Modeling the potential response of 147 bird species to climate change in the Eastern United States

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Before we talk about the bird atlas, it is important to highlight that bird distributions are influenced by climate: with winter temperatures limiting the northern distribution of some species and the pulse of seasonal temperature changes influencing others.
But there is also a habitat component. However, there is also an important habitat component. The above example visually demonstrates temperature alone cannot describe the species distribution. Therefore, it is important that we think about changes in climate and tree species as we model the potential response of bird habitat to climate change. As discussed in the DISTRIB Tree section of our work, because past climate change resulted in trees shifting independent of current forest community types, we must use the individual tree species as predictors in the bird models.
Research Objectives

- Use inventory/survey data to characterize 147 eastern US bird species distributions

- Relate environmental variables to current distributions using statistical tools, esp. Random Forests

- Predict present distributions from derived relationships

- Estimate potential future shifts of suitable habitat under three climate models (HadCM3 (harshest), PCM (mildest) and GFDL) and two emission scenarios (A1fi and B1) by 2100

How we approach modeling birds.
Methods

- Used Breeding Bird Survey data from 1000 routes
- A route is ~40 km, with stops every 0.8 km to record all birds seen or heard
- Selected routes surveyed at least 7 out 10 years (1990’s)
- Incidence per route for each species used as a index of abundance (ranges 0 to 1)
- Modeled bird incidence with climate, elevation and tree species importance values

We use data from the Breeding Bird Survey to generate incidence values as an index of relative abundance for each bird species. By using both climate and tree species as predictors we can learn how a species distribution may respond to shifts in climate and changing tree species across the landscape.
This schematic shows our modeling scheme. For each species we had the current distribution according to BBS routes. Then we had the model predicted output. The DISTRIB model was based on RandomForests statistical technique (Please see DISTRIB Tree additional modeling information). In order to find out how our model would predict under changed climate, we reran the models after swapping current climate and tree distributions with future climates and tree habitat.
Important!

- With these models, we are predicting potential suitable habitat by year 2100. We are NOT predicting where the species will be at that time.
- These models do not account for future biotic interactions (competition) or disturbances (human or natural).

Make sure that you note these before interpreting the atlas!
Please take a look at both the bird and tree atlas online!
Note that Hadley Hi is the harshest and PCM Lo is the mildest of the scenarios. Some species like the black-throated blue warbler are projected to lose habitat with a contraction to the northeast and residual refugia of habitat in the higher elevation zone of the Appalachians.
Species like the wood thrush that currently are widely distributed show variable patterns of change depending on the climate change model and emissions scenarios.
And other species like the prothonotary warbler are projected to increase in habitat.
### Changes by region or state:

<table>
<thead>
<tr>
<th>Model Reliability</th>
<th>Common Name</th>
<th>Current Area-Weighted Incidence Value</th>
<th>Ratio of Current to Future Potential Habitat</th>
<th>PCM Model Low emissions</th>
<th>Average of 3 GCMs Low emissions</th>
<th>Average of 3 GCMs High emissions</th>
<th>HAD Model High emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>Blue-headed Vireo</td>
<td>34.0</td>
<td></td>
<td>0.6</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
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<tr>
<td>Low</td>
<td>Bank Swallow</td>
<td>18.7</td>
<td></td>
<td>0.6</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
<td>&lt;0.5</td>
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<tr>
<td>Low</td>
<td>Ruffed Grouse</td>
<td>10.6</td>
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<td>0.6</td>
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<tr>
<td>High</td>
<td>Veery</td>
<td>67.2</td>
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<tr>
<td>Medium</td>
<td>Least Flycatcher</td>
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<td>Black-throated Green Warbler</td>
<td>43.9</td>
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<td>Rose-breasted Grosbeak</td>
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<tr>
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<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>High</td>
<td>Blue-winged Cuckoo</td>
<td>94.0</td>
<td></td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

In addition to the individual species pages, we also provide extensive state and regional summaries.
Take home messages

The models capture the general pattern of a species distribution and adding the tree species information make a big difference to the bird models. Pay attention to the reliability of each species model – and regardless, there still will be errors! Edge boundaries are ‘fuzzy’, both now and in future – core areas of higher incidences are more indicative. Designed for Eastern United States only.

If you abide by the caveats, you can use the results to:

a. Learn which species are in, or could be in, your location now
b. Learn which environmental factors are likely driving species’ suitable habitat, e.g., which are most susceptible to climate drivers
c. Learn what species are most and least likely to have their habitats move, and how much
d. Learn which species could incur the most risk under climate change
e. Learn which species could become newly suitable for your location.