Birds and Climate Change

National Park Service
U.S. Department of the Interior

Mammoth Cave National Park

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 Mammoth Cave National Park (hereafter, the Park) 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.

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 Park based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Park 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.

Results

Climate change is expected to alter the bird community at the Park, 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 Park today, climate suitability in summer under the high-emissions pathway is projected to improve for 5, remain stable for 39, and worsen for 17 species. Suitable climate ceases to occur for 17 species in summer, potentially resulting in extirpation of those species from the Park (e.g., Figure 2). Climate is projected to become suitable in summer for 18 species not found at the Park today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 20, remain stable for 24, and worsen for 7 species. Suitable climate ceases to occur for 4 species in winter, potentially resulting in extirpation from the Park. Climate is projected to become suitable in winter for 38 species not found at the Park today, potentially resulting in local colonization.

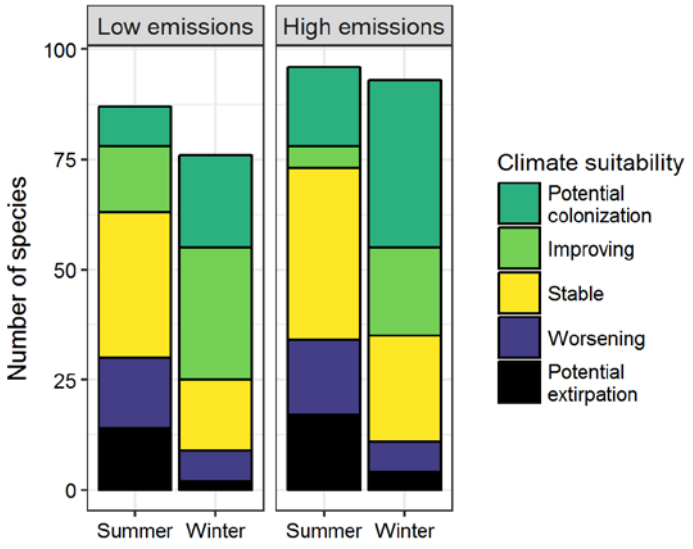

Figure 1. Projected changes in climate suitability for birds at the Park, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Park between the present and 2050 is 0.18 in summer (26th percentile across all national parks) and 0.18 in winter (23rd percentile) under the high-emissions pathway. Potential species turnover declines to 0.11 in summer and 0.11 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 Park is home to one species, the Pine Warbler (*Setophaga pinus*), that is highly sensitive to climate change across its range (i.e., it is projected to lose climate suitability in over 50% of its current summer range in North America by 2050; Table 1; Langham et al. 2015). Suitable climate is not projected to disappear for this species at the Park; instead the Park may serve as an important refuge for this climate-sensitive species.

Figure 2. Although currently found at the Park, 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, Mammoth Cave National Park falls within the low change group.** Parks anticipating low change can best support landscape-scale bird conservation by emphasizing habitat restoration, maintaining natural disturbance regimes, and reducing other stressors.

Furthermore, park managers have an opportunity to focus on supporting the 1 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 Park based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Park 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	-
Wood Duck	x	Stable
Mallard	-	Stable
Blue-winged Teal	-	Potential colonization
Northern Bobwhite	Stable	-
Wild Turkey	x	Potential extirpation
Pied-billed Grebe	x	Improving
Eared Grebe	-	Potential colonization
Wood Stork	Potential colonization	-
Neotropic Cormorant	-	Potential colonization
Anhinga	-	Potential colonization
American White Pelican	-	Potential colonization
Great Blue Heron	Improving	Improving

Common Name	Summer Trend	Winter Trend
Great Egret	Potential colonization	Potential colonization
Little Blue Heron	Potential colonization	-
Cattle Egret	Potential colonization	Potential colonization
Green Heron	Stable	-
Yellow-crowned Night-Heron	Potential colonization	-
White Ibis	Potential colonization	Potential colonization
Black Vulture	Stable	Improving
Turkey Vulture	x	Improving
Osprey	-	Potential colonization
Golden Eagle	-	Potential extirpation
Red-shouldered Hawk	Stable	Stable
Red-tailed Hawk	Stable	Stable
Killdeer	Stable	-
Spotted Sandpiper	x	Potential

Common Name	Summer Trend	Winter Trend
		colonization
Greater Yellowlegs	-	Potential colonization
Lesser Yellowlegs	-	Potential colonization
Least Sandpiper	-	Potential colonization
American Woodcock	x	Improving
Gull-billed Tern	-	Potential colonization
Forster's Tern	-	Potential colonization
Rock Pigeon	Stable	-
Eurasian Collared-Dove	-	Potential colonization
White-winged Dove	-	Potential colonization
Mourning Dove	Stable	Worsening
Inca Dove	Potential colonization	Potential colonization
Common Ground-Dove	Potential colonization	-
Yellow-billed Cuckoo	Improving	-
Greater Roadrunner	Potential colonization	-
Eastern Screech-Owl	x	Improving
Great Horned Owl	-	Potential extirpation
Barred Owl	x	Improving
Common Nighthawk	Potential colonization	-
Chuck-will's-widow	Stable	-
Chimney Swift	Stable	-
Ruby-throated Hummingbird	Stable	-
Belted Kingfisher	Stable	Stable
Red-headed Woodpecker	Stable	Stable
Golden-fronted Woodpecker	Potential colonization	-
Red-bellied Woodpecker	Stable	Stable

Common Name	Summer Trend	Winter Trend
Yellow-bellied Sapsucker	-	Improving
Downy Woodpecker	Worsening	Stable
Hairy Woodpecker	Potential extirpation	Worsening*
Red-cockaded Woodpecker	-	Potential colonization
Northern Flicker	Stable	Stable
Pileated Woodpecker	Stable	Stable
American Kestrel	x	Stable
Eastern Wood-Pewee	Worsening	-
Acadian Flycatcher	Worsening	-
Eastern Phoebe	Worsening	Improving
Great Crested Flycatcher	Stable	-
Eastern Kingbird	Worsening	-
Loggerhead Shrike	-	Improving*
White-eyed Vireo	Improving	Potential colonization
Yellow-throated Vireo	Stable	-
Warbling Vireo	Potential extirpation	-
Red-eyed Vireo	Potential extirpation	-
Blue Jay	Stable	Stable
American Crow	Stable	Stable
Fish Crow	-	Potential colonization
Northern Rough-winged Swallow	Stable	-
Purple Martin	Stable	-
Tree Swallow	Potential extirpation	-
Barn Swallow	Stable	-
Cliff Swallow	Potential colonization	-
Carolina Chickadee	Stable	Improving
Tufted Titmouse	Stable	Improving
White-breasted Nuthatch	Potential extirpation	Worsening*

Common Name	Summer Trend	Winter Trend
Brown Creeper	-	Worsening*
House Wren	Potential extirpation	Potential colonization
Pacific/Winter Wren	-	Stable
Marsh Wren	-	Potential colonization
Carolina Wren	Stable	Stable
Bewick's Wren	-	Potential colonization
Blue-gray Gnatcatcher	Worsening	-
Golden-crowned Kinglet	-	Stable
Eastern Bluebird	Worsening	Improving
Hermit Thrush	-	Stable
Wood Thrush	Worsening*	-
American Robin	Potential extirpation	Stable
Gray Catbird	Potential extirpation	-
Brown Thrasher	Worsening	-
Northern Mockingbird	Stable	Improving
European Starling	Potential extirpation	Stable
American Pipit	-	Potential colonization
Sprague's Pipit	-	Potential colonization
Cedar Waxwing	Potential extirpation	-
Chestnut-collared Longspur	-	Potential colonization
Smith's Longspur	-	Potential colonization
Ovenbird	Potential extirpation	-
Worm-eating Warbler	Worsening	-
Black-and-white Warbler	Stable	-
Prothonotary Warbler	Improving*	-
Swainson's Warbler	Potential colonization	-
Orange-crowned Warbler	-	Potential colonization
Kentucky Warbler	Stable	-
Common Yellowthroat	Worsening	Potential colonization
Hooded Warbler	Improving*	-
American Redstart	Stable	-
Northern Parula	Worsening	-
Pine Warbler	Stable^	-
Yellow-rumped Warbler	-	Improving
Yellow-throated Warbler	Stable	-
Prairie Warbler	Stable	-
Yellow-breasted Chat	Stable	-
Eastern Towhee	Potential extirpation	x
Bachman's Sparrow	Potential colonization	Potential colonization
American Tree Sparrow	-	Potential extirpation
Chipping Sparrow	Potential extirpation	-
Field Sparrow	Worsening*	-
Lark Sparrow	Potential colonization	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
Summer Tanager	Stable	-
Scarlet Tanager	Potential extirpation	-
Northern Cardinal	Stable	Improving
Pyrrhuloxia	-	Potential colonization
Blue Grosbeak	Worsening	-
Indigo Bunting	Stable	-

Common Name	Summer Trend	Winter Trend
Painted Bunting	Potential colonization	-
Red-winged Blackbird	Worsening	Stable
Eastern Meadowlark	Stable	Stable
Western Meadowlark	-	Potential colonization
Rusty Blackbird	-	Improving
Common Grackle	Worsening	Improving
Great-tailed Grackle	Potential colonization	Potential colonization
Bronzed Cowbird	-	Potential

Common Name	Summer Trend	Winter Trend
		colonization
Brown-headed Cowbird	Worsening	Improving
Orchard Oriole	Stable	-
House Finch	Potential extirpation	-
Purple Finch	-	Worsening*
Pine Siskin	-	Stable
American Goldfinch	Potential extirpation	Stable
House Sparrow	x	Worsening*