Birds and Climate Change

National Park Service
U.S. Department of the Interior

Saguaro 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 Saguaro 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 50 (e.g., Figure 2), remain stable for 42, and worsen for 10 species. Suitable climate ceases to occur for 8 species in summer, potentially resulting in extirpation of those species from the Park. Climate is projected to become suitable in summer for 11 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 62, remain stable for 54, and worsen for 25 species. Suitable climate ceases to occur for 14 species in winter, potentially resulting in extirpation from the Park. Climate is projected to become suitable in winter for 47 species not found at the Park today, potentially resulting in local colonization.

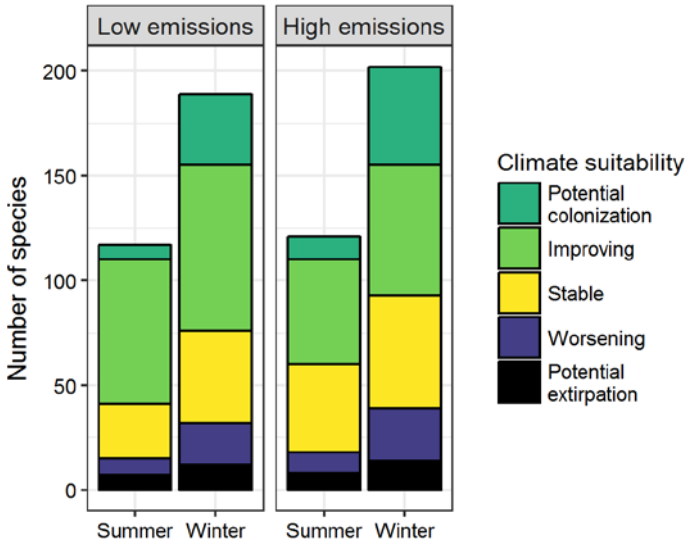

Figure 1. Projected changes in climate suitability for birds at the Park, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Park between the present and 2050 is 0.10 in summer (12th percentile across all national parks) and 0.16 in winter (19th percentile) under the high-emissions pathway. Potential species turnover declines to 0.08 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 22 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 21 of these climate-sensitive species, one, the Lesser Yellowlegs (*Tringa flavipes*), might be extirpated from the Park in summer by 2050.

Figure 2. Climate at the Park 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, Saguaro 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 21 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

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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
Black-bellied Whistling-Duck	Improving	x
Muscovy Duck	-	Potential colonization
Wood Duck	-	Stable
Gadwall	-	Improving
American Wigeon	-	Stable
Mallard	Improving^	Potential extirpation
Mottled Duck	-	Potential colonization
Blue-winged Teal	Stable	Improving
Cinnamon Teal	x	Improving
Northern Shoveler	Stable^	Improving
Green-winged Teal	-	Improving
Canvasback	-	Improving
Ring-necked Duck	-	Stable
Lesser Scaup	-	Stable
Bufflehead	-	Improving
Common Goldeneye	-	Improving*
Barrow's Goldeneye	-	Potential colonization^
Hooded Merganser	-	Improving^
Common Merganser	-	Potential colonization
Red-breasted Merganser	-	Potential colonization^
Ruddy Duck	Improving	Improving
Plain Chachalaca	-	Potential colonization
Gambel's Quail	Improving	Stable
Northern Bobwhite	Potential colonization	Potential colonization
Wild Turkey	-	Potential extirpation
Pied-billed Grebe	x	Stable
Eared Grebe	-	Improving
Magnificent Frigatebird	-	Potential colonization
Neotropic Cormorant	x	Improving
Double-crested Cormorant	-	Improving*

Common Name	Summer Trend	Winter Trend
Anhinga	-	Potential colonization
Brown Pelican	Potential colonization	Potential colonization^
Least Bittern	-	Potential colonization
Great Blue Heron	Improving	Stable
Great Egret	Improving	Improving*
Snowy Egret	x	Improving*
Little Blue Heron	Potential colonization	-
Reddish Egret	-	Potential colonization
Green Heron	Improving	Improving
Black-crowned Night-Heron	x	Improving*
White Ibis	-	Potential colonization
Black Vulture	Improving	Improving
Turkey Vulture	x	Improving*
White-tailed Kite	-	Potential colonization
Golden Eagle	x	Worsening*
Northern Harrier	-	Stable
Sharp-shinned Hawk	-	Stable
Cooper's Hawk	x	Stable
Bald Eagle	-	Improving
Harris's Hawk	Improving*	Worsening
Gray Hawk	Stable	-
Swainson's Hawk	Worsening*^	-
Red-tailed Hawk	Improving	Stable
Clapper Rail	-	Potential colonization
Virginia Rail	-	Improving
Sora	-	Improving
Common Gallinule	x	Improving*
American Coot	x	Stable
Black-necked Stilt	x	Improving*

Common Name	Summer Trend	Winter Trend
American Avocet	x	Improving^
Black-bellied Plover	-	Potential colonization
Snowy Plover	-	Potential colonization
Wilson's Plover	-	Potential colonization
Semipalmated Plover	-	Potential colonization^
Killdeer	Improving*	Stable
Spotted Sandpiper	-	Improving*
Wandering Tattler	-	Potential colonization
Greater Yellowlegs	Stable	Improving*
Willet	-	Potential colonization^
Lesser Yellowlegs	Potential extirpation^	Potential colonization
Whimbrel	-	Potential colonization
Marbled Godwit	-	Potential colonization
Ruddy Turnstone	-	Potential colonization^
Dunlin	-	Improving*^
Least Sandpiper	-	Improving
Western Sandpiper	-	Improving*
Short-billed Dowitcher	-	Potential colonization^
Long-billed Dowitcher	-	Improving*
Wilson's Snipe	-	Stable
Western Gull	-	Potential colonization^
Iceland Gull (Thayer's)	-	Potential colonization
Caspian Tern	-	Potential colonization
Forster's Tern	-	Potential colonization
Royal Tern	-	Potential colonization^

Common Name	Summer Trend	Winter Trend
Black Skimmer	-	Potential colonization^
Rock Pigeon	Stable	Stable
Eurasian Collared-Dove	x	Improving
White-winged Dove	Improving	Stable
Mourning Dove	Stable	Improving
Inca Dove	Improving*	Improving
Common Ground-Dove	Improving*	Improving*
White-tipped Dove	Potential colonization	Potential colonization
Yellow-billed Cuckoo	Improving	-
Greater Roadrunner	Improving	Worsening
Barn Owl	x	Worsening
Western Screech-Owl	x	Improving
Great Horned Owl	x	Potential extirpation
Northern Pygmy-Owl	-	Potential colonization
Lesser Nighthawk	Improving	Potential colonization
White-throated Swift	x	Improving
Black-chinned Hummingbird	Improving*	-
Anna's Hummingbird	Improving	Improving*
Costa's Hummingbird	Stable	Improving
Broad-tailed Hummingbird	Stable	-
Ringed Kingfisher	-	Potential colonization
Belted Kingfisher	-	Improving
Acorn Woodpecker	Stable	Stable
Gila Woodpecker	Improving	Improving
Red-naped Sapsucker	-	Worsening*
Ladder-backed Woodpecker	Stable	Stable
Arizona Woodpecker	-	Stable
Northern Flicker	Stable	Worsening
Gilded Flicker	Stable	Stable
Crested Caracara	Potential colonization	-

Common Name	Summer Trend	Winter Trend
American Kestrel	x	Stable
Merlin	-	Worsening^
Peregrine Falcon	x	Improving*
Prairie Falcon	x	Stable
Northern Beardless-Tyrannulet	Stable	x
Western Wood-Pewee	Stable^	-
Hammond's Flycatcher	-	Improving*
Gray Flycatcher	-	Improving
Pacific-slope Flycatcher	Stable	-
Cordilleran Flycatcher	Improving	-
Black Phoebe	Improving*	Improving
Eastern Phoebe	-	Improving
Say's Phoebe	Worsening*	Stable
Vermilion Flycatcher	Improving	Improving
Ash-throated Flycatcher	Improving	x
Great Crested Flycatcher	-	Potential colonization
Brown-crested Flycatcher	Improving*	-
Great Kiskadee	Potential colonization	-
Couch's Kingbird	-	Potential colonization
Cassin's Kingbird	Stable	-
Western Kingbird	Stable	-
Loggerhead Shrike	Stable	Stable
White-eyed Vireo	Potential colonization	Potential colonization
Bell's Vireo	Improving	-
Hutton's Vireo	Stable^	Improving
Warbling Vireo	Potential extirpation	-
Black-whiskered Vireo	Potential colonization	-
Green Jay	Potential colonization	Potential colonization
Steller's Jay	-	Potential extirpation

Common Name	Summer Trend	Winter Trend
California/Woodhouse's Scrub-Jay (Western Scrub-Jay)	Stable	Potential extirpation
Mexican Jay	x	Stable
Chihuahuan Raven	-	Worsening*
Common Raven	Stable	Stable
Horned Lark	-	Potential extirpation
Northern Rough-winged Swallow	Improving*	Improving
Purple Martin	Improving	-
Tree Swallow	Potential extirpation	Potential colonization
Violet-green Swallow	Stable	-
Barn Swallow	Stable	x
Cliff Swallow	Improving	-
Carolina Chickadee	-	Potential colonization
Bridled Titmouse	Stable	Stable
Verdin	Improving	Worsening
Bushtit	Potential extirpation	Worsening*
White-breasted Nuthatch	Stable	Potential extirpation
Pygmy Nuthatch	Stable	Stable^
Brown Creeper	-	Potential extirpation
Rock Wren	Stable	Stable
Canyon Wren	x	Worsening*
House Wren	Potential extirpation	Stable
Marsh Wren	-	Stable
Bewick's Wren	Improving	Worsening*
Cactus Wren	Stable	Stable
Blue-gray Gnatcatcher	Improving	Improving
Black-tailed Gnatcatcher	Stable	Improving
Ruby-crowned Kinglet	-	Stable
Western Bluebird	-	Worsening*
Mountain Bluebird	-	Stable

Common Name	Summer Trend	Winter Trend
Townsend's Solitaire	-	Worsening
Hermit Thrush	Potential extirpation	Worsening*
American Robin	Potential extirpation	Potential extirpation
Curve-billed Thrasher	Stable	Worsening
Bendire's Thrasher	-	Stable
Crissal Thrasher	Improving	Worsening*
Sage Thrasher	-	Stable
Northern Mockingbird	Worsening*	Improving
European Starling	Improving	Improving
American Pipit	-	Stable
Cedar Waxwing	-	Potential extirpation
Phainopepla	Stable	Stable
Smith's Longspur	-	Potential colonization
Orange-crowned Warbler	-	Improving
Lucy's Warbler	Improving	-
Common Yellowthroat	Improving	Improving
Yellow Warbler	Improving	x
Yellow-rumped Warbler	Improving	Worsening
Black-throated Gray Warbler	Stable	Improving*
Wilson's Warbler	Stable	-
Red-faced Warbler	Stable	-
Yellow-breasted Chat	Improving	-
Olive Sparrow	Potential colonization	Potential colonization
Green-tailed Towhee	-	Stable
Spotted Towhee	Stable	x
Rufous-crowned Sparrow	x	Stable
Canyon Towhee	Stable	Worsening*
Abert's Towhee	Improving*	Improving
Rufous-winged Sparrow	Worsening*	Worsening*
Cassin's Sparrow	-	Worsening
Bachman's Sparrow	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Chipping Sparrow	Potential extirpation	Stable
Brewer's Sparrow	-	Stable
Black-chinned Sparrow	x	Worsening*
Vesper Sparrow	-	Stable
Lark Sparrow	Stable	Improving
Black-throated Sparrow	Worsening*	Stable
Lark Bunting	-	Improving
Savannah Sparrow	-	Improving
Song Sparrow	Improving*	Potential extirpation
Lincoln's Sparrow	-	Stable
Swamp Sparrow	-	Stable
White-throated Sparrow	-	Stable
White-crowned Sparrow	-	Stable
Dark-eyed Junco	-	Potential extirpation
Hepatic Tanager	Stable	-
Summer Tanager	Worsening*	-
Western Tanager	Stable	Improving
Northern Cardinal	Improving	Stable
Pyrrhuloxia	Worsening*	Worsening*
Black-headed Grosbeak	Stable	-
Blue Grosbeak	Worsening*	-

Common Name	Summer Trend	Winter Trend
Lazuli Bunting	Stable	x
Red-winged Blackbird	Improving	Stable
Eastern Meadowlark	Potential colonization	Stable
Western Meadowlark	-	Stable
Yellow-headed Blackbird	Improving	x
Brewer's Blackbird	-	Stable
Great-tailed Grackle	Improving*	Improving
Bronzed Cowbird	Improving	-
Brown-headed Cowbird	Improving	Stable
Hooded Oriole	Stable	-
Bullock's Oriole	Improving	-
Altamira Oriole	-	Potential colonization
Audubon's Oriole	-	Potential colonization
Scott's Oriole	Worsening*	-
House Finch	Worsening*	Worsening
Red Crossbill	Improving^	-
Pine Siskin	-	Potential extirpation
Lesser Goldfinch	Improving*	Worsening*
House Sparrow	x	Potential extirpation