Birds and Climate Change

National Park Service
U.S. Department of the Interior

Tonto National Monument

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 Tonto National Monument (hereafter, the Monument) 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 Monument based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Monument 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 Monument, 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 Monument today, climate suitability in summer under the high-emissions pathway is projected to improve for 21, remain stable for 15 (e.g., Figure 2), and worsen for 2 species. Suitable climate does not cease to occur for any species in summer. Climate is projected to become suitable in summer for 15 species not found at the Monument today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 9, remain stable for 11, and worsen for 13 species. Suitable climate ceases to occur for 2 species in winter, potentially resulting in extirpation from the Monument. Climate is projected to become suitable in winter for 59 species not found at the Monument today, potentially resulting in local colonization.

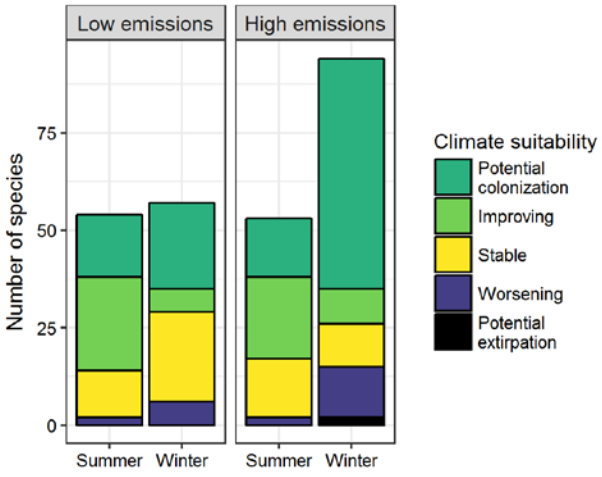

Figure 1. Projected changes in climate suitability for birds at the Monument, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Monument between the present and 2050 is 0.11 in summer (14th percentile across all national parks) and 0.17 in winter (21st percentile) under the high-emissions pathway. Potential species turnover declines to 0.10 in summer and 0.06 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 Monument 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). Suitable climate is not projected to disappear for these 14 species at the Monument; instead the Monument may serve as an important refuge for these climate-sensitive species.

Figure 2. Climate at the Monument in summer is projected to remain suitable for the Northern Cardinal (*Cardinalis cardinalis*) through 2050. Photo by Andy Morffew/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, Tonto National Monument 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 14 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.

Contacts

Gregor Schuurman, Ph.D.
Ecologist, NPS Climate Change Response Program
970-267-7211, gregor_schuurman@nps.gov

Joanna Wu
Biologist, National Audubon Society
415-644-4610, science@audubon.org

Species Projections

Table 1. Climate suitability projections by 2050 under the high-emissions pathway for all birds currently present at the Monument based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Monument 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
Muscovy Duck	-	Potential colonization
Mallard	Potential colonization^	-
Mottled Duck	-	Potential colonization
Greater Scaup	-	Potential colonization^
Common Goldeneye	-	Potential colonization
Barrow's Goldeneye	-	Potential colonization^
Hooded Merganser	-	Potential colonization^
Common Merganser	-	Potential colonization
Red-breasted Merganser	-	Potential colonization^
Ruddy Duck	Potential colonization	-
Plain Chachalaca	-	Potential colonization
Gambel's Quail	Improving	Improving
Northern Bobwhite	-	Potential colonization
Horned Grebe	-	Potential colonization
Magnificent Frigatebird	-	Potential colonization
Neotropic Cormorant	-	Potential colonization
Double-crested Cormorant	x	Improving*
Anhinga	-	Potential colonization
Brown Pelican	-	Potential colonization^
Least Bittern	-	Potential colonization
Great Blue Heron	Improving	-
Great Egret	Potential colonization	-
Snowy Egret	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Little Blue Heron	Potential colonization	-
Reddish Egret	-	Potential colonization
Black-crowned Night-Heron	-	Potential colonization
White Ibis	-	Potential colonization
Turkey Vulture	x	Potential colonization
White-tailed Kite	-	Potential colonization
Red-tailed Hawk	Improving	Worsening
Clapper Rail	-	Potential colonization
American Coot	-	Stable
Limpkin	-	Potential colonization
Black-necked Stilt	-	Potential colonization
American Avocet	-	Potential colonization^
Snowy Plover	-	Potential colonization
Wilson's Plover	-	Potential colonization
Semipalmated Plover	-	Potential colonization^
Killdeer	Potential colonization	-
Mountain Plover	Potential colonization	-
Lesser Yellowlegs	-	Potential colonization
Whimbrel	-	Potential colonization
Dunlin	-	Potential colonization^
Western Sandpiper	-	Potential colonization
Short-billed Dowitcher	-	Potential colonization^
Bonaparte's Gull	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Ring-billed Gull	-	Improving
Forster's Tern	-	Potential colonization
Royal Tern	-	Potential colonization^
Black Skimmer	-	Potential colonization^
Eurasian Collared-Dove	-	Potential colonization
White-winged Dove	Improving*	-
Mourning Dove	Stable	Worsening
White-tipped Dove	-	Potential colonization
Greater Roadrunner	Improving	-
Lesser Nighthawk	-	Potential colonization
Black-chinned Hummingbird	Improving	-
Anna's Hummingbird	Potential colonization	-
Costa's Hummingbird	Improving	-
Allen's Hummingbird	-	Potential colonization
Ringed Kingfisher	-	Potential colonization
Belted Kingfisher	-	Potential colonization
Gila Woodpecker	Improving*	Improving*
Ladder-backed Woodpecker	Improving	Stable
Northern Flicker	-	Worsening
American Kestrel	-	Worsening
Merlin	-	Potential colonization^
Cordilleran Flycatcher	Potential colonization	-
Black Phoebe	Potential colonization	-
Eastern Phoebe	-	Potential colonization
Say's Phoebe	Stable	Stable
Vermilion Flycatcher	Stable	-

Common Name	Summer Trend	Winter Trend
Ash-throated Flycatcher	Stable	-
Brown-crested Flycatcher	Improving*	-
Great Kiskadee	Potential colonization	Potential colonization
Couch's Kingbird	-	Potential colonization
Western Kingbird	Improving	-
White-eyed Vireo	Potential colonization	Potential colonization
Bell's Vireo	Stable	-
Green Jay	-	Potential colonization
Clark's Nutcracker	-	Potential colonization
Common Raven	Stable	Potential extirpation
Northern Rough-winged Swallow	Improving	-
Tree Swallow	-	Potential colonization
Violet-green Swallow	-	Potential colonization
Cliff Swallow	Improving	-
Verdin	Improving	Stable
Rock Wren	Stable	Stable
Canyon Wren	x	Worsening*
Bewick's Wren	Stable	Worsening*
Cactus Wren	Stable	Stable
Blue-gray Gnatcatcher	-	Improving
Black-tailed Gnatcatcher	Improving	Improving
Ruby-crowned Kinglet	-	Stable
Gray Catbird	-	Potential colonization
Curve-billed Thrasher	Stable	Stable
Northern Mockingbird	Stable	Stable

Common Name	Summer Trend	Winter Trend
Phainopepla	Improving*	Improving
Lucy's Warbler	Improving*	-
Yellow-rumped Warbler	Stable	Worsening
Townsend's Warbler	-	Potential colonization
Hermit Warbler	-	Potential colonization^
Olive Sparrow	-	Potential colonization
Rufous-crowned Sparrow	x	Worsening*
Canyon Towhee	Stable	Worsening*
Abert's Towhee	Improving*	Improving
Brewer's Sparrow	-	Improving
Black-throated Sparrow	Worsening*	Stable
White-crowned Sparrow	-	Stable
Dark-eyed Junco	-	Potential extirpation
Northern Cardinal	Stable	Worsening*
Red-winged Blackbird	Potential colonization	-
Eastern Meadowlark	Potential colonization	Potential colonization
Western Meadowlark	Potential colonization	Worsening*
Yellow-headed Blackbird	Potential colonization	-
Brown-headed Cowbird	Improving	-
Hooded Oriole	Stable	-
Bullock's Oriole	Improving	-
Altamira Oriole	-	Potential colonization
House Finch	Worsening*	Worsening
Lesser Goldfinch	Improving	Worsening*