Birds and Climate Change

National Park Service
U.S. Department of the Interior

Arches 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 Arches 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 8, remain stable for 42 (e.g., Figure 2), and worsen for 4 species. Suitable climate ceases to occur for 16 species in summer, potentially resulting in extirpation of those species from the Park. Climate is projected to become suitable in summer for 21 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 7, remain stable for 20, and worsen for 10 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 50 species not found at the Park today, potentially resulting in local colonization.

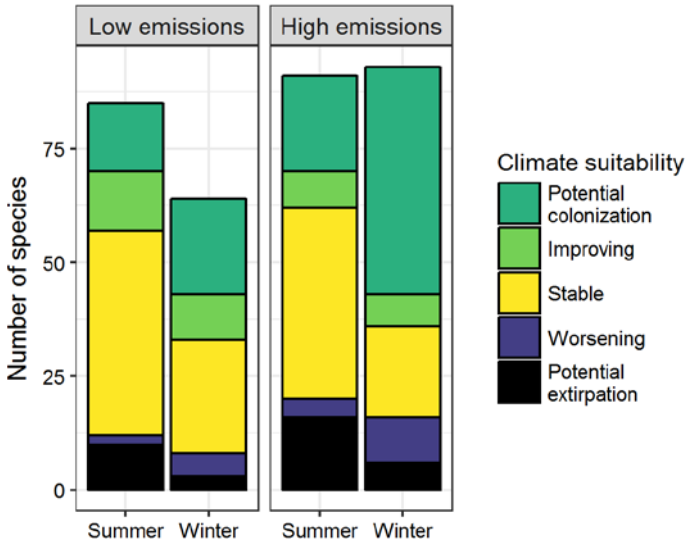

Figure 1. Projected changes in climate suitability for birds at the Park, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Park between the present and 2050 is 0.21 in summer (34th percentile across all national parks) and 0.23 in winter (33rd percentile) under the high-emissions pathway. Potential species turnover declines to 0.14 in summer and 0.12 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 14 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 10 of these climate-sensitive species, 4 might be extirpated from the Park in at least one season by 2050.

Figure 2. Climate at the Park in summer is projected to remain suitable for the Violet-green Swallow (*Tachycineta thalassina*) through 2050. Photo by Becky Matsubara/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, Arches National Park falls within the high potential colonization group.** Parks anticipating high potential colonization 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 10 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
Gadwall	-	Stable
American Wigeon	-	Stable
Mallard	Potential extirpation^	Stable
Blue-winged Teal	-	Potential colonization
Green-winged Teal	-	Stable
Greater Scaup	-	Potential colonization^
Common Goldeneye	-	Stable
Hooded Merganser	-	Improving^
Common Merganser	-	Worsening
Red-breasted Merganser	-	Potential colonization^
Northern Bobwhite	Potential colonization	Potential colonization
Common Loon	-	Potential colonization^
Least Grebe	-	Potential colonization
Horned Grebe	-	Potential colonization
Neotropic Cormorant	-	Potential colonization
Great Blue Heron	Potential extirpation	Improving
Great Egret	-	Potential colonization
Cattle Egret	Potential colonization	-
Golden Eagle	x	Worsening*
Northern Harrier	Potential extirpation^	Stable
Sharp-shinned Hawk	-	Stable
Harris's Hawk	Potential colonization	Potential colonization
Swainson's Hawk	Improving*^	-
Red-tailed Hawk	Stable	Stable
Sora	-	Potential colonization
Common Gallinule	-	Potential

Common Name	Summer Trend	Winter Trend
		colonization
Least Sandpiper	-	Potential colonization
Long-billed Dowitcher	-	Potential colonization
Bonaparte's Gull	-	Potential colonization
Ring-billed Gull	-	Potential colonization
Gull-billed Tern	-	Potential colonization
Rock Pigeon	Stable	-
Eurasian Collared-Dove	x	Potential colonization
White-winged Dove	-	Potential colonization
Mourning Dove	Stable	Improving
Greater Roadrunner	Potential colonization	-
Great Horned Owl	-	Potential extirpation
Burrowing Owl	Stable^	Potential colonization
Lesser Nighthawk	Potential colonization	-
Common Nighthawk	Stable	-
Common Pauraque	-	Potential colonization
Black-chinned Hummingbird	Stable	-
Costa's Hummingbird	-	Potential colonization
Broad-tailed Hummingbird	Stable	-
Gila Woodpecker	-	Potential colonization
Golden-fronted Woodpecker	Potential colonization	Potential colonization
Ladder-backed Woodpecker	Potential colonization	Potential colonization
Hairy Woodpecker	-	Stable
Northern Flicker	Stable	Worsening
Gilded Flicker	-	Potential

Common Name	Summer Trend	Winter Trend
		colonization
American Kestrel	x	Stable
Western Wood-Pewee	Stable^	-
Black Phoebe	-	Potential colonization
Say's Phoebe	Worsening*	-
Vermilion Flycatcher	-	Potential colonization
Ash-throated Flycatcher	Improving*	-
Brown-crested Flycatcher	Potential colonization	-
Cassin's Kingbird	Stable	-
Western Kingbird	Stable	-
Scissor-tailed Flycatcher	Potential colonization	-
Loggerhead Shrike	Improving*	Improving
Pinyon Jay	Stable	Worsening*
California/Woodhouse's Scrub-Jay (Western Scrub-Jay)	Stable	Stable
Black-billed Magpie	Potential extirpation^	Worsening*
American Crow	Potential extirpation	Stable
Chihuahuan Raven	Potential colonization	-
Common Raven	Potential extirpation	Potential extirpation
Horned Lark	Worsening*	Worsening*
Northern Rough-winged Swallow	-	Potential colonization
Tree Swallow	Potential extirpation	-
Violet-green Swallow	Stable	-
Barn Swallow	Stable	-
Cliff Swallow	Improving	-
Black-capped Chickadee	Potential extirpation	Potential extirpation
Mountain Chickadee	Improving	-
Juniper Titmouse	Stable	Stable

Common Name	Summer Trend	Winter Trend
Verdin	Potential colonization	Potential colonization
Bushtit	Stable	Stable
Rock Wren	Stable	Improving*
Canyon Wren	x	Improving
House Wren	Potential extirpation	Potential colonization
Bewick's Wren	Stable	Improving*
Cactus Wren	Potential colonization	Potential colonization
Blue-gray Gnatcatcher	Stable	-
Mountain Bluebird	Stable	Stable
American Robin	Potential extirpation	Worsening
Curve-billed Thrasher	Potential colonization	Potential colonization
Brown Thrasher	-	Potential colonization
Sage Thrasher	Worsening*	-
Northern Mockingbird	Stable	Potential colonization
European Starling	Potential extirpation	-
American Pipit	-	Potential colonization
Sprague's Pipit	-	Potential colonization
Lucy's Warbler	Potential colonization	-
Common Yellowthroat	Stable	-
Yellow Warbler	Potential extirpation	-
Yellow-rumped Warbler	Stable	-
Black-throated Gray Warbler	Stable	-
Yellow-breasted Chat	Potential extirpation	-
Green-tailed Towhee	Stable^	Potential colonization
Spotted Towhee	Stable	x
Canyon Towhee	Potential colonization	Potential colonization
Abert's Towhee	Potential colonization	-
Cassin's Sparrow	Potential colonization	Potential colonization
Chipping Sparrow	Potential extirpation	Potential colonization
Brewer's Sparrow	Worsening	-
Vesper Sparrow	Potential extirpation	Potential colonization
Lark Sparrow	Stable	-
Black-throated Sparrow	Stable	-
Sagebrush/Bell's Sparrow (Sage Sparrow)	Stable^	-
Lark Bunting	-	Potential colonization
Savannah Sparrow	-	Potential colonization
Henslow's Sparrow	-	Potential colonization
Song Sparrow	Potential extirpation	Stable
Lincoln's Sparrow	-	Potential colonization
White-crowned Sparrow	Stable	Stable
Dark-eyed Junco	x	Stable
Western Tanager	Stable	-
Pyrrhuloxia	-	Potential colonization
Black-headed Grosbeak	Stable	-
Blue Grosbeak	Improving*	-
Lazuli Bunting	Stable	-
Indigo Bunting	Stable	-
Painted Bunting	Potential colonization	-
Red-winged Blackbird	Stable	Worsening
Eastern Meadowlark	Potential colonization	Potential colonization
Western Meadowlark	Stable	-
Common Grackle	-	Potential colonization

Common Name	Summer Trend	Winter Trend
		colonization
Great-tailed Grackle	Improving	-
Bronzed Cowbird	-	Potential colonization
Brown-headed Cowbird	Stable	-
Hooded Oriole	Potential colonization	-
Bullock's Oriole	Stable	-
Scott's Oriole	Potential colonization	-

Common Name	Summer Trend	Winter Trend
Gray-crowned Rosy-Finch	-	Potential extirpation^
Black Rosy-Finch	-	Worsening^
House Finch	Improving*	Stable
Cassin's Finch	Stable	Stable
Lesser Goldfinch	Stable	-
American Goldfinch	Stable	Potential extirpation
Evening Grosbeak	-	Potential extirpation