Birds and Climate Change

National Park Service
U.S. Department of the Interior

Montezuma Castle 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 Montezuma Castle 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 41 (e.g., Figure 2), remain stable for 33, and worsen for 6 species. Suitable climate ceases to occur for 9 species in summer, potentially resulting in extirpation of those species from the Monument. Climate is projected to become suitable in summer for 22 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 22, remain stable for 49, and worsen for 24 species. Suitable climate ceases to occur for 10 species in winter, potentially resulting in extirpation from the Monument. Climate is projected to become suitable in winter for 40 species not found at the Monument today, potentially resulting in local colonization.

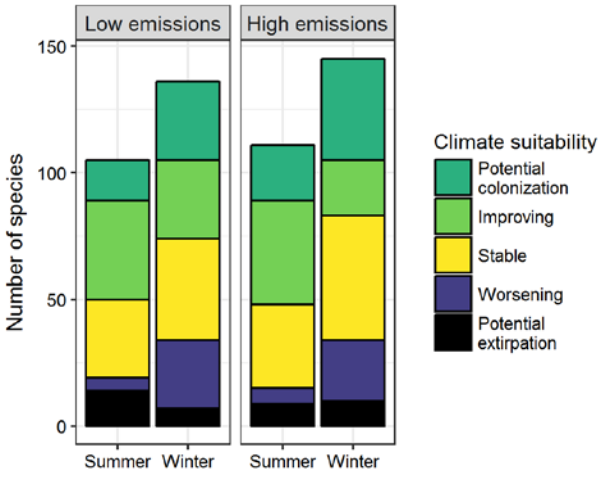

Figure 1. Projected changes in climate suitability for birds at the Monument, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Monument between the present and 2050 is 0.19 in summer (28th percentile across all national parks) and 0.15 in winter (17th percentile) under the high-emissions pathway. Potential species turnover declines to 0.16 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 Monument 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). Suitable climate is not projected to disappear for these 11 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 Red-winged Blackbird (*Agelaius phoeniceus*) through 2050. 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, Montezuma Castle National Monument 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 11 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 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
Black-bellied Whistling-Duck	Potential colonization	-
Fulvous Whistling-Duck	Potential colonization	-
Muscovy Duck	-	Potential colonization
Wood Duck	x	Stable
Gadwall	Improving^	Stable
American Wigeon	-	Worsening
Mallard	Stable^	Worsening
Mottled Duck	Potential colonization	-
Blue-winged Teal	-	Potential colonization
Cinnamon Teal	-	Improving*
Northern Shoveler	-	Worsening
Northern Pintail	Improving	x
Green-winged Teal	-	Stable
Canvasback	-	Stable
Ring-necked Duck	-	Worsening
Lesser Scaup	-	Stable
Bufflehead	-	Stable
Common Goldeneye	-	Stable
Hooded Merganser	-	Stable^
Common Merganser	-	Worsening*
Ruddy Duck	Improving	Stable
Gambel's Quail	Improving*	Stable
Least Grebe	-	Potential colonization
Pied-billed Grebe	-	Stable
Eared Grebe	x	Improving*
Western Grebe	-	Worsening
Wood Stork	Potential colonization	-
Magnificent Frigatebird	-	Potential colonization
Neotropic Cormorant	x	Improving*

Common Name	Summer Trend	Winter Trend
Double-crested Cormorant	x	Stable
Anhinga	Potential colonization^	-
Brown Pelican	Potential colonization	-
Least Bittern	-	Potential colonization
Great Blue Heron	Improving	Worsening
Great Egret	Potential colonization	-
Tricolored Heron	Potential colonization^	-
Cattle Egret	-	Potential colonization
Green Heron	Stable	-
Roseate Spoonbill	-	Potential colonization
Black Vulture	Potential colonization	-
Osprey	-	Potential colonization
White-tailed Kite	Potential colonization	-
Golden Eagle	-	Worsening
Northern Harrier	-	Stable
Sharp-shinned Hawk	-	Worsening
Cooper's Hawk	x	Stable
Bald Eagle	-	Stable
Harris's Hawk	Potential colonization	-
White-tailed Hawk	-	Potential colonization
Swainson's Hawk	Worsening*^	-
Red-tailed Hawk	Worsening*	Stable
Ferruginous Hawk	-	Stable
Virginia Rail	-	Stable
American Coot	x	Stable
Limpkin	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Black-necked Stilt	-	Potential colonization
American Avocet	-	Potential colonization^
Killdeer	Stable	Improving
Mountain Plover	Potential colonization	-
Lesser Yellowlegs	-	Potential colonization
Stilt Sandpiper	-	Potential colonization
Dunlin	-	Potential colonization^
Western Sandpiper	-	Potential colonization
Yellow-footed Gull	-	Potential colonization
Gull-billed Tern	-	Potential colonization
Rock Pigeon	Stable	Potential extirpation
Band-tailed Pigeon	Improving	-
Eurasian Collared-Dove	x	Improving
White-winged Dove	Improving*	-
Mourning Dove	Stable	Stable
Inca Dove	Potential colonization	-
Common Ground-Dove	-	Potential colonization
Yellow-billed Cuckoo	Improving	-
Greater Roadrunner	Stable	Stable
Groove-billed Ani	-	Potential colonization
Great Horned Owl	x	Stable
Lesser Nighthawk	Stable	-
Common Pauraque	-	Potential colonization
Black-chinned Hummingbird	Improving	-
Anna's Hummingbird	Stable	Improving*
Broad-tailed Hummingbird	Stable	-

Common Name	Summer Trend	Winter Trend
Buff-bellied Hummingbird	-	Potential colonization
Ringed Kingfisher	-	Potential colonization
Belted Kingfisher	Stable	Worsening
Acorn Woodpecker	Stable	-
Gila Woodpecker	Improving*	Improving*
Red-naped Sapsucker	-	Worsening*
Ladder-backed Woodpecker	Improving	Stable
Hairy Woodpecker	-	Potential extirpation
Northern Flicker	Stable	Worsening
Crested Caracara	Potential colonization	Potential colonization
American Kestrel	x	Stable
Merlin	-	Stable^
Peregrine Falcon	-	Potential colonization
Prairie Falcon	-	Improving
Western Wood-Pewee	Stable^	-
Gray Flycatcher	-	Improving*
Cordilleran Flycatcher	Improving	-
Black Phoebe	Improving	Stable
Eastern Phoebe	-	Potential colonization
Say's Phoebe	Worsening*	Stable
Vermilion Flycatcher	Improving	-
Ash-throated Flycatcher	Stable	-
Brown-crested Flycatcher	Improving*	-
Great Kiskadee	Potential colonization	-
Cassin's Kingbird	Improving	Potential colonization
Western Kingbird	Stable	-
Loggerhead Shrike	-	Stable
White-eyed Vireo	Potential colonization	Potential colonization
Bell's Vireo	Improving*	-

Common Name	Summer Trend	Winter Trend
Hutton's Vireo	-^	Improving
Warbling Vireo	Potential extirpation	-
Steller's Jay	Stable	-
California/Woodhouse's Scrub-Jay (Western Scrub-Jay)	-	Worsening*
Common Raven	Stable	Stable
Northern Rough-winged Swallow	Improving	Potential colonization
Purple Martin	Potential colonization	-
Tree Swallow	-	Potential colonization
Violet-green Swallow	Stable	-
Barn Swallow	Stable	-
Cliff Swallow	Improving	-
Cave Swallow	Potential colonization	-
Carolina Chickadee	-	Potential colonization
Mountain Chickadee	Stable	Potential extirpation
Bridled Titmouse	Stable	Stable
Juniper Titmouse	Potential extirpation	Potential extirpation
Black-crested Titmouse	Potential colonization	-
Verdin	Improving*	Stable
Bushtit	Potential extirpation	Worsening*
White-breasted Nuthatch	Stable	Potential extirpation
Brown Creeper	-	Stable
Rock Wren	Improving	Stable
Canyon Wren	x	Worsening
House Wren	Potential extirpation	-
Bewick's Wren	Improving*	Worsening*
Cactus Wren	Improving	Stable

Common Name	Summer Trend	Winter Trend
Blue-gray Gnatcatcher	Improving	-
Black-tailed Gnatcatcher	-	Improving*
Ruby-crowned Kinglet	Stable	Stable
Western Bluebird	Potential extirpation	Worsening*
Townsend's Solitaire	-^	Worsening*
Hermit Thrush	-	Improving
American Robin	Stable	Potential extirpation
Curve-billed Thrasher	Improving	Stable
Long-billed Thrasher	-	Potential colonization
LeConte's Thrasher	Potential colonization	-
Crissal Thrasher	-	Worsening*
Sage Thrasher	-	Worsening*
Northern Mockingbird	Worsening*	Improving
European Starling	Stable	Stable
Phainopepla	Improving	Stable
Orange-crowned Warbler	-	Improving
Lucy's Warbler	Improving*	-
Common Yellowthroat	Improving	-
Northern Parula	-	Potential colonization
Yellow Warbler	Improving	-
Yellow-rumped Warbler	Improving	Stable
Townsend's Warbler	-	Potential colonization
Hermit Warbler	-	Potential colonization^
Wilson's Warbler	-	Potential colonization
Yellow-breasted Chat	Improving*	-
Olive Sparrow	Potential colonization	-
Green-tailed Towhee	-	Improving*
Rufous-crowned Sparrow	x	Stable
Canyon Towhee	Stable	Stable

Common Name	Summer Trend	Winter Trend
Abert's Towhee	Improving*	Improving*
Bachman's Sparrow	Potential colonization	-
Chipping Sparrow	Potential extirpation	Improving
Brewer's Sparrow	Potential extirpation	Improving
Vesper Sparrow	-	Improving
Lark Sparrow	Worsening*	-
Black-throated Sparrow	Stable	Improving*
Savannah Sparrow	-	Stable
Grasshopper Sparrow	-	Potential colonization
Henslow's Sparrow	-	Potential colonization
Song Sparrow	Improving	Worsening
Lincoln's Sparrow	-	Stable
White-throated Sparrow	-	Stable
White-crowned Sparrow	-	Stable
Dark-eyed Junco	x	Potential extirpation
Hepatic Tanager	Worsening	-
Summer Tanager	Improving	-
Western Tanager	Potential extirpation	-
Northern Cardinal	Improving*	Improving*
Black-headed Grosbeak	Stable	-
Blue Grosbeak	Stable	-
Lazuli Bunting	Potential extirpation	-
Indigo Bunting	Stable	Potential colonization
Red-winged Blackbird	Improving	Stable
Western Meadowlark	-	Worsening
Brewer's Blackbird	Stable	Worsening
Great-tailed Grackle	Stable	Improving
Bronzed Cowbird	Improving	Potential colonization

Common Name	Summer Trend	Winter Trend
Brown-headed Cowbird	Improving	Stable
Hooded Oriole	Improving	-
Bullock's Oriole	Improving	-
House Finch	Stable	Worsening
Cassin's Finch	-	Stable

Common Name	Summer Trend	Winter Trend
Pine Siskin	-	Potential extirpation
Lesser Goldfinch	Improving	Stable
American Goldfinch	-	Potential extirpation
House Sparrow	x	Potential extirpation