



Harmony Hall

Background

Birds are useful indicators of ecological change because they are highly mobile and generally conspicuous. As climate in a particular place changes, suitability may worsen for some species and improve for others. These changes in climate may create the potential for local extirpation or new colonization. **This brief summarizes projected changes in climate suitability by mid-century for birds at Harmony Hall (hereafter, the Site) under two climate change scenarios (see Wu et al. 2018 for full results, and Langham et al. 2015 for more information regarding how climate suitability is characterized).** The high-emissions pathway (RCP8.5) represents a future in which little action is taken to reduce global emissions of greenhouse gases. The low-emissions pathway (RCP2.6) is a best-case scenario of aggressive efforts to reduce emissions. These emissions pathways are globally standardized and established by the Intergovernmental Panel on Climate Change for projecting future climate change. The findings below are model-based projections of how species distributions may change in response to climate change. A 10-km buffer was applied to each park to match the spatial resolution of the species distribution models (10 x 10 km), and climate suitability was taken as the average of all cells encompassed by the park and buffer.

Results

Climate change is expected to alter the bird community at the Site, with greater impacts under the high-emissions pathway than under the low-emissions pathway (Figure 1). Among the species likely to be found at the Site today, climate suitability in summer under the high-emissions pathway is projected to improve for 6, remain stable for 14, and worsen for 9 species. Suitable climate ceases to occur for 12 species in summer, potentially resulting in extirpation of those species from the Site (e.g., Figure 2). Climate is projected to become suitable in summer for 25 species not found at the Site today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 26, remain stable for 15, and worsen for 6 species. Suitable climate ceases to occur for 3 species in winter, potentially resulting in extirpation from the Site. Climate is projected to become suitable in winter for 49 species not found at the Site today, potentially resulting in local colonization.

IMPORTANT

This study focuses exclusively on changing climatic conditions for birds over time. But projected changes in climate suitability are not definitive predictions of future species ranges or abundances. Numerous other factors affect where species occur, including habitat quality, food abundance, species adaptability, and the availability of microclimates (see Caveats). Therefore, managers should consider changes in climate suitability alongside these other important influences.

We report trends in climate suitability for all species identified as currently present at the Site based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Site is projected to become suitable in the future (Figure 1 & Table 1). This brief provides park-specific projections whereas Wu et al. (2018), which did not incorporate park-specific species data and thus may differ from this brief, provides system-wide comparison and conclusions.

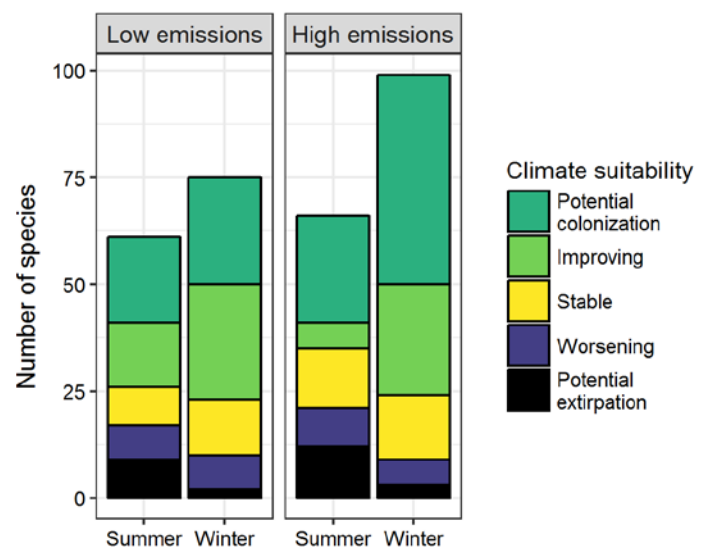


Figure 1. Projected changes in climate suitability for birds at the Site, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Site between the present and 2050 is 0.27 in summer (46th percentile across all national parks) and 0.26 in winter (39th percentile) under the high-emissions pathway. Potential species turnover declines to 0.21 in summer and 0.18 in winter under the low-emissions pathway. Turnover index was calculated based on the theoretical proportions of potential extirpations and potential colonizations by 2050 relative to today (as reported in Wu et al. 2018), and therefore assumes that all potential extirpations and colonizations are realized. According to this index, no change would be represented as 0, whereas a complete change in the bird community would be represented as 1.

Climate Sensitive Species

The Site is or may become home to 8 species that are highly sensitive to climate change across their range (i.e., they are projected to lose climate suitability in over 50% of their current range in North America in summer and/or winter by 2050; Table 1; Langham et al. 2015). While the Site may

serve as an important refuge for 6 of these climate-sensitive species, 2 might be extirpated from the Site in at least one season by 2050.



Figure 2. Although currently found at the Site, suitable climate for the American Goldfinch (*Spinus tristis*) may cease to occur here in summer by 2050, potentially resulting in local seasonal extirpation. Photo by John Benson/Flickr (CC BY 2.0).

Management Implications

Parks differ in potential colonization and extirpation rates, and therefore different climate change adaptation strategies may apply. **Under the high-emissions pathway, Harmony Hall falls within the high turnover group.** Parks anticipating high turnover can focus on actions that increase species' ability to respond to environmental change, such as increasing the amount of potential habitat, working with cooperating agencies and landowners to improve habitat connectivity for birds

across boundaries, managing the disturbance regime, and possibly more intensive management actions. Furthermore, park managers have an opportunity to focus on supporting the 6 species that are highly sensitive to climate change across their range (Table 1; Langham et al. 2015) but for which the park is a potential refuge. Monitoring to identify changes in bird communities will inform the selection of appropriate management responses.

Caveats

The species distribution models included in this study are based solely on climate variables (i.e., a combination of annual and seasonal measures of temperature and precipitation), which means there are limits on their interpretation. Significant changes in climate suitability, as measured here, will not always result in a species response, and all projections should be interpreted as potential trends. Multiple other factors mediate responses to climate change, including habitat availability, ecological processes

that affect demography, biotic interactions that inhibit and facilitate species' colonization or extirpation, dispersal capacity, species' evolutionary adaptive capacity, and phenotypic plasticity (e.g., behavioral adjustments). Ultimately, models can tell us where to focus our concern and which species are most likely to be affected, but monitoring is the only way to validate these projections and should inform any on-the-ground conservation action.

More Information

For more information, including details on the methods, please see the scientific publication ([Wu et al. 2018](#)) and the [project overview brief](#), and visit the [NPS Climate Change Response Program website](#).

References

eBird Basic Dataset (2016) Version: ebd_relAug-2016. Cornell Lab of Ornithology, Ithaca, New York.

Langham et al. (2015) Conservation Status of North American Birds in the Face of Future Climate Change. PLOS ONE.

Wu et al. (2018) Projected avifaunal responses to climate change across the U.S. National Park System. PLOS ONE.

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Species Projections

Table 1. Climate suitability projections by 2050 under the high-emissions pathway for all birds currently present at the Site based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Site is projected to become suitable in the future. "Potential colonization" indicates that climate is projected to become suitable for the species, whereas "potential extirpation" indicates that climate is suitable today but projected to become unsuitable. Omitted species were either not modeled due to data deficiency or were absent from the I&M and eBird datasets. Observations of late-season migrants may result in these species appearing as present in the park when they may only migrate through. Species are ordered according to taxonomic groups, denoted by alternating background shading.

* Species in top and bottom 10th percentile of absolute change

^ Species that are highly climate sensitive

- Species not found or found only occasionally, and not projected to colonize by 2050

x Species not modeled in this season

Common Name	Summer Trend	Winter Trend
Fulvous Whistling-Duck	Potential colonization	-
Cackling/Canada Goose	x	Worsening*
Gadwall	-	Improving
American Black Duck	-	Potential extirpation
Mallard	Potential extirpation [^]	Stable
Blue-winged Teal	-	Potential colonization
Green-winged Teal	-	Improving
Canvasback	-	Improving
Ring-necked Duck	-	Improving
Lesser Scaup	-	Improving
Common Goldeneye	-	Stable
Hooded Merganser	-	Improving [^]
Common Merganser	-	Stable
Ruddy Duck	-	Improving
Pied-billed Grebe	-	Improving

Common Name	Summer Trend	Winter Trend
Eared Grebe	-	Potential colonization
Wood Stork	Potential colonization	-
Neotropic Cormorant	-	Potential colonization
Double-crested Cormorant	-	Improving
Anhinga	Potential colonization [^]	Potential colonization
American White Pelican	-	Potential colonization
Brown Pelican	-	Potential colonization [^]
Great Blue Heron	Stable	Improving
Great Egret	Improving*	Potential colonization
Little Blue Heron	Potential colonization	-
Cattle Egret	Potential colonization	-
Yellow-crowned Night-Heron	Potential colonization	-

Common Name	Summer Trend	Winter Trend
White Ibis	-	Potential colonization
Black Vulture	-	Improving*
Osprey	-	Potential colonization
Mississippi Kite	Potential colonization	-
Bald Eagle	x	Stable
White-tailed Hawk	-	Potential colonization
Red-shouldered Hawk	-	Improving
Virginia Rail	-	Potential colonization
Sora	-	Potential colonization
American Coot	-	Improving
Killdeer	Improving	-
Spotted Sandpiper	-	Potential colonization
Greater Yellowlegs	-	Potential colonization
Lesser Yellowlegs	-	Potential colonization
Least Sandpiper	-	Potential colonization
Western Sandpiper	-	Potential colonization
Long-billed Dowitcher	-	Potential colonization
Ring-billed Gull	-	Stable
Herring Gull	Potential extirpation	Worsening*^
Great Black-backed Gull	-	Potential extirpation
Gull-billed Tern	-	Potential colonization
Forster's Tern	-	Potential colonization
Rock Pigeon	-	Stable
Eurasian Collared-Dove	-	Potential colonization

Common Name	Summer Trend	Winter Trend
White-winged Dove	-	Potential colonization
Mourning Dove	-	Worsening
Inca Dove	Potential colonization	Potential colonization
Yellow-billed Cuckoo	Improving	-
Greater Roadrunner	Potential colonization	-
Groove-billed Ani	-	Potential colonization
Barn Owl	-	Potential colonization
Common Nighthawk	Potential colonization	-
Chimney Swift	Worsening	-
Belted Kingfisher	Stable	Improving
Red-bellied Woodpecker	Stable	Improving
Yellow-bellied Sapsucker	-	Improving
Ladder-backed Woodpecker	Potential colonization	-
Downy Woodpecker	Worsening	Stable
Red-cockaded Woodpecker	-	Potential colonization
American Three-toed Woodpecker	-	Potential colonization^
Northern Flicker	Stable	Worsening
Pileated Woodpecker	Potential colonization	Stable
Eastern Wood-Pewee	Worsening*	-
Acadian Flycatcher	Worsening	-
Eastern Phoebe	Potential colonization	-
Great Crested Flycatcher	Worsening	-
Western Kingbird	Potential colonization	-
Eastern Kingbird	Worsening	-
Scissor-tailed Flycatcher	Potential colonization	-
Loggerhead Shrike	Potential colonization	-

Common Name	Summer Trend	Winter Trend
White-eyed Vireo	Stable	Potential colonization
Red-eyed Vireo	Potential extirpation	-
Blue Jay	Stable	Stable
American Crow	Stable	Stable
Fish Crow	Stable	Stable
Cliff Swallow	Potential colonization	-
Cave Swallow	Potential colonization	-
Carolina Chickadee	-	Improving
Tufted/Black-crested Titmouse	-	Improving
White-breasted Nuthatch	Potential extirpation	Worsening*
Brown-headed Nuthatch	Potential colonization^	-
House Wren	-	Potential colonization
Marsh Wren	-	Potential colonization
Carolina Wren	Stable	Improving
Bewick's Wren	-	Potential colonization
Blue-gray Gnatcatcher	Stable	Potential colonization
American Robin	Potential extirpation	Stable
Gray Catbird	Potential extirpation	Stable
Northern Mockingbird	Improving	Improving
European Starling	Worsening	-
American Pipit	-	Potential colonization
Sprague's Pipit	-	Potential colonization
Chestnut-collared Longspur	-	Potential colonization
Smith's Longspur	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Prothonotary Warbler	Stable	-
Swainson's Warbler	Potential colonization	-
Orange-crowned Warbler	-	Potential colonization
Common Yellowthroat	Potential extirpation	Potential colonization
Hooded Warbler	Improving	-
Northern Parula	Stable	-
Pine Warbler	Potential extirpation^	-
Yellow-rumped Warbler	-	Improving
Rufous-winged Sparrow	Potential colonization	-
Bachman's Sparrow	Potential colonization	Potential colonization
Chipping Sparrow	Potential extirpation	Improving
Vesper Sparrow	-	Potential colonization
Lark Sparrow	Potential colonization	Potential colonization
Grasshopper Sparrow	-	Potential colonization
Henslow's Sparrow	-	Potential colonization
Song Sparrow	Potential extirpation	Stable
Lincoln's Sparrow	-	Potential colonization
White-throated Sparrow	-	Improving
Harris's Sparrow	-	Potential colonization
Dark-eyed Junco	-	Worsening*
Northern Cardinal	Improving	Improving
Indigo Bunting	Stable	-
Painted Bunting	Potential colonization	-
Red-winged Blackbird	Stable	Improving
Western Meadowlark	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Brewer's Blackbird	-	Potential colonization
Common Grackle	Worsening	Improving
Great-tailed Grackle	Potential colonization	Potential colonization
Baltimore Oriole	Worsening	-

Common Name	Summer Trend	Winter Trend
House Finch	Potential extirpation	Potential extirpation
Purple Finch	-	Potential colonization
American Goldfinch	Potential extirpation	Stable