Are all birds moving poleward?

Understanding distributional shifts in Ohio's breeding birds

Katharine E. Batdorf, Paul G. Rodewald, Stephen N. Matthews, Matthew B. Shumar

Terrestrial Wildlife Ecology Lab, School of Environment and Natural Resources, The Ohio State University

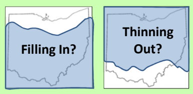
Background

Recent widespread changes in climate and land cover have been shown to affect plants and animals in many ways[1,2] including causing changes in their distributions. Several studies have reported poleward shifts in bird distributions likely in response to recent climate change[3]. However, few multispecies studies have used fine-scaled regional data such as that generated by Breeding Bird Atlas projects, exceptions being Great Britian[4], the Czech Republic[5] and New York State[6] (the only North American study). Additional research is needed to test whether distributional changes are replicated in regions with different landscape composition and species assemblages. We tested for poleward shifts using breeding bird data atlas from Ohio, where >50% of land is in active agricultural use, asking the central research question:

Have the distributions of breeding bird species in Ohio responded to recent climatic changes?

More specifically, we predicted that:

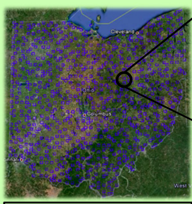
1. **Species' northern and southern range boundaries and centers of occurrence will have shifted northward**
2. **Southerly species will have gained blocks (filled in) relative to northerly species, which will have lost blocks (thinned out)** ➡



3. **Species with range boundaries closer to Ohio ("extent proximity") will show greater changes**
4. **Southerly species will show greater changes than northerly species**

We used fine-scaled grid-based data collected during two Ohio Breeding Bird Atlas projects to quantify avian distribution changes in 67 bird species.

The Ohio Breeding Bird Atlas I & II



764 blocks, 25 km² each covering 1/6th of Ohio

Within each block, we surveyed for potential breeding bird species in all available habitats over several visits (total ~25 hrs), resulting in the presence/absence of each species in the block. Data were collected by volunteer observers and field technicians, and includes external data sources such as U.S.G.S. Breeding Bird Survey and eBird.

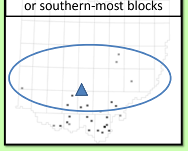
Two Time Periods: **Atlas 1** **1982-1987** — **Atlas 2** **2006-2011**

~ 25 Years

Methods

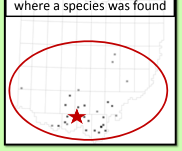
Boundary

Mean latitude of 10 northern or southern-most blocks



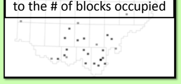
Center of Occurrence

Mean location of all blocks where a species was found

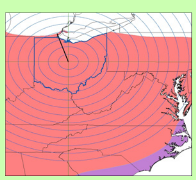


Occupancy

Was calculated using: **Ln(# blocks occupied in Atlas 2) – Ln(# blocks occupied in Atlas 1)** to describe change relative to the # of blocks occupied



Extent Proximity: Measurement (km) of the distance from Ohio's centroid to the nearest range boundary using NatureServe distribution maps[7] (*see map to right*).



Species were categorized as either ***Northerly*** or ***Southerly*** based on the location of their distributions relative to Ohio. Species for which this was not apparent were eliminated from analyses.

Species Selection: Species were eliminated from analyses if their extent proximity was >650 km from Ohio's centroid, or if they were extremely rare, ubiquitous, had detection biases between atlases, or have life histories that would introduce other biases

Statistical Analyses: Boundary and Center of Occurrence

AIC_c was used to examine and rank a candidate set of 8 ordinary least squares regression models, consisting of variables:

1) Change in Occupancy
2) Extent Proximity
3) Northerly vs. Southerly species

In both analyses 1*2*3 and 1*3 were both top models

We used the **Rayleigh Test of Uniformity** to test for directional trends in centers of occurrence. Because of the lack of a directional trend (p=0.56), we tested for a northward response.

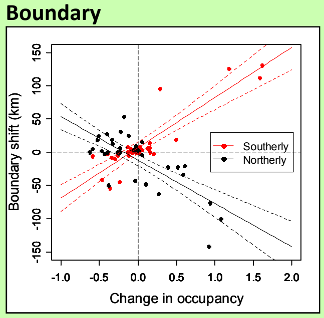
Distance and direction of change in center of occurrence of southerly and northerly species.

Statistical Analyses: Occupancy

A linear model of variables 2 & 3 above was considered

Results

Boundary

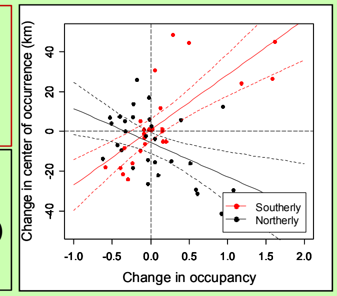


Y Intercepts:

Boundaries and Centers of *southerly* species shifted North by 6.8 (± 4.5) and 0.7 km (± 2.8), respectively

Boundaries and Centers of *northerly* species shifted South by 11.8 (± 6.1) and 5.7 km (± 3.8), respectively

Center of Occurrence



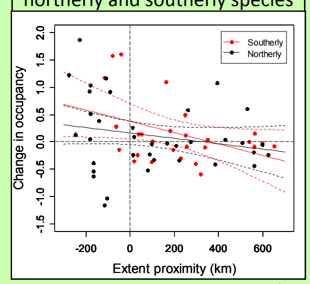
Change in latitude (km) versus change in occupancy for boundaries (left), and centers of occurrence (right) for southerly and northerly species. Adjusted R^2 = 0.68 and 0.42, respectively. Y-intercepts indicate shift beyond that expected with changes in occupancy. 95% CI's shown.

Species	Center of Occurrence	N Boundary	S Boundary	Occupancy
Pine Warbler	48.7	95.7	---	+
Black Vulture	45.2	131.4	---	++
Carolina Wren	44.7	19.4	---	+
Prothonotary Warbler	30.9	4.2	---	0
Northern Parula	26.6	112.1	---	++
Sharp-shinned Hawk	26.1	---	53.6	-
Swamp Sparrow	-26.3	---	-43.0	0
Canada Goose	-29.1	---	-32.9	+
Cliff Swallow	-29.5	---	-100.2	++
Tree Swallow	-31.2	---	-20.1	+
Sedge Wren	-41.3	---	-141.3	+

Results for species with center of occurrence shifts > 25 km. Positive values indicate northward shifts, negative values indicate southward shifts. Occupancy: (++) > 1.0, (+) 1.0 – 0.05, (0) 0.05 – -0.05, (-) -0.05 – -1.0, (--) < -1.0.

Occupancy

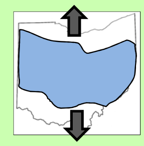
Change *did not* differ between northerly and southerly species



Change in occupancy versus extent proximity for southerly and northerly species. 95% CI's shown.

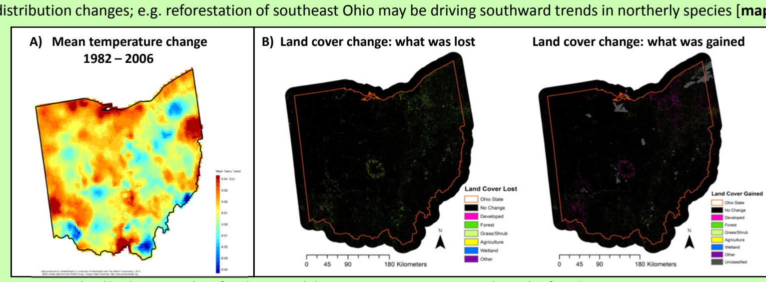
Conclusions

1. Poleward distribution shifts were less consistent in our study compared with previous studies, as we found evidence *suggesting* a ***northward shift*** in southerly species, but stronger evidence for a ***southward shift*** in northerly species.
2. We found no significant difference in ***occupancy*** change between northerly and southerly species. Thus it does not appear that species are "filling in" or "thinning out" in response to climate change.
3. We found that ***extent proximity*** provided additional insight in our models, and it trended as we predicted: with closer extent proximities, effect size increased across variables. Additionally, it allowed us to include more species than if we had used a closer extent cutoff for selecting species.



So why a less clear climate change signal in Ohio?

This could be because **1) temperature increase has been less extreme** in Ohio during this time period [**map A**], **2)** wide-spread anthropogenic land use patterning in Ohio has created a heterogeneous habitat landscape in which species often **cannot fill new potential climatic regions due to lack of habitat**, making a climate change signal more difficult to detect than in more contiguous landscapes, or **3) land cover has changed** substantially in Ohio over this time period, resulting in distribution changes; e.g. reforestation of southeast Ohio may be driving southward trends in northerly species [**map B**].



A. Map produced by Climate Wizard, U. of Washington, and The Nature Conservancy, 2012. Base climate data from the PRISM group, Oregon State U.
B. Land cover change, lost and gained, 1992 – 2006. Maps created using National Land Cover Database.

Our ongoing research is exploring the spatial influences of both climate and land cover change on the shifts in avian species distributions we observed

Citations

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Katharine Batdorf, M.S. student: batdorf.14@osu.edu