainline Mississippi River levees or within the public land estate. In spite of these losses, the MAV continues to support significant migratory bird habitats and populations and is home to many federal-listed fish, plant, invertebrate, and mammal species. The Partners in Flight North American Landbird Conservation Plan (Rosenberg et al. 2016) highlighted the importance of the MAV as continentally important for six Watch List species and five Common Birds in Steep Decline that are reliant on forest habitats.

The Lower Mississippi Valley Joint Venture (LMVJV) vision is a landscape supporting healthy native bird populations and other wildlife. As such, the LMVJV partnership is committed to actions that help reverse bird population declines and maintain and improve the quantity and quality of bottomland hardwood forested habitat within the MAV. Herein, we specifically address "how much" forest habitat (bottomland hardwood forest and other forest types) is necessary to support target populations of forest breeding landbirds in MAV. It is integral to other recent planning efforts pertinent to forest breeding landbirds in the MAV that examine "where" bottomland hardwood forest reforestation (LMVJV 2015) and forest protection activities should be prioritized (Elliott et al. 2020), and "what conditions" should be sought in managing bottomland hardwood forest habitats for priority birds and wildlife (LMVJV Forest Resource Conservation Working Group 2007).

Previous Planning Context for Forest Breeding Landbirds – 1999 Plan

Establishing transparent, biologically-based, landscape-scale population and habitat objectives has been central to the work of the LMVJV partnership for over two decades. The Partners in Flight Bird Conservation Plan for the MAV: Version 1.0 (Twedt et al. 1999; hereafter, 1999 Plan) established forest-interior breeding landbird goals for the MAV based on an approach that expressed quantitative relationships between forest patch size and capacity of these patches to sustain "local source populations" of priority forest-interior breeding landbirds (Mueller et al. 2000). Specifically, the forest-interior breeding landbird goals were based on the amount of contiguous "core forest" habitat presumed necessary for supporting local source populations of high priority, forest-interior breeding species. Forest patches capable of supporting ≥500 breeding pairs of these focal species were assumed to also support at least that many pairs of other, less vulnerable forest breeding bird species which have less restrictive habitat requirements and typically occur at higher densities.

The 1999 Plan recognized that local source populations of different focal species would require contiguous patches of core forest habitat of differing extent. Thus, it was determined that local source populations of Swainson's and Prothonotary Warblers would require forest patches >4,000 ha, whereas Cerulean Warbler (>8,000 ha) and Swallow-tailed Kite (>40,000 ha) each required respectively larger forest patches. The 1999 Plan then identified existing forest patches and grouped them into 87 discrete Bird Conservation Areas according to their size, juxtaposition, and potential to "build" contiguous core forest in each of the desired size configurations: >4,000 ha (n = 52), >8,000 ha (n = 36) and >40,000 ha (n = 13). Forest habitat restoration objectives for each Bird Conservation Area were subsequently established by examining the area of non-forested habitat that would require restoration in order to achieve target core forest patch sizes. Based on distribution and condition of extant forest, as well as perceived conservation opportunity for non-forested tracts, the 1999 Plan identified priority areas for restoring and expanding core forest in each Bird Conservation Area. Achievement of patch size targets within all Bird Conservation Areas would require >1.5 million ha of forest restoration.

The breeding landbird goals for the MAV specified within the 1999 Plan were not species specific, nor were they derived in a way that was predicated on population size or trend (e.g., losses over time). Rather, forest-interior breeding landbird goals were largely a product of the opportunities inherent in and near extant forest and potential for restoration in relation to core forest patch sizes believed capable of supporting viable local breeding populations of a few focal species. Since publication of the 1999 Plan, extensive bottomland hardwood forest reforestation has increased the availability of forest habitat within the MAV (King et al. 2006; Mitchell et al. 2016). In addition, monitoring efforts continue to collect important bird population data. Current efforts identifying bird population goals and forest habitat objectives take into account these refinements over time.

Present Planning Context for Forest Breeding Landbirds

The effort herein relates to and builds upon three existing LMVJV conservation planning products with relevance to forest breeding landbirds:

1. Desired Forest Conditions for Wildlife in the MAV (LMVJV Forest Resource Conservation Working Group 2007), available at - **www.lmvjv.org/desired-forest-conditions**,
2. MAV Forest Breeding Bird Decision Support Model (LMVJV 2015), available at - **www.lmvjv.org/mav-bbdsm**, and
3. Forest Protection Priorities for the MAV (Elliott et al. 2020), available at - **www.lmvjv.org/s/MAV-Forest-Protection**

These three products respectively describe: landscape and stand-level bottomland hardwood forest habitat conditions desirable for supporting priority forest-interior breeding birds (Tables 1 & 2), bottomland hardwood reforestation priorities bearing optimal potential for creating and expanding core

"interior" forest (Fig. 1), and forest protection priorities to promote enduring benefits of extant forest habitats that may not be sufficiently secure at present (Fig. 1). These products collectively speak to the need to secure existing forest habitats, augment availability of core forest habitat, and promote habitat conditions favorable for a range of forest breeding bird priorities. All are rooted in explicitly established linkages that describe demonstrated or assumed relationships between forest breeding birds and the amount, condition and configuration of forest habitats.

Population goals and habitat objectives build upon and relate to these three existing planning products by establishing quantitative population goals for forest breeding landbirds rooted in population change, examining the capacity of extant forest habitat to fulfill these objectives, and estimating how much more habitat is necessary for those species whose goals are not presently supported.

Table 1. Desired landscape characteristics for bottomland hardwood forests within the Mississippi Alluvial Valley (LMVJV Forest Resources Conservation Working Group 2007).

Habitat Type	Percent of Area	Description
Forest Cover	70-100%	Large (>10,000 acre) contiguous forested areas are desired. At any point in time, a minimum 35% and optimum 50% of the forest should meet the desired stand structure conditions (See *Management of Bottomland Hardwood Forests, Table 2*).
Actively Managed Forest	70-95%	Forests that are managed via prescribed silvicultural treatments to meet desired stand conditions.
- **Regenerating Forest**	≤ 10%	Forest regeneration on areas > 7 acres (e.g., clearcuts where >80% of overstory has been removed) or forest restoration on agricultural lands (i.e., reforestation). However, achieving increased forest cover via reforestation overrides the 10% limitation.
- **Shrub/Scrub**	≤ 5%	Thamnic woody vegetation (hydric or mesic) within bottomland forests, including forests in early seral (successional) stages.
Passively Managed Forest	5-30%	Forest areas that are not subjected to silvicultural manipulation (e.g., no-cut, wilderness, set-aside, and natural areas).

Table 2. Desired stand characteristics for bottomland hardwood forests within the Mississippi Alluvial Valley (LMVJV Forest Resources Conservation Working Group 2007)

Forest Variables[1]	Desired Stand Structure	Conditions That May Warrant Management
Primary Management Factors		
Overstory Canopy Cover	60-70%	> 80%
Midstory Cover	25-40%	< 20% or > 50%
Basal Area	60-70 ft^2/acre with ≥ 25% in older age classes[2]	> 90 ft^2/acre or ≥ 60% in older age classes
Tree Stocking	60-70%	< 50% or > 90%
Secondary Management Factors		
Dominant Trees[3]	> 2/acre	< 1/acre
Understory Cover	25-40%	< 20%
Regeneration[4]	30-40% of area	< 20% of area
Coarse Woody Debris (>10 inch diameter)	≥ 200 ft^3/acre	< 100 ft^3/acre
Small Cavities (<10 inch diameter)	> 4 visible holes/acre or > 4 "snag" stems ≥ 4 inch dbh or ≥ 2 stems > 20 inch dbh	< 2 visible holes/acre or < 2 snags ≥ 4 inch dbh or < 1 stem ≥ 20 inch dbh
Den Trees/Large Cavities[5] (>10 inch diameter)	1 visible hole/10 acres or ≥ 2 stems ≥ 26 inch dbh (≥ 8 ft^2 BA ≥ 26 inch dbh)	0 visible holes/10 acres or < 1 stem ≥ 26 inch dbh (< 4 ft^2 BA ≥ 26 inch dbh)
Standing Dead and/or Stressed Trees[5]	> 6 stems/acre ≥ 10 inch dbh or ≥ 2 stems ≥ 20 inch dbh (> 4 ft^2 BA ≥ 10 inch dbh)	< 4 stems ≥ 10 inch dbh/acre or < 1 stem ≥ 20 inch dbh (< 2 ft^2 BA ≥ 10 inch dbh)

[1] Promotion of species and structural diversity within stands is the underlying principle of management. Management should promote vines, cane, and Spanish moss within site limitations.

[2] "Older age class" stems are those approaching biological maturity, (i.e., senescence). We do not advocate aging individual trees but use of species-site-size relationships as a practical surrogate to discern age.

[3] Dominants (a.k.a. emergents) should have stronger consideration on more diverse sites, such as ridges and first bottoms.

[4] Advanced regeneration of shade-intolerant trees in sufficient numbers (circa 400/acre) to ensure their succession to forest canopy. Areas lacking canopy (i.e., group cuts) should be restricted to < 20% of stand area.

[5] Utilizing BA parameters allows the forest manager to maintain this variable in size classes that are most suitable for the stand instead of using specific size classes noted.

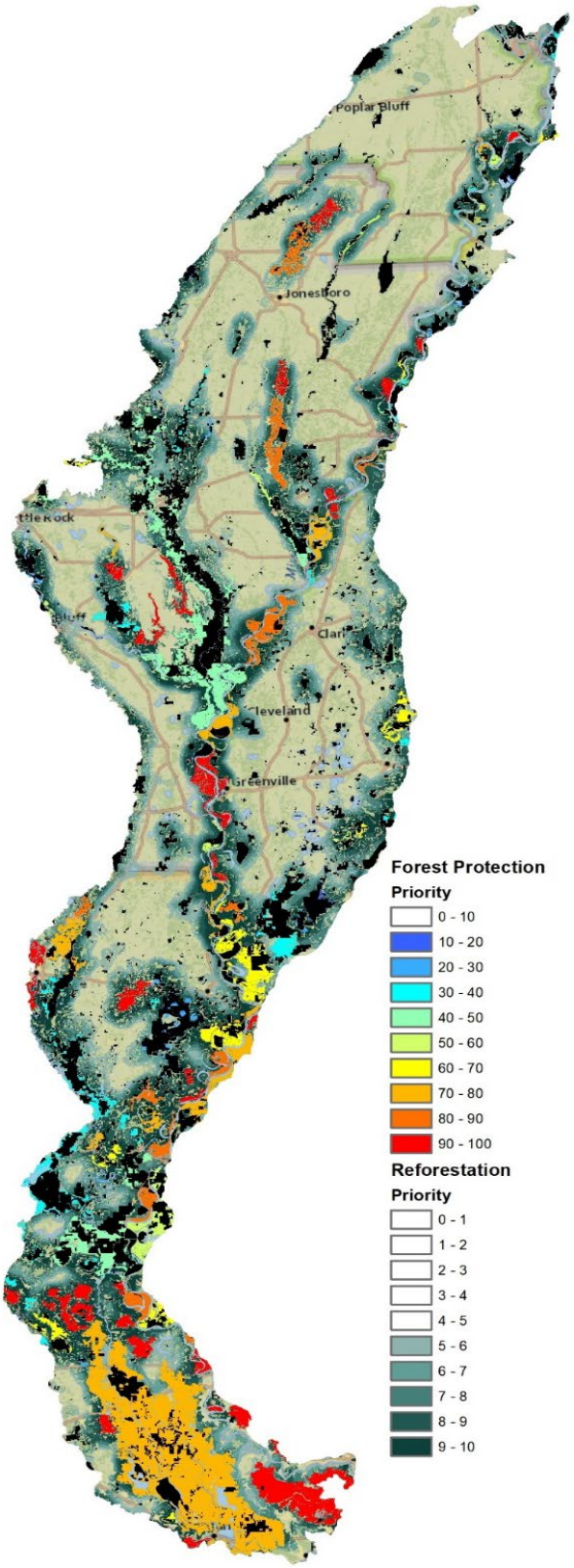

Figure 1. Higher priority reforestation areas identified within Forest Breeding Bird Decision Support Model (LMVJV 2015) and protection priorities specified by the Forest Conservation-Protection Model (Elliott et al. 2020) for the Mississippi Alluvial Valley.

Establishing Forest Breeding Landbird Population Goals and Habitat Objectives

We established population goals for each forest breeding bird species in the MAV (Tables 3-5) using their current estimated population and the long-term population trend for each species. We then evaluated the capacity of extant forest habitat in the MAV to support these species-specific population goals using empirically derived estimates of minimum sustainable populations and estimated occupancy of each species within the MAV (Twedt and Mini 2020). Population size (number of pairs), minimum sustainable population, probability of occupancy, and long-term trend (Sauer et al. 2017) for each species were estimated using data from the North American Breeding Bird Survey (BBS; Pardieck et al. 2016). This evaluation elucidated which species' population goals could be achieved with existing forest habitat and which species required additional forest habitat to achieve their population goals.

Our objectives were: (1) to establish population goals for forest-breeding bird species based on quantitative, regional avian surveys; (2) to estimate the minimum sustainable population of each species that has a low likelihood (≤1%) of extirpation over a 100-year interval; (3) to estimate probability of occupancy of these species relative to measurable landscape covariates such as, forest cover, flood frequency, and geographic location; (4) to determine the minimum area of forest habitat required to support a minimum sustainable population for each species based on published density estimates in forest habitat for each species; and (5) to estimate the population of each breeding species within those forest patches deemed capable of supporting sustainable populations of the species.

If the estimated regional population of a species, summed for all 'sustainable populations', was less than the MAV population goal for that species, we hypothesize that additional management actions are required to attain the stated population goal. Management actions include: (1) alteration of the type of silvicultural management (Twedt 2012), (2) increasing the area of bottomland hardwood forest habitat via forest restoration (Twedt et al. 2006), or (3) for species not entirely dependent on forest habitat, recommending landscape changes likely to increase the area of occupied habitat.

Trend-based bird population goals are presented herein, with the intent of supporting populations assumed present in the late 1960s. As such, we back-projected 2015 population estimates to 1966 population estimates and determined how much habitat would be needed to support these populations. Based on published 1966-2015 avian population trend estimates for the MAV (Sauer et al. 2017), we categorized species as having:

(1) a positive (upward) population trend, including all values within the credible interval (CI) for the trend estimate;
(2) a positive (upward) population trend, but which included a negative (downward) value as the lower limit of the CI for the trend estimate; or
(3) a negative (downward) trend estimate.

For those species with a positive (upward) population trend (inclusive of CI), we assumed our current population estimate sufficed as the population goal for the MAV. For species with an apparent positive trend (albeit with a CI that suggested a possible decrease), we established a population goal that was the current population estimate back-projected by the lower CI value for 50 years. For species with a negative population trend from 1966 to 2015, we established a population goal that was the current population estimate back-projected by the negative trend estimate for 50 years. We exempted non-native species (i.e., Cattle Egret, Eurasian Collared-Dove, European Starling, House Sparrow, and Rock Pigeon), adopting a population goal for these species of no more than their current estimated population.

Based on the results of Twedt and Mini (2020), we grouped birds into 3 categories:

1) Species with habitat sufficient to support their population goals,

2) Species with sustainable forest habitat sufficient to support population goals if optimally managed, and
3) Species with additional habitat needed to support their population goals.

Species with habitat sufficient to support their population goals.

For 30 species, sustainable habitat models indicated their population goals could be achieved within the current area of extant forest (Table 3). Twelve of these species had positive population trends. Sixteen

Table 3. Species with habitat sufficient to support population goals – either within sustainable habitat or within all habitat – within the Mississippi Alluvial Valley Bird Conservation Region

Common Name	% Population[a]	ACAD RCS-b[b]	Population Goal	Population Supported within Sustainable Habitat	Trend[c]
Swainson's Warbler	11.2	17	85,860	118,170	-/+
Red-headed Woodpecker[1,2,3]	4.1	16	347,030	460,170 [d]	-/+
Acadian Flycatcher[1]	2.67	16	597,420	4,751,318	+
Yellow-billed Cuckoo[1,3]	5.35	15	1,344,810	1,401,533	-
White-eyed Vireo[3]	2.98	15	2,586,730	4,607,796	-
Mississippi Kite[2]	13.6	13	434,040	658,926[d]	+
Ruby-throated Hummingbird	1.92	13	1,309,130	6,995,026	-/+
Kentucky Warbler[1]	1.54	13	87,400	194,259	-/+
Yellow-throated Vireo[1,3]	1.10	13	132,590	182,078	-/+
Swallow-tailed Kite	0.53	13	1,790	2,235 [d]	+
Barred Owl[1,3]	8.2	12	40,110	235,846 [d]	+
Carolina Wren[1]	5.29	12	2,711,610	4,937,279	+
Red-bellied Woodpecker[2,3]	4.64	12	914,650	2,004,691	+
Boat-tailed Grackle[2]	4.30	12	14,900	18,472 [e]	-/+
Tufted Titmouse	3.00	12	973,910	1,535,361	+
Downy Woodpecker[1,2,3]	2.69	12	1,471,890	1,872,009	-/+
Summer Tanager[1,2,3]	2.59	12	761,750	1,170,215	+
Hooded Warbler	1.70	12	476,370	727,601	-/+
Pileated Woodpecker[1]	1.66	12	161,820	216,763	-/+
Eastern Wood-Pewee[1]	2.63	11	243,990	268,622	+
Northern Cardinal[1,3]	4.34	10	4,426,020	6,998,153	-/+
Great Crested Flycatcher	2.15	10	594,630	992,494	+
White-breasted Nuthatch	0.21	10	56,110	232,145	-/+
Black-and-White Warbler	0.006	10	33,190	131,917 [e]	-/+
Blue-gray Gnatcatcher[1]	2.06	9	2,467,450	9,594,162	-/+
American Crow	1.03	9	280,150	363,444	+
Eastern Phoebe[3]	0.4	9	35,110	45,480 [d]	-/+
American Redstart	0.02	9	113,840	291,295	-/+
Red-eyed Vireo	0.09	8	495,640	938,754	-/+
American Robin[2]	0.23	7	721,950	807,124 [d]	+

[a] Percent of global population found in MAV Bird Conservation Region; [b] Avian Conservation Assessment Database Regional Concern Score for Breeding (see http://pif.birdconservancy.org/ACAD/;Panjabi et al., 2020); [c] + = positive trend; -/+ = confidence interval overlaps 0; - = negative trend; [d] estimates are based on total habitat, not sustainable forest habitat; [e] no estimate within sustainable habitat; [1] Positive association with edge; [2] Positive association with urban; [3] Negative association with forest.

species had credible intervals that overlapped zero, indicating an uncertainty in their population trend. Two species (White-eyed Vireo, Yellow-billed Cuckoo) appear to have sufficient habitat to support their population goals but significant negative population trends associated with these species suggest continuing conservation attention is warranted. Notably, some species, based on their occupancy models, are not forest-dependent but rather are associated with forest edges, urban areas, or not strongly associated with forest.

Species with forest habitat sufficient to support their population goals if optimally managed.

To account for management of existing forest, we examined the U.S. Forest Service's Forest Inventory and Analysis (FIA) database to estimate the proportion of forest stands likely to have been subjected to management (i.e., timber harvest). These data indicated 14% of stands had evidence of silvicultural treatment within the past five years: 26% of these treated stands had been clear-cut with the remaining stands subjected to partial harvest or thinning. Density estimates for each species that were associated with these silvicultural treatments, proportional to the application of those treatments within the MAV, were used to assess current populations. We then estimated each species' theoretical population based on the number of territories that could be located within the entirety of occupied habitat in the MAV, at each management specific density.

For six species, our sustainable habitat models indicated that population goals could be met if existing forest was managed for their 'optimal' density (Table 4). Two of these species had uncertain population trends whereas four species had negative population trends. Further, several species assumed to have sufficient habitat at present (i.e., in Table 3) depend upon relatively specific ranges of forest structural attributes. For example, Swainson's Warbler is often associated with well-developed cane brake habitat, many other species have associations with under- and mid-story conditions requiring canopy gaps, and Kentucky and Swainson's Warblers exhibit a dependence upon higher elevation, less-frequently flooded forests. These examples highlight the importance of promoting conservation-management actions focused on the LMVJV's Desired Forest Conditions for Wildlife.

Table 4. Species with habitat sufficient to support population goals given optimal management of forest habitat within the Mississippi Alluvial Valley Bird Conservation Region

Common Name	% Population	ACAD RCS-b	Population Goal	Population Supported by Optimally Managed Forest	Trend
Yellow-breasted Chat[1,3]	3.32	15	1,276,300	1,432,649	-
Brown Thrasher[1,2]	1.47	14	529,250	865,775	-
Wood Thrush	0.89	14	69,990	215,289	-
Cerulean Warbler	0.33	14	10,100	24,963	-
Eastern Towhee[1]	1.67	12	353,030	837,257	-/+
Indigo Bunting[1]	4.53	11	3,122,820	3,282,164	-/+

[1] Positive association with edge; [2] Positive association with urban; [3] Negative association with forest.

Species with additional habitat needed to support their population goals.

For 19 species, our habitat models indicated that the current amount of habitat, even if managed for optimal density of the species, is insufficient to sustain their population goals. For nine of these species (Blue Jay, Common Yellowthroat, Chimney Swift, Field Sparrow, Fish Crow, Orchard Oriole, Painted Bunting, Baltimore Oriole, Common Grackle), we determined that their population goals could not likely be achieved solely within forest habitat, and therefore their population goals would need to be met in other ways. For 10 species (Table 5), we estimated that an additional 700,000 ha of sustainable forested habitat would be sufficient to meet their population goals (Twedt and Mini 2020).

Table 5. Species that need additional forest habitat to support their current population goals

Common Name	% Population	ACAD RCS-b	Population Goal	Additional Habitat Need	Trend
Prothonotary Warbler	32.09	17	3,999,000	958,299	-
Northern Parula	2.85	16	3,160,600	566,835	-
Carolina Chickadee[1,2]	4.35	13	3,707,440	509,444	-/+
Red-shouldered Hawk	3.10	12	145,560	687,676	-/+
Yellow-throated Warbler	1.12	12	33,330	701,649	+
Pine Warbler	0.69	11	830	103,242	-/+
Hairy Woodpecker	0.26	10	123,170	267,915	-
Wild Turkey	0.17	10	2,530	498,311	-/+
Warbling Vireo	0.12	10	58,630	702,783	-/+
American Goldfinch	0.18	8	126,990	138,928	-/+

[1] Positive association with edge; [2] Positive association with urban; [3] Negative association with forest.

Discussion

The current 'State of the Birds' (NABCI 2019) reported forest birds have suffered a 22% decrease since 1970, and Rosenberg et al. (2019) estimate a decline of nearly 650 million breeding Eastern Forest and Forest Generalist birds since 1970. Several of the species treated here are on the Partners in Flight Continental Plan Watch List or are Common Birds in Steep Decline. Additionally, population trends for some of these species are more steeply declining within the MAV than in Eastern North America (i.e., Eastern BBS region). For example, the 4 species with negative population trends that need additional habitat to support their population goals, have much steeper declines in the MAV than in eastern North America (Table 6).

Table 6. Species needing additional habitat to support their current population goals, which also are in steeper decline in the MAV than in the Eastern U.S.

Species	MAV-wide BBS trend 1966-2015	Eastern BBS trend 1966-2015
Prothonotary Warbler	-1.40 (-2.47, -0.30)	-0.74 (-1.19, -0.29)
Northern Parula	-3.38 (-4.78, -1.86)	1.33 (0.97, 1.66)
Field Sparrow	-3.85 (-8.25, -1.98)	-2.79 (-2.97, -2.63)
Hairy Woodpecker	-2.11 (-3.81, -0.39)	0.93 (0.31, 1.39)

One important concept confirmed through our modeling is that the quality/condition of the forest has a significant impact on potential occupancy and population estimate. The LMVJV Forest Resources Conservation Working Group (2007) recommended silvicultural management to positively influence bottomland hardwood forest structure (Table 2) and to promote "Desired Forest Conditions for Wildlife." These habitat parameters explicitly link wildlife needs to structural bottomland hardwood forest attributes, addressing important aspects of bottomland hardwood forest conservation for provision of wildlife habitat in the MAV. Pursuit of these stand scale and landscape scale (Table 1) desired conditions by partners will continue to be a priority of the LMVJV, especially with the understanding that meeting forest breeding bird objectives is dependent upon attaining desired conditions within bottomland hardwood forest habitats of the MAV.

This planning effort confirms the high value of sufficient forest core habitat to the conservation of our priority bird populations. Increasing and maintaining forest core in the MAV requires both the strategic

placement of reforestation activities and retention of existing forest within and contributing to forest core (Fig. 1). The LMVJV's MAV Forest Protection Model (Elliott et al. 2020) and MAV Forest Breeding Bird Decision Support Model (https://www.lmvjv.org/mav-breeding-bird-decision-support-model) provide partners with spatial guidance for placement of protection and reforestation, respectively.

As we are unsure of what is causing more steeply declining populations within the MAV, further investigation of these species' population trends is warranted. We recognize the need to consider the full annual cycle of landbirds that breed in the MAV. Most of these birds make long migrations across the Gulf of Mexico and spend the winter in Central and South America. For example, Prothonotary Warblers breed across much of the Eastern United States but have a limited winter range (Fig. 2). It is possible, for this and other species, that the limiting factors may not entirely be on the breeding grounds. We are supportive of efforts to better elucidate limiting factors throughout the life cycles of forest nesting birds that breed in the LMVJV region, and will incorporate this information into our objectives as it comes available. Meanwhile, it is the responsibility the LMVJV partnership to work towards ensuring that sufficient breeding habitat is provided within our geography.

The LMVJV partnership has leveraged and marshaled resources over the past three decades towards an impressive record of substantial, strategic restoration of bottomland hardwood forest habitat in the MAV (https://www.lmvjv.org/brochures-summaries). We are confident that through continued collaboration and cooperation we can ultimately attain our partnership goal of sustaining populations of forest breeding landbirds.

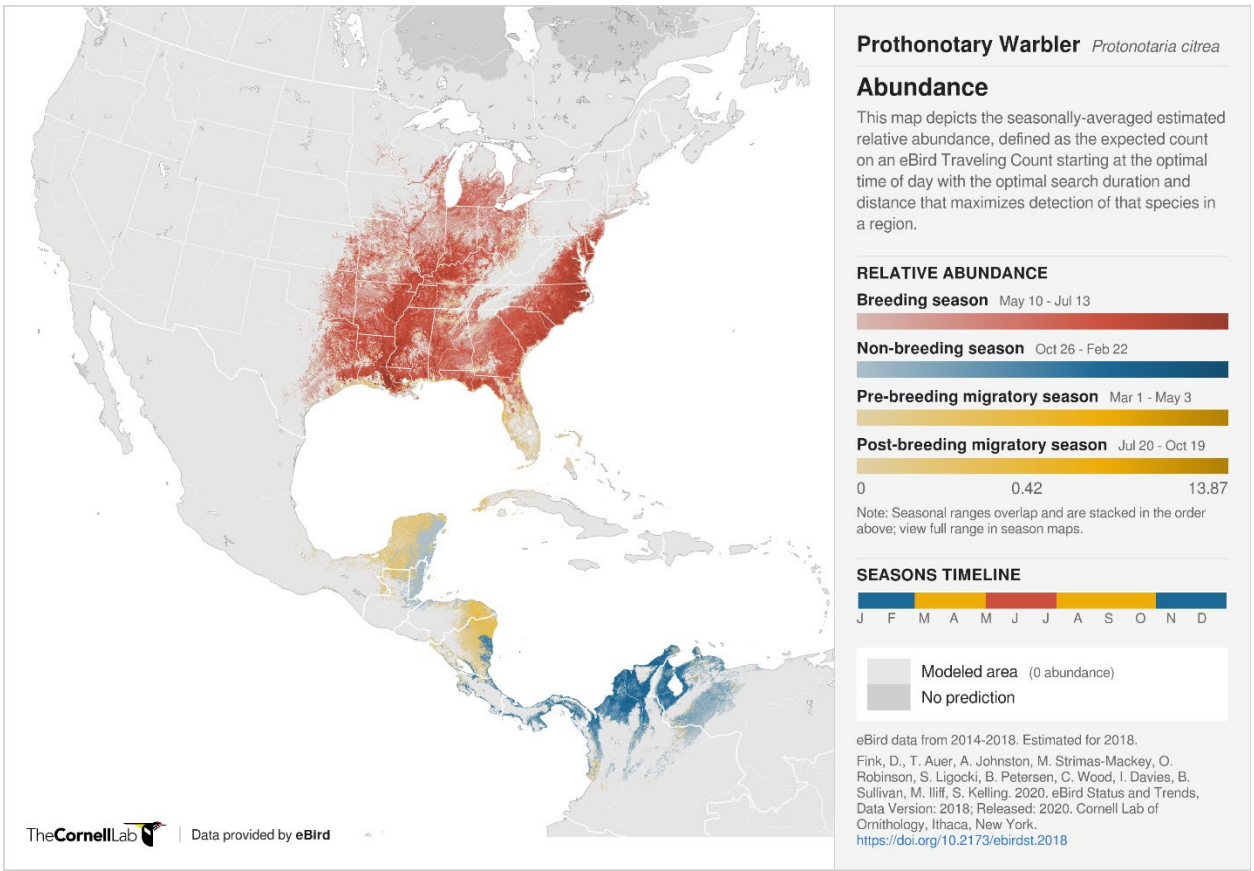

Figure 2. Seasonal distribution of Prothonotary Warbler.

Research Needs

Given the uncertainties in what may be driving population trends and occupancy of habitat, research projects that address certain fundamental needs are crucial. As such, research and information needs remain an LMVJV priority (Table 7).

Table 7. Research and information needs for birds in the Mississippi Alluvial Valley.

Category	Question	End-point to measure management performance	Uncertainty Description	Uncertainty Category	Effect Size
Site/area management and habitat quality	How do silvicultural practices affect habitat quality for forest landbirds? What are appropriate silvicultural techniques?	Survival, population size, productivity (breeding), pre-migratory body condition	Silvicultural practices can have positive and negative effects on habitat quality of adjacent forest	High	High
Site/area characteristics and population demographics	What are the important forest stand characteristics (block shape/size, age, species composition, vertical structure, proximity to other forest blocks, etc.) for maintaining and/or increasing populations of forest landbirds?	Survival, population size, productivity (breeding), pre-migratory body condition	It is currently unclear how interactions among stand- and site-level vegetation characteristics, forest block size, shape and connectivity, and arthropod and fruit densities affect avian demography. The degree to which silvicultural practices and other management can replicate natural processes in creating habitat for bird species of concern is not clear, or varies by species	High	High
Climatic processes	Will climate-induced changes in vegetation structure and composition affect resources available to forest breeding landbirds?	Invertebrate species richness and abundance, fruiting plant species richness and abundance, body condition at autumn departure, productivity, habitat use	There is uncertainty about how climate-induced changes in the vegetation composition and structure of habitats influence food availability and nesting substrates for forest breeding landbirds	High	High

Recommended Conservation Actions

- ACHIEVE **OPTIMAL FOREST SPATIAL CONFIGURATION AND STRUCTURE** AS GUIDED BY DESIRED FOREST CONDITIONS FOR WILDLIFE WITHIN ALL FOREST HABITAT
- FACILITATE **LONG-TERM INTEGRITY OF FOREST HABITAT** THROUGH APPROPRIATE MEANS OF PROTECTION, PRIORITIZED AS GUIDED BY THE MAV FOREST CONSERVATION-PROTECTION MODEL
- SEEK TO ESTABLISH A MINIMUM OF **700,000 HECTARES OF ADDITIONAL SUSTAINABLE FOREST** HABITAT, PRIORITIZED AS GUIDED BY THE MAV FOREST BREEDING BIRD DECISION SUPPORT MODEL
- **ADDRESS KEY UNCERTAINTIES** IN MODELS DRIVING OUR UNDERSTANDING OF POPULATION TRENDS AND OCCUPANCY OF HABITATS THROUGH SCIENCE

Citations

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