Breeding, stopover, and wintering habitat in the eastern US and the role of private, working forests

Working Forests, Forest Sustainability, and At-risk Species Program
Progress Report - September 2023

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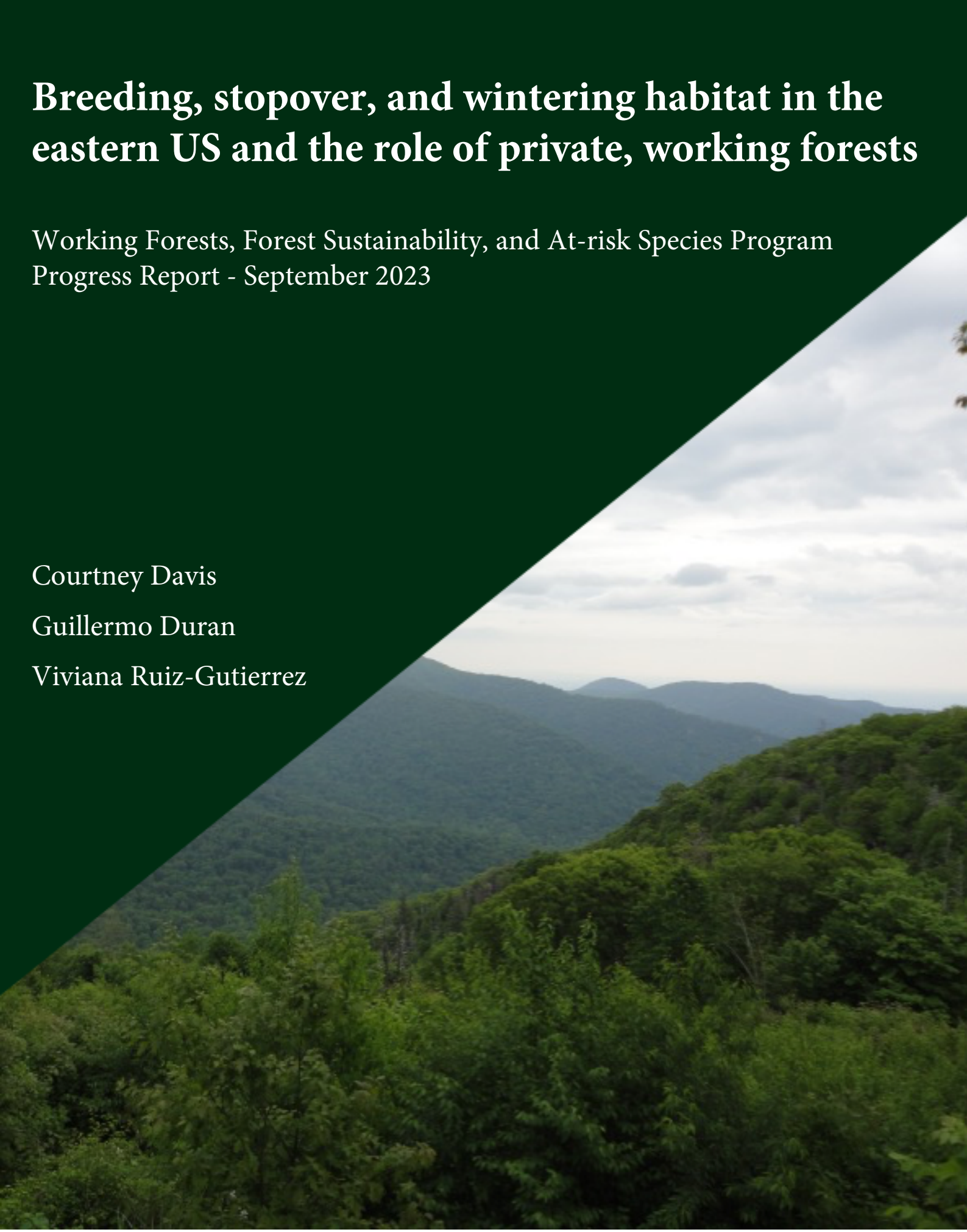

The Cornell Lab of Ornithology

Cornell University

NCASI
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Summary of Progress

We have made significant progress to date on our objectives of assessing the contribution of private working forests to migratory bird habitat. We have now generated priority area surfaces that we refer to as Bird Concentration Areas (BCAs) for migratory forest birds in the Eastern United States. In this report, we present results of a preliminary analysis evaluating the contribution of all forests to BCAs that support a high diversity or abundance of forest bird species in the region of interest. In doing so, we have accomplished a key objective of our work.

We continue to align similar work across partners, including the United States Fish and Wildlife Service, to ensure that similar methodologies can and are being used to identify avian priority areas across the full annual cycle. A key next step will be evaluating the contribution of private working forests relative to all other forests and other land cover types. We anticipate the landscape-level contribution of private working forests, across multiple owners, to provide important resources during the annual migration cycle given that they are commonly concentrated in large blocks in rural landscapes.

Wood thrush
© John Petruzzi

Next Steps

1. Cornell is working in parallel with the United States Fish and Wildlife Service to refine the methodologies used to create Bird Concentration Areas for different species groups of interest, including the use of species-specific weights based on regional population trends and/or conservation scores. The use of species-specific weights will ensure that areas of highest importance are adequately captured in future BCAs, particularly those related to species abundance.

2. Cornell will use GIS information to be provided by NCASI to estimate the contribution of private working forests and member parcels to forest bird BCAs using two metrics: 1) the percent of BCAs covered by private working forests vs other forests vs all other land covers; and 2) the percent of the population within a BCA for species of interest that are found within private working forests.

3. Cornell will generate additional summaries and visualizations, including the discretization of continuous BCA surfaces into polygons, and the identification of areas that support high species diversity ***and*** abundance (i.e., by overlaying the two types of BCA layers included in this report). Cornell will also incorporate any feedback to improve summaries and visualizations to ensure that the generated information is as useful as possible for monitoring, prioritization, and decision-making. Points of discussion could include changing the threshold by which forests are defined or by which we select areas of highest importance.

Bird Concentration Areas (BCAs)


Pine warbler
© Luke Seitz

Overview

We created Bird Concentration Areas (BCAs) using eBird data products on species' relative abundance for 175 forest-breeding migratory landbirds that occur in the Eastern United States. These BCAs reflect priority areas across the Eastern United States that either maximize the total number of birds or the total number of species predicted to occur throughout the full annual cycle. BCAs are characterized by a continuous Bird Concentration Index (BCI) that captures fine-scale differences in the relative importance of locations and can be independently generated for different species groups of interest (e.g., migratory forest birds) and seasons across the full annual cycle (e.g., breeding vs. migratory periods).

Here, we generated season-specific BCAs (**Appendix A**) using species-specific time frames for the breeding, non-breeding, and migratory periods. We also generated year-round BCAs by taking the maximum relative abundance values for each species and pixel across all 52 weeks of the year (**Figure 1**). More details on how we derived BCAs are provided below.

Identifying BCAs based on species diversity

For each 2.8km x 2.8km cell and species, we thresholded weekly eBird relative abundance estimates to a binary occurrence value. We then summed pixel values across the 175 species included in our analysis to create a continuous BCI of species diversity.

Identifying BCAs based on species abundances

For each 2.8km x 2.8km cell and species, we used the eBird relative abundance estimates to calculate the percent of the species' population across the entire range of values for a given season. We then estimated the maximum value for each season and across all 52 weeks of the year. Finally, we thresholded species-species values to retain pixels above the 80th percentile, and summed pixel values across the 175 species included in our analysis to create a continuous BCI of species abundances.

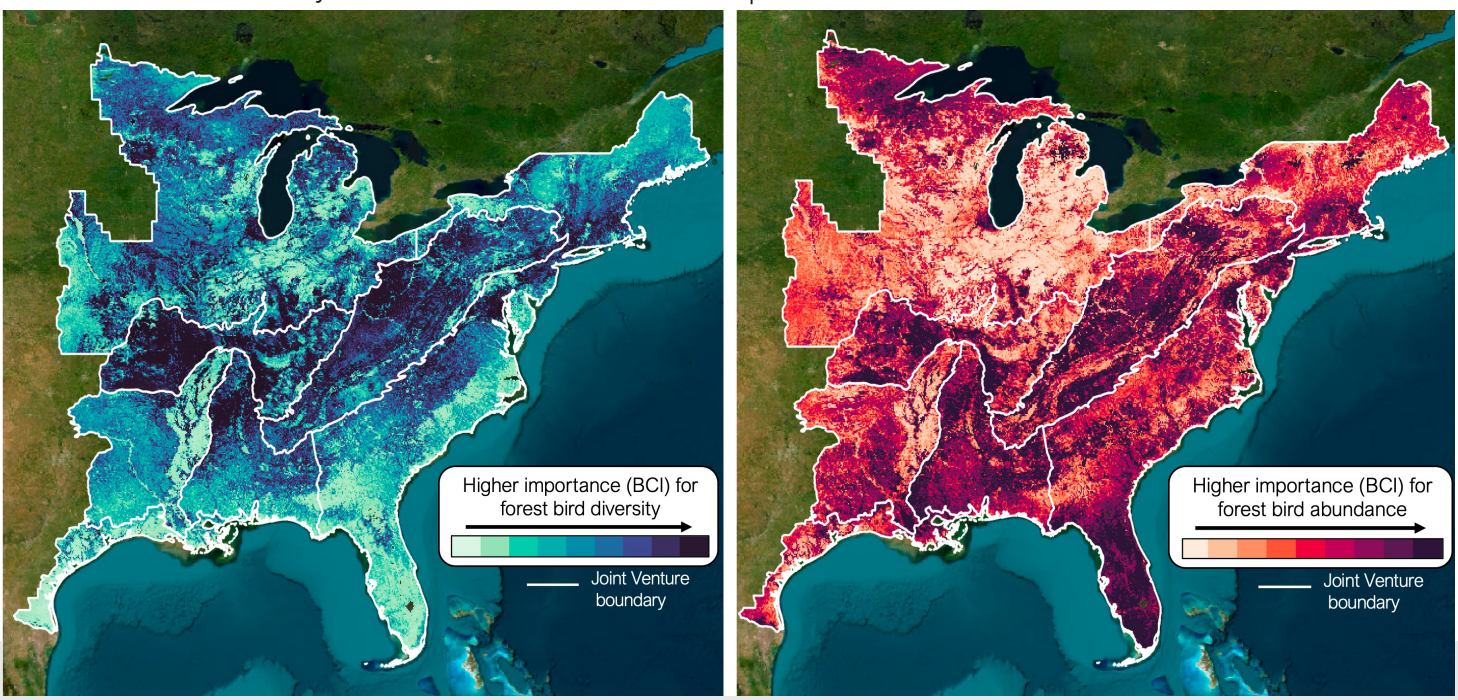


Figure 1: Bird Concentration Areas (BCAs) that support a high number of migratory forest bird species (left panel) and abundance (right panel) across the full annual cycle. BCAs are characterized by a continuous Bird Concentration Index (BCI) that differentiate areas of highest importance in each season of the annual cycle and across all 52 weeks of the year (as shown here) at a high spatial resolution of 2.8km x 2.8km.

Contributions of Forest to BCAs

Overview

We evaluated the contribution of eastern forests to BCAs of migratory bird diversity and abundance using several different metrics. To do this, we first retrieved land cover data from the National Land Cover Database (NLCD). We combined deciduous forest, evergreen forest, and mixed forest into a single forest type. We then re-sampled the 30-meter resolution NLCD data to match the spatial resolution eBird data, and calculated the percent of the 2.8 x 2.8km covered by forest. Finally, we classified any pixel with a percent cover greater than or equal to 33% as forest. All other pixels were classified as non-forest for this analysis.

Forests contribute significantly to migratory BCAs

Eastern forests contribute significantly to migratory BCAs. We found that a high percentage of high-BCI pixels (i.e., those that exceed the 80th percentile of all pixel values) for migratory bird diversity and abundance occur in forested areas compared to non-forested landscapes (**Figure 2**).

Overall, forests had significantly higher mean BCI values and less variation in BCI values than non-forested areas (**Figure 3**). These patterns were stronger for species diversity and in the breeding season. The observed patterns for species abundance may be driven by one or two highly abundant species, and the incorporation of species-specific weights based on conservation score or population trend will help to further refine these patterns (i.e., by down-weighting highly abundant species). Taken together, our results suggest that eastern forests provide critically important habitat for the set of migratory birds we analyzed, supporting more diverse and abundant bird communities.

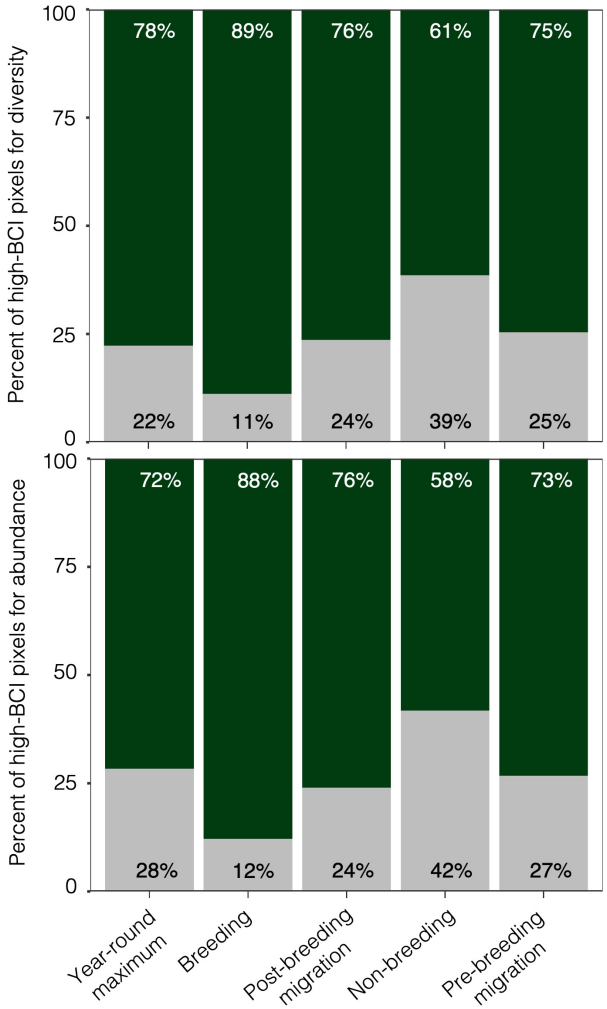


Figure 2: Percent of high-BCI pixels for migratory bird diversity (top panel) and abundance (bottom panel) that occur in forested areas vs. other land covers in each season of the annual cycle. High-BCI pixels are those that exceed the 80th percentile of all pixel values for a given season.

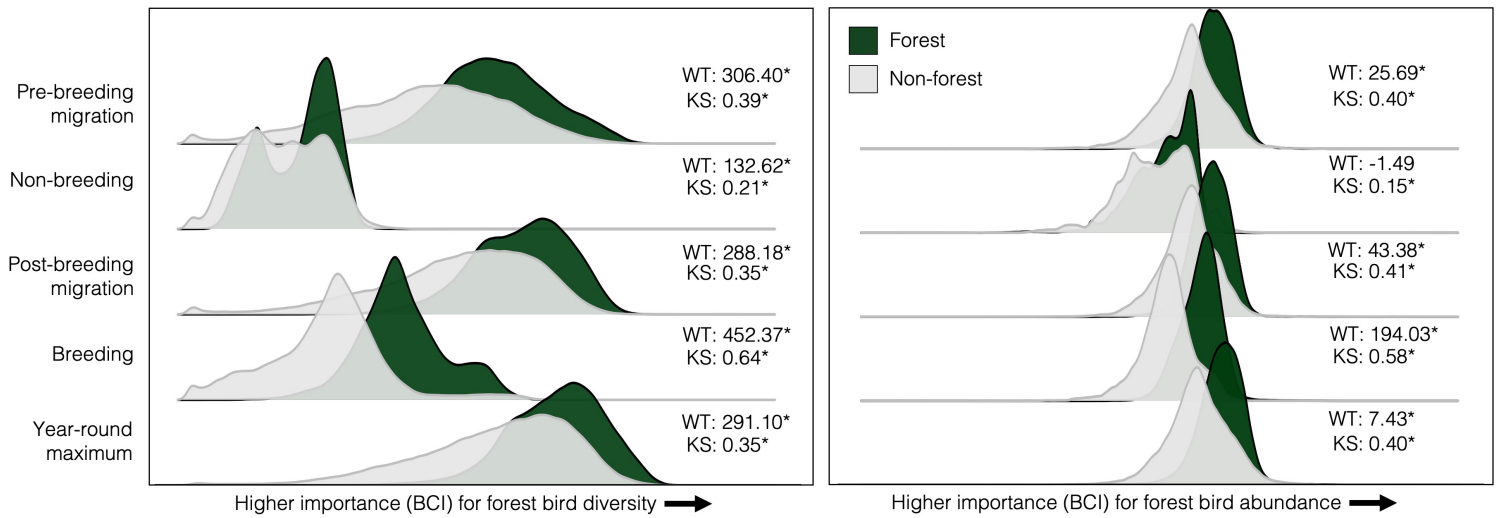


Figure 3: Distribution of BCI values for migratory bird diversity (left panel) and abundance (right panel) that occur in forested areas vs. other land covers in each season of the annual cycle. WT = test statistic from Welsh's two-sample t-test evaluating differences between mean values. KS = es statistic from Kolmogorov-Smirov two sample test evaluating differences between distributions. * = significant differences between forested areas and other land covers for a given test, season, and type of BCA. Forested areas were significantly more important for forest bird diversity and abundance than other (non-forested) land covers.

Species-specific Priority Areas

Overview

In addition to the group-level BCAs discussed above, we generated summaries for species-specific priority areas that support a high percentage of each species' population throughout the full annual cycle. Species-specific priority areas, which are the building blocks of the group-level BCAs, can help identify areas that are more important for individual species of concern. For example, the Appalachian mountains, Central Hardwoods and western portion of the Southeastern Coastal Plain are extremely important areas for the wood thrush across its annual life cycle (top panel of **Figure 4**). Additional species-specific maps and summaries for a subset of species are included in Appendix B.

Forests provide critical habitat for migratory species

Unsurprisingly, we found that an overwhelming percent of high-BCI pixels for forest-dependent species like wood thrush (Figure 4), cerulean warbler, Kentucky warbler, and hooded warbler occurred in forest. Some species, like the Swainson's thrush, Acadian flycatcher, and prairie warbler, relied more heavily on forest only in the breeding season (Appendix B).

For each species, we also summarized the percent of the species' population in the study region that overlapped with forested areas versus all other land cover types (**Table 1**). We found that a large percentage of migratory species' populations overlapped with forest. Percentages were highest during the breeding season for most species, but varied by season. Species that prefer more open habitats and forest edges, such as the Indigo Bunting, had the lowest percentage of their regional population in forest across the full annual cycle (**Table 1**).

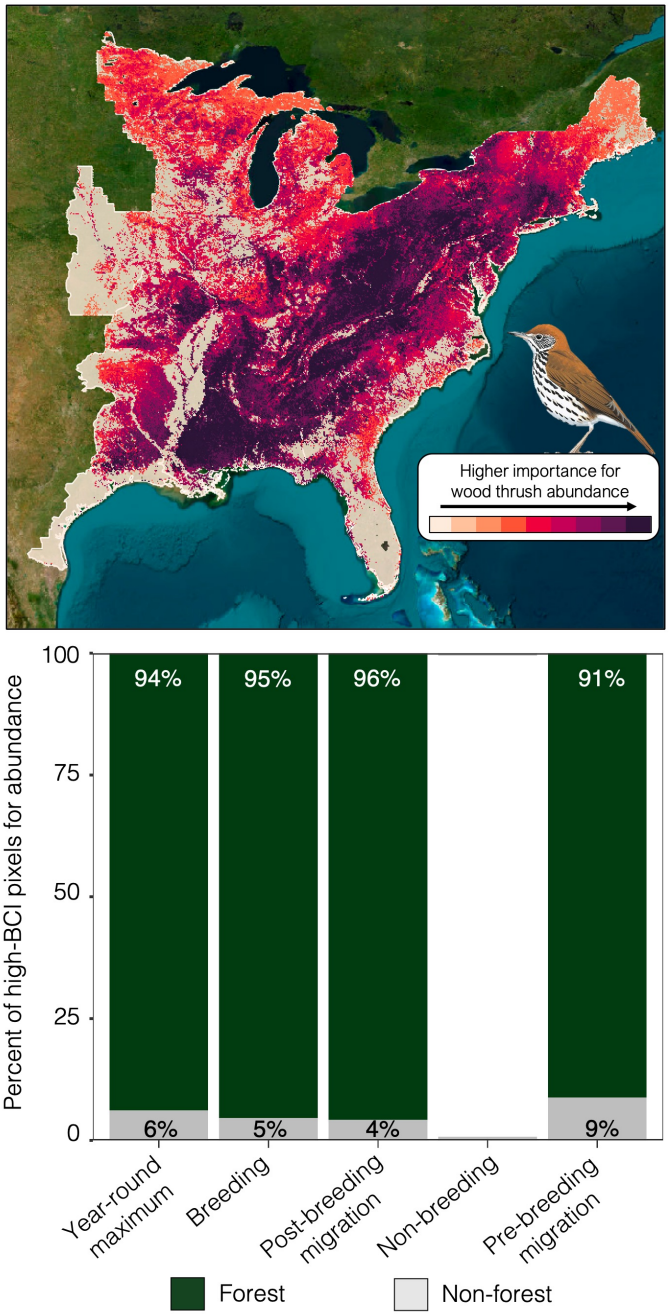


Figure 4: Map of year-round maximum percent of population for wood thrush (top panel), used to identify species-specific priority areas, and the percent of high-BCI pixels that occur in forested areas vs. other land covers in each season of the annual cycle (bottom panel).

Table 1: Percent of species-specific priority areas that fall in forested areas vs. all other land covers across the annual cycle for 9 of 175 mgiratory bird species included in our analysis.

	Year-round max.	Breeding	Post-breeding migration	Nonbreeding	Pre-breeding migration
Acadian flycatcher	73%	81%	73%	--	75%
Cerulean warbler	95%	99%	97%	--	95%
Hooded warbler	87%	93%	89%	--	87%
Indigo bunting	46%	56%	44%	0.1%	51%
Kentucky warbler	86%	92%	87%	--	87%
Pine warbler	73%	80%	73%	68%	74%
Prairie warbler	72%	91%	71%	4%	75%
Swainson's thrush	66%	91%	69%	--	58%
Wood thrush	82%	84%	87%	--	82%

Appendix A: Seasonal BCAs for Species Diversity

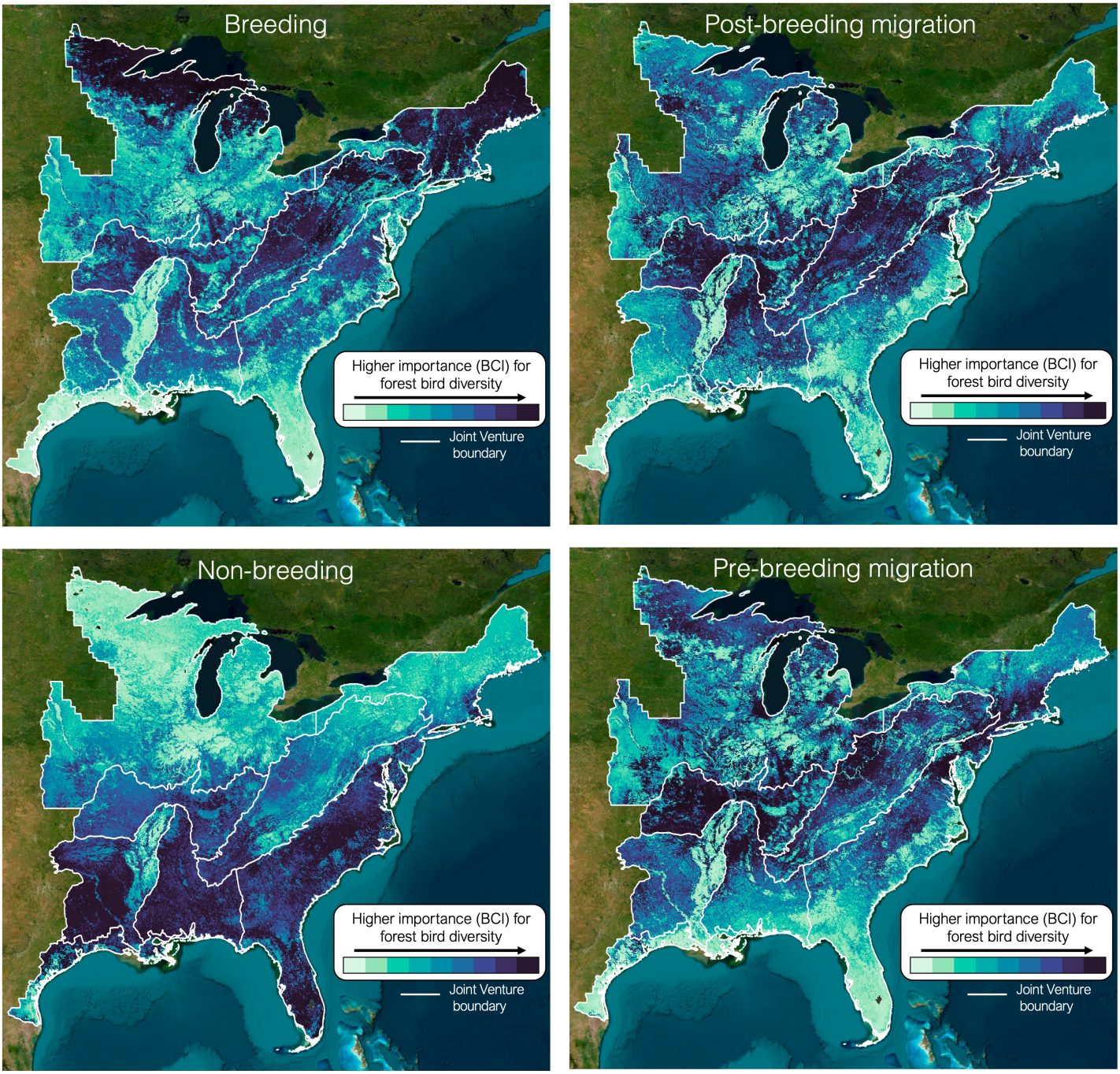


Figure A1: Seasonal bird Concentration Areas (BCAs) that support a high number of migratory forest bird species across the full annual cycle. BCAs are characterized by a continuous Bird Concentration Index (BCI) that differentiate areas of highest importance in each season of the annual cycle (as shown here) and across all 52 weeks of the year (shown in Figure 1) at a high spatial resolution of 2.8km x 2.8km.

Appendix A: Seasonal BCAs for Species Abundance

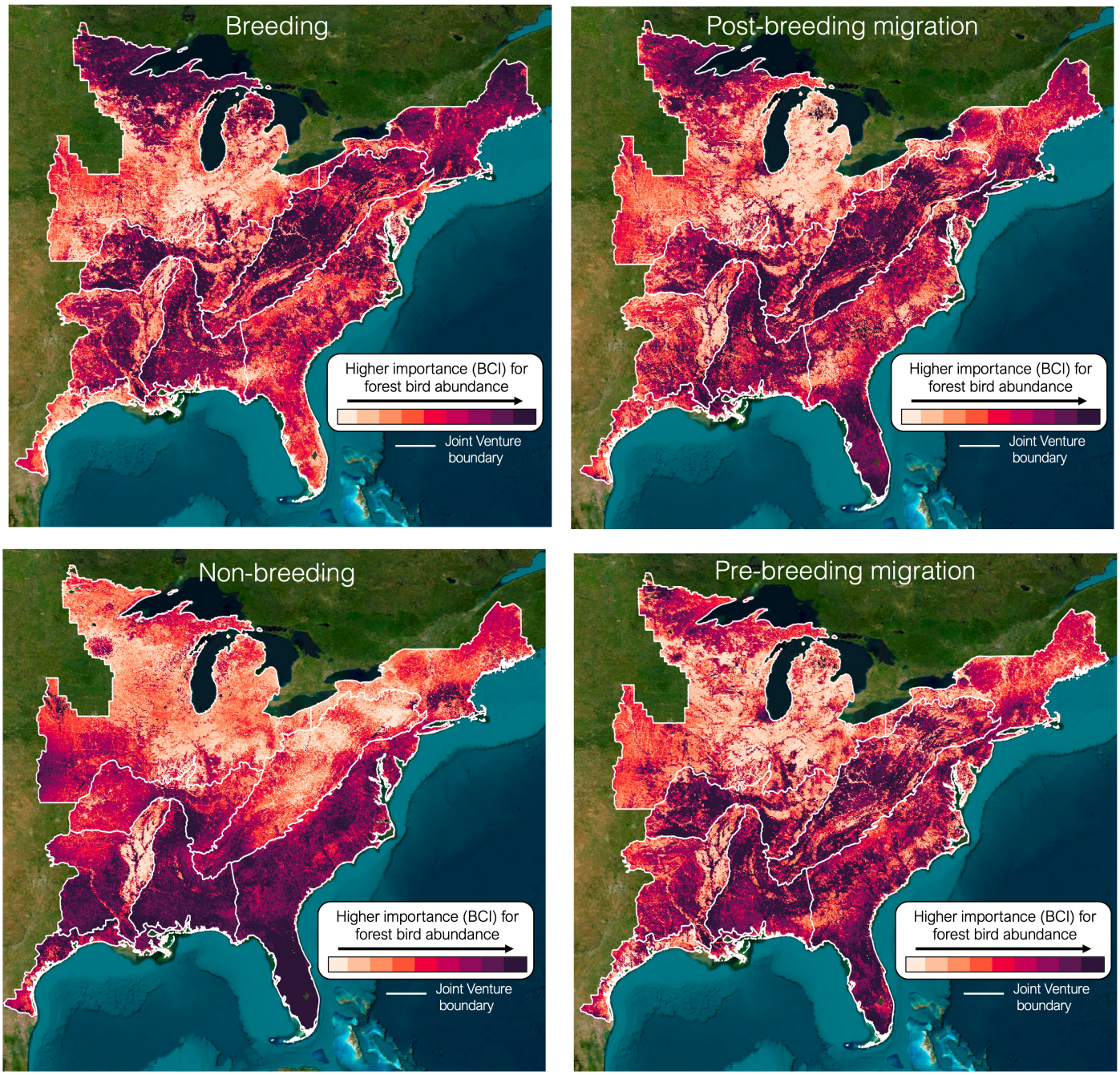
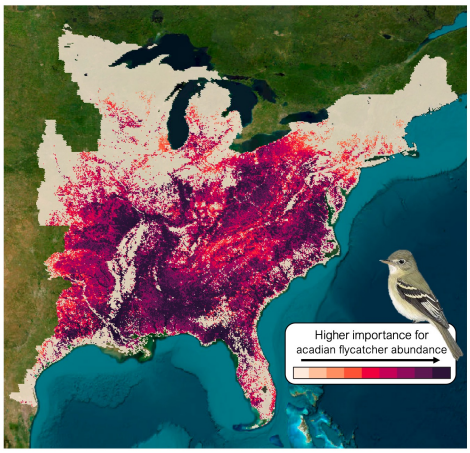
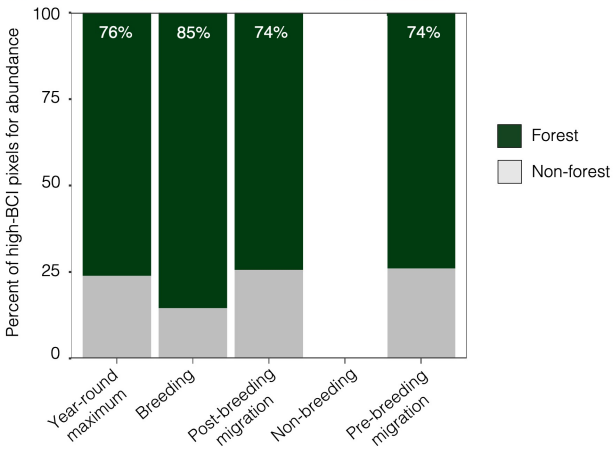
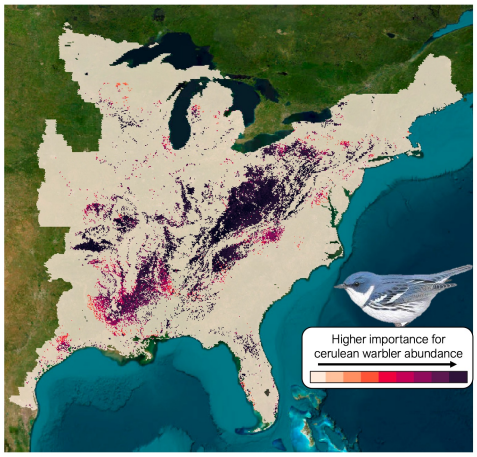


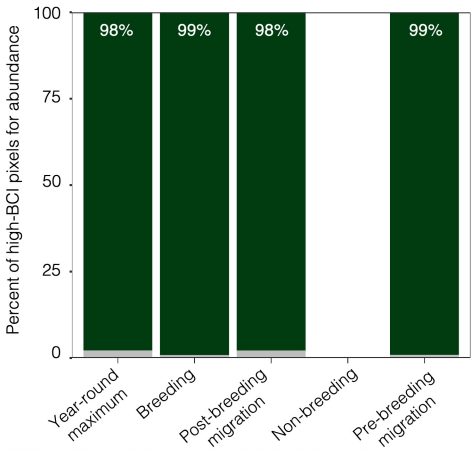
Figure A2: Seasonal bird Concentration Areas (BCAs) that support a high number of migratory forest bird abundance across the full annual cycle. BCAs are characterized by a continuous Bird Concentration Index (BCI) that differentiate areas of highest importance in each season of the annual cycle (as shown here) and across all 52 weeks of the year (shown in Figure 1) at a high spatial resolution of 2.8km x 2.8km.

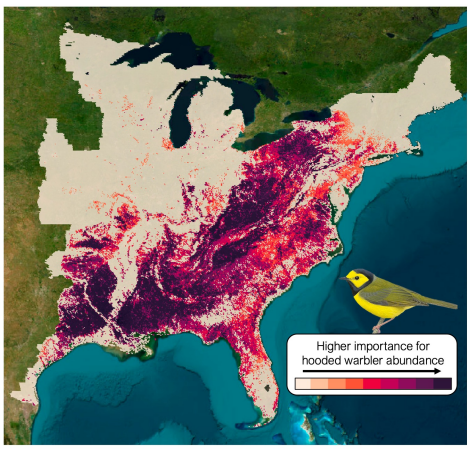
Appendix B: Additional Species-Specific Priority Areas

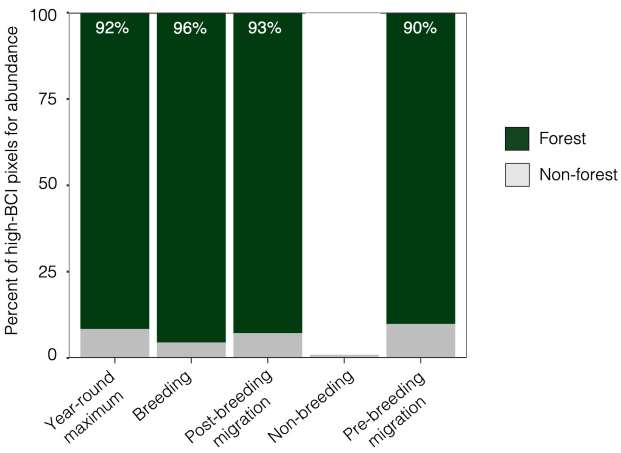


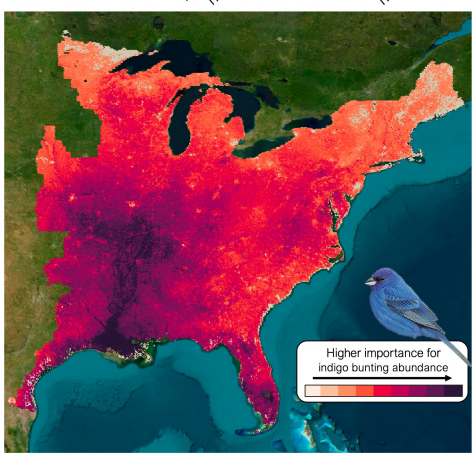


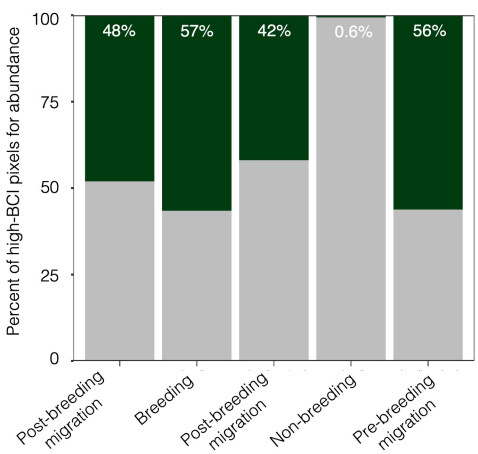












Appendix B: Additional Species-Specific Priority Areas