Birds and Climate Change

National Park Service
U.S. Department of the Interior

Great Smoky Mountains 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 Great Smoky Mountains 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 42, remain stable for 21, and worsen for 12 species. Suitable climate ceases to occur for 38 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 12 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 51, remain stable for 20, and worsen for 7 species. Suitable climate ceases to occur for 6 species in winter, potentially resulting in extirpation from the Park. Climate is projected to become suitable in winter for 31 species not found at the Park today, potentially resulting in local colonization.

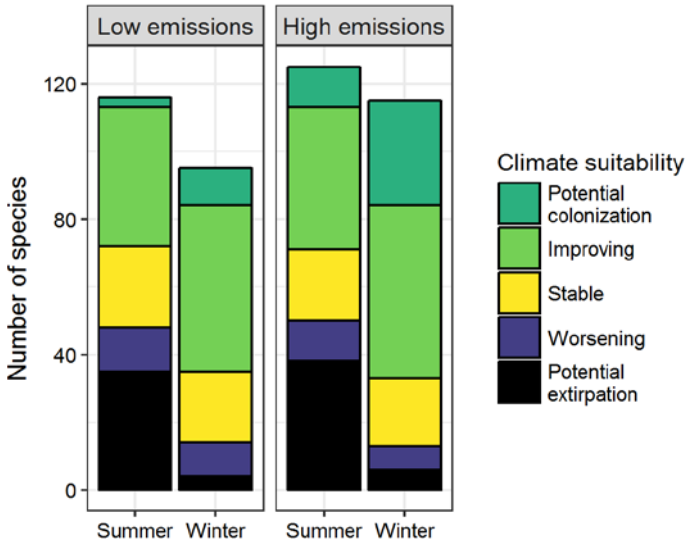

Figure 1. Projected changes in climate suitability for birds at the Park, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Park between the present and 2050 is 0.16 in summer (24th percentile across all national parks) and 0.19 in winter (26th percentile) under the high-emissions pathway. Potential species turnover declines to 0.10 in summer and 0.08 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 or may become home to 11 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 Park may serve as an important refuge for 8 of these climate-sensitive species, 3 might be extirpated from the Park in at least one season by 2050.

Figure 2. Although currently found at the Park, suitable climate for the Red-winged Blackbird (*Agelaius phoeniceus*) may cease to occur here in summer by 2050, potentially resulting in local seasonal extirpation. Photo by Andy Reago & Chrissy McClarren/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, Great Smoky Mountains 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 8 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
Cackling/Canada Goose	x	Worsening*
Wood Duck	x	Improving
Gadwall	-	Improving
American Black Duck	-	Worsening*
Mallard	Potential extirpation^	Stable
Northern Shoveler	-	Potential colonization
Green-winged Teal	-	Potential colonization
Ring-necked Duck	-	Improving
Greater Scaup	-	Potential colonization^
Bufflehead	-	Stable
Hooded Merganser	-	Improving^
Red-breasted Merganser	-	Potential colonization^
Ruddy Duck	-	Potential colonization
Northern Bobwhite	Improving*	Improving
Ruffed Grouse	x	Potential extirpation
Wild Turkey	x	Stable
Pied-billed Grebe	x	Improving
Eared Grebe	-	Potential colonization
Double-crested Cormorant	x	Potential colonization
Anhinga	-	Potential colonization
American White Pelican	-	Potential colonization
Great Blue Heron	Improving	Improving
Great Egret	Potential colonization	Potential colonization
Little Blue Heron	Potential colonization	-
Cattle Egret	Potential colonization	-
Green Heron	Improving	-
Yellow-crowned Night-Heron	Potential	-

Common Name	Summer Trend	Winter Trend
	colonization	
Black Vulture	Improving	Improving
Turkey Vulture	x	Stable
Mississippi Kite	Potential colonization	-
Northern Harrier	-	Improving
Sharp-shinned Hawk	x	Stable
Cooper's Hawk	x	Stable
Bald Eagle	x	Improving
Red-shouldered Hawk	Improving	Improving
Red-tailed Hawk	Improving	Improving
Ferruginous Hawk	-	Potential colonization
American Coot	-	Stable
Killdeer	Improving	Improving
Least Sandpiper	-	Potential colonization
Wilson's Snipe	-	Stable
American Woodcock	x	Improving*
Bonaparte's Gull	-	Potential colonization
Laughing Gull	Potential colonization^	-
Ring-billed Gull	-	Improving
Forster's Tern	-	Potential colonization
Rock Pigeon	Stable	Stable
Eurasian Collared-Dove	-	Potential colonization
Mourning Dove	Improving	Improving
Yellow-billed Cuckoo	Improving*	-
Black-billed Cuckoo	Potential extirpation	-
Greater Roadrunner	Potential colonization	Potential colonization
Barn Owl	-	Potential colonization
Eastern Screech-Owl	x	Improving

Common Name	Summer Trend	Winter Trend
Great Horned Owl	x	Stable
Barred Owl	x	Improving
Common Nighthawk	Improving	-
Chuck-will's-widow	Improving*	-
Chimney Swift	Improving	-
Ruby-throated Hummingbird	Improving	-
Belted Kingfisher	Stable	Improving
Red-headed Woodpecker	Improving*	Improving*
Red-bellied Woodpecker	Improving	Improving
Yellow-bellied Sapsucker	Potential extirpation	Improving
Downy Woodpecker	Stable	Stable
Hairy Woodpecker	Stable	Worsening
Red-cockaded Woodpecker	-	Potential colonization
Northern Flicker	Stable	Improving
Pileated Woodpecker	Stable	Stable
American Kestrel	x	Improving
Olive-sided Flycatcher	Potential extirpation	-
Eastern Wood-Pewee	Worsening	-
Acadian Flycatcher	Worsening	-
Alder Flycatcher	Potential extirpation	-
Willow Flycatcher	Potential extirpation	-
Least Flycatcher	Potential extirpation	-
Eastern Phoebe	Worsening	Improving
Great Crested Flycatcher	Improving*	-
Eastern Kingbird	Improving	-
Loggerhead Shrike	Potential colonization	-
White-eyed Vireo	Improving*	Potential colonization
Yellow-throated Vireo	Stable	-
Warbling Vireo	Potential	-

Common Name	Summer Trend	Winter Trend
	extirpation	
Red-eyed Vireo	Worsening	-
Blue Jay	Improving	Worsening
American Crow	Stable	Worsening
Fish Crow	Improving	Potential colonization
Common Raven	Potential extirpation	Potential extirpation
Northern Rough-winged Swallow	Improving	-
Purple Martin	Improving*	-
Tree Swallow	Potential extirpation	-
Barn Swallow	Improving	-
Cliff Swallow	Improving*	-
Carolina Chickadee	Improving	Improving
Black-capped Chickadee	Potential extirpation	Potential extirpation
Tufted Titmouse	Improving	Improving
Red-breasted Nuthatch	Potential extirpation	Stable
White-breasted Nuthatch	Worsening*	Worsening
Brown-headed Nuthatch	Improving^	-
Brown Creeper	Potential extirpation^	Stable
House Wren	Potential extirpation	-
Pacific/Winter Wren	-	Improving
Sedge Wren	-	Potential colonization
Carolina Wren	Improving	Improving
Blue-gray Gnatcatcher	Improving	-
Golden-crowned Kinglet	Potential extirpation	Stable
Ruby-crowned Kinglet	Potential extirpation	Improving
Eastern Bluebird	Improving	Improving
Veery	Potential extirpation	-

Common Name	Summer Trend	Winter Trend
Hermit Thrush	Potential extirpation	Improving
Wood Thrush	Stable	-
American Robin	Potential extirpation	Improving
Gray Catbird	Potential extirpation	Potential colonization
Brown Thrasher	Improving	Improving*
Northern Mockingbird	Improving	Improving
European Starling	Worsening*	Stable
American Pipit	-	Improving*
Cedar Waxwing	Potential extirpation	Improving
Chestnut-collared Longspur	-	Potential colonization
Smith's Longspur	-	Potential colonization
Ovenbird	Potential extirpation	-
Worm-eating Warbler	Worsening*	-
Blue-winged Warbler	Worsening	-
Golden-winged Warbler	Stable	-
Black-and-white Warbler	Stable	-
Swainson's Warbler	Improving	-
Orange-crowned Warbler	-	Potential colonization
Kentucky Warbler	Stable	-
Common Yellowthroat	Stable	Potential colonization
Hooded Warbler	Stable	-
American Redstart	Potential extirpation	-
Northern Parula	Stable	-
Magnolia Warbler	Potential extirpation	-
Blackburnian Warbler	Potential extirpation	-
Yellow Warbler	Potential extirpation	-
Chestnut-sided Warbler	Potential	-

Common Name	Summer Trend	Winter Trend
	extirpation	
Black-throated Blue Warbler	Potential extirpation	-
Palm Warbler	-	Improving*^
Pine Warbler	Improving*^	Improving*
Yellow-rumped Warbler	Potential extirpation	Improving
Yellow-throated Warbler	Stable	-
Prairie Warbler	Improving	-
Black-throated Green Warbler	Potential extirpation	-
Canada Warbler	Potential extirpation	-
Yellow-breasted Chat	Improving	-
Eastern Towhee	Stable	x
Bachman's Sparrow	Potential colonization	Potential colonization
Chipping Sparrow	Worsening	Improving
Field Sparrow	Stable	Improving
Vesper Sparrow	Potential extirpation	Potential colonization
Savannah Sparrow	-	Improving*
Grasshopper Sparrow	Stable	-
LeConte's Sparrow	-	Potential colonization
Seaside Sparrow	Potential colonization^	-
Fox Sparrow	-	Improving
Song Sparrow	Potential extirpation	Stable
Lincoln's Sparrow	-	Potential colonization
Swamp Sparrow	-	Improving
White-throated Sparrow	-	Improving

Common Name	Summer Trend	Winter Trend
Dark-eyed Junco	x	Worsening
Summer Tanager	Improving*	-
Scarlet Tanager	Worsening*	-
Northern Cardinal	Improving	Improving
Rose-breasted Grosbeak	Potential extirpation	-
Blue Grosbeak	Improving*	-
Indigo Bunting	Improving	-
Painted Bunting	Potential colonization	-
Dickcissel	Potential colonization	-
Red-winged Blackbird	Potential extirpation	Improving
Eastern Meadowlark	Improving	Improving
Rusty Blackbird	-	Improving
Brewer's Blackbird	-	Potential colonization
Common Grackle	Stable	Improving
Brown-headed Cowbird	Stable	-
Orchard Oriole	Improving*	-
Baltimore Oriole	Potential extirpation	-
House Finch	Worsening*	Stable
Purple Finch	-	Stable
Red Crossbill	Potential extirpation^	x
Pine Siskin	Potential extirpation	Potential extirpation
American Goldfinch	Worsening*	Stable
Evening Grosbeak	-	Potential extirpation
House Sparrow	x	Potential extirpation