



Grand Canyon 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 Grand Canyon 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.

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 29, remain stable for 36 (e.g., Figure 2), and worsen for 19 species. Suitable climate ceases to occur for 46 species in summer, potentially resulting in extirpation of those species from the Park. Climate is projected to become suitable in summer for 17 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 43, remain stable for 30, and worsen for 22 species. Suitable climate ceases to occur for 16 species in winter, potentially resulting in extirpation from the Park. Climate is projected to become suitable in winter for 36 species not found at the Park today, potentially resulting in local colonization.

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.

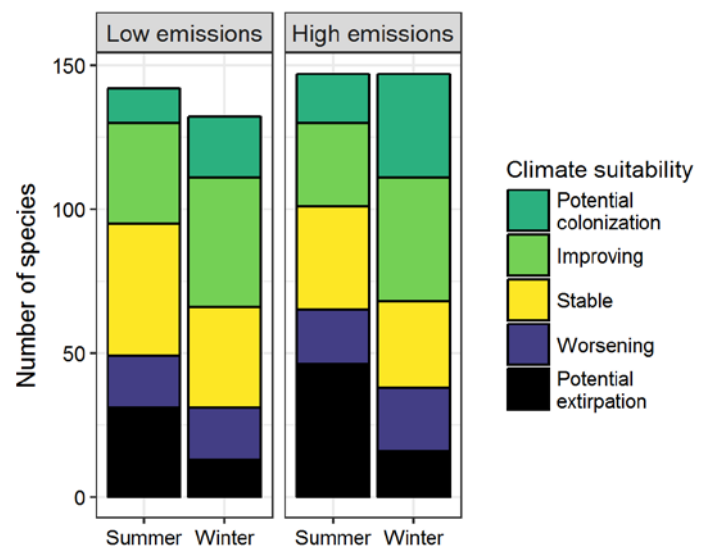


Figure 1. Projected changes in climate suitability for birds at the Park, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Park between the present and 2050 is 0.22 in summer (35th percentile across all national parks) and 0.17 in winter (22nd percentile) under the high-emissions pathway. Potential species turnover declines to 0.15 in summer and 0.10 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 11 of these

Management Implications

Parks differ in potential colonization and extirpation rates, and therefore different climate change adaptation strategies may apply. **Under the high-emissions pathway, Grand Canyon National Park falls within the high potential extirpation group.** Parks anticipating high potential extirpation 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

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

climate-sensitive species, 11 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 Mourning Dove (*Zenaida macroura*) through 2050. Photo by KS Black/Flickr (Public Domain).

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.

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 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	-	Potential extirpation
Gadwall	Potential extirpation [^]	Stable
American Wigeon	-	Stable
Mallard	Potential extirpation [^]	Stable
Blue-winged Teal	-	Potential colonization
Northern Shoveler	Potential extirpation [^]	Stable
Green-winged Teal	-	Stable
Canvasback	-	Improving
Ring-necked Duck	-	Improving
Greater Scaup	-	Stable [^]
Lesser Scaup	-	Stable
Long-tailed Duck	-	Stable
Bufflehead	-	Improving
Common Goldeneye	-	Worsening
Barrow's Goldeneye	-	Stable [^]

Common Name	Summer Trend	Winter Trend
Common Merganser	x	Worsening
Ruddy Duck	-	Improving
Gambel's Quail	Improving*	Improving
Chukar	Stable	-
Wild Turkey	x	Stable
Least Grebe	-	Potential colonization
Pied-billed Grebe	-	Improving
Clark's Grebe	x	Stable
Wood Stork	Potential colonization	-
Neotropic Cormorant	-	Potential colonization
Double-crested Cormorant	x	Potential extirpation
Anhinga	Potential colonization [^]	-
Least Bittern	-	Potential colonization
Great Blue Heron	Stable	Improving

Common Name	Summer Trend	Winter Trend
Great Egret	-	Potential colonization
Snowy Egret	x	Potential colonization
Cattle Egret	Potential colonization	-
Green Heron	-	Potential colonization
Roseate Spoonbill	-	Potential colonization
White-tailed Kite	Potential colonization	-
Golden Eagle	x	Worsening*
Northern Harrier	Potential extirpation [^]	Stable
Sharp-shinned Hawk	x	Worsening
Cooper's Hawk	x	Improving
Northern Goshawk	x	Potential extirpation
Bald Eagle	-	Potential extirpation
Harris's Hawk	-	Potential colonization
White-tailed Hawk	-	Potential colonization
Gray Hawk	Potential colonization	-
Swainson's Hawk	Improving* [^]	-
Red-tailed Hawk	Stable	Improving
Ferruginous Hawk	Worsening [^]	-
Clapper Rail	-	Potential colonization
Common Gallinule	-	Potential colonization
American Coot	x	Stable
Limpkin	-	Potential colonization
American Avocet	-	Potential colonization [^]
Killdeer	Stable	Improving
Mountain Plover	Potential	-

Common Name	Summer Trend	Winter Trend
	colonization	
Spotted Sandpiper	x	Improving
Long-billed Curlew	-	Potential colonization
Stilt Sandpiper	-	Potential colonization
Wilson's Phalarope	Potential extirpation [^]	-
Ring-billed Gull	-	Stable
Yellow-footed Gull	-	Potential colonization
Rock Pigeon	Stable	Potential extirpation
Band-tailed Pigeon	Stable	-
Eurasian Collared-Dove	x	Improving
White-winged Dove	Improving*	-
Mourning Dove	Stable	Improving
Inca Dove	Potential colonization	-
Common Ground-Dove	-	Potential colonization
White-tipped Dove	Potential colonization	-
Greater Roadrunner	Improving*	Improving*
Western Screech-Owl	x	Worsening
Great Horned Owl	x	Worsening
Northern Pygmy-Owl	x	Worsening
Lesser Nighthawk	Improving*	-
Common Nighthawk	Stable	-
Black-chinned Hummingbird	Stable	-
Anna's Hummingbird	Stable	Potential colonization
Costa's Hummingbird	Improving	Potential colonization
Broad-tailed Hummingbird	Potential extirpation	x
Rufous Hummingbird	Stable	-
Buff-bellied Hummingbird	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Belted Kingfisher	-	Worsening
Lewis's Woodpecker	x	Stable
Acorn Woodpecker	Stable	Stable
Gila Woodpecker	Potential colonization	-
Golden-fronted Woodpecker	Potential colonization	-
Red-naped Sapsucker	Potential extirpation ^	Improving*
Ladder-backed Woodpecker	Improving*	Improving*
Downy Woodpecker	Stable	Potential extirpation
Hairy Woodpecker	Potential extirpation	Potential extirpation
Northern Flicker	Potential extirpation	Worsening
American Kestrel	x	Improving
Merlin	-	Stable ^
Peregrine Falcon	x	Improving
Olive-sided Flycatcher	Potential extirpation	-
Western Wood-Pewee	Potential extirpation ^	-
Willow Flycatcher	Stable	-
Hammond's Flycatcher	-	Improving
Gray Flycatcher	Worsening	Potential colonization
Dusky Flycatcher	Worsening	Potential colonization
Cordilleran Flycatcher	Worsening	-
Black Phoebe	Improving	Improving*
Say's Phoebe	Worsening	Improving
Vermilion Flycatcher	Potential colonization	-
Ash-throated Flycatcher	Improving*	-
Brown-crested Flycatcher	Improving*	-
Cassin's Kingbird	Stable	-
Western Kingbird	Stable	-
Scissor-tailed Flycatcher	Potential	-

Common Name	Summer Trend	Winter Trend
	colonization	
Loggerhead Shrike	Improving*	Improving
Bell's Vireo	Improving	-
Hutton's Vireo	Stable ^	Potential colonization
Warbling Vireo	Potential extirpation	-
Pinyon Jay	Worsening*	Worsening*
Steller's Jay	Potential extirpation	Worsening*
California/Woodhouse's Scrub-Jay (Western Scrub-Jay)	Stable	Worsening*
Clark's Nutcracker	Potential extirpation ^	Worsening
American Crow	Potential extirpation	Potential extirpation
Common Raven	Potential extirpation	Potential extirpation
Horned Lark	Potential extirpation	Worsening
Northern Rough-winged Swallow	Improving	Potential colonization
Purple Martin	Improving	-
Tree Swallow	Potential extirpation	-
Violet-green Swallow	Worsening*	-
Barn Swallow	Stable	-
Cliff Swallow	Stable	-
Cave Swallow	Potential colonization	-
Mountain Chickadee	Potential extirpation	Worsening*
Juniper Titmouse	Worsening	Worsening
Bushtit	Worsening	Worsening*
Red-breasted Nuthatch	Potential extirpation	Potential extirpation
White-breasted Nuthatch	Stable	Stable
Pygmy Nuthatch	Worsening	Worsening ^
Brown Creeper	Potential extirpation ^	Stable

Common Name	Summer Trend	Winter Trend
Rock Wren	Worsening	Improving
Canyon Wren	x	Stable
House Wren	Potential extirpation	Improving
Marsh Wren	x	Stable
Bewick's Wren	Stable	Stable
Blue-gray Gnatcatcher	Stable	Improving*
Black-tailed Gnatcatcher	Improving*	-
American Dipper	x	Potential extirpation
Golden-crowned Kinglet	Potential extirpation	Stable
Ruby-crowned Kinglet	Potential extirpation	Improving
Western Bluebird	Worsening	Stable
Mountain Bluebird	Potential extirpation	Worsening
Townsend's Solitaire	Potential extirpation [^]	Worsening*
Hermit Thrush	Potential extirpation	Improving
American Robin	Potential extirpation	Potential extirpation
Long-billed Thrasher	-	Potential colonization
Crissal Thrasher	Improving	-
Sage Thrasher	Potential extirpation	-
Northern Mockingbird	Improving	Improving*
European Starling	Stable	Stable
American Pipit	-	Improving*
Sprague's Pipit	-	Potential colonization
Cedar Waxwing	Potential extirpation	-
Phainopepla	Improving	Improving*
Orange-crowned Warbler	Potential extirpation	Improving*
Lucy's Warbler	Improving	-
MacGillivray's Warbler	Potential	-

Common Name	Summer Trend	Winter Trend
	extirpation	
Common Yellowthroat	Stable	-
Yellow Warbler	Potential extirpation	-
Yellow-rumped Warbler	Stable	Improving
Grace's Warbler	Stable	-
Black-throated Gray Warbler	Potential extirpation	Potential colonization
Townsend's Warbler	Stable	-
Wilson's Warbler	Potential extirpation	-
Red-faced Warbler	Stable	-
Yellow-breasted Chat	Improving	-
Green-tailed Towhee	Worsening [^]	Improving
Spotted Towhee	Worsening*	x
Rufous-crowned Sparrow	x	Stable
Canyon Towhee	Improving	Improving*
Abert's Towhee	Potential colonization	-
Rufous-winged Sparrow	-	Potential colonization
Cassin's Sparrow	-	Potential colonization
Chipping Sparrow	Potential extirpation	Improving*
Brewer's Sparrow	Potential extirpation	Improving*
Vesper Sparrow	Potential extirpation	-
Lark Sparrow	Worsening*	Potential colonization
Black-throated Sparrow	Stable	Improving*
Sagebrush/Bell's Sparrow (Sage Sparrow)	Worsening [^]	Stable
Henslow's Sparrow	-	Potential colonization
Song Sparrow	Potential extirpation	Stable
Lincoln's Sparrow	-	Improving
White-crowned Sparrow	Stable	Improving

Common Name	Summer Trend	Winter Trend
Dark-eyed Junco	x	Worsening
Hepatic Tanager	Stable	-
Summer Tanager	Improving	-
Western Tanager	Potential extirpation	-
Rose-breasted Grosbeak	Stable	-
Black-headed Grosbeak	Worsening*	-
Blue Grosbeak	Improving*	-
Lazuli Bunting	Worsening	-
Indigo Bunting	Stable	Potential colonization
Painted Bunting	Potential colonization	-
Red-winged Blackbird	Stable	Improving
Eastern Meadowlark	Potential colonization	Potential colonization
Western Meadowlark	Worsening*	Stable
Brewer's Blackbird	Potential extirpation	Stable
Great-tailed Grackle	Improving*	Improving*

Common Name	Summer Trend	Winter Trend
Bronzed Cowbird	Potential colonization	Potential colonization
Brown-headed Cowbird	Improving	-
Hooded Oriole	Improving	-
Bullock's Oriole	Improving*	-
Altamira Oriole	-	Potential colonization
Scott's Oriole	Stable	-
House Finch	Improving	Improving
Cassin's Finch	Potential extirpation	Worsening
Red Crossbill	Potential extirpation [^]	x
Pine Siskin	Potential extirpation	Potential extirpation
Lesser Goldfinch	Improving	Improving
American Goldfinch	Potential extirpation	Potential extirpation
Evening Grosbeak	Potential extirpation	Potential extirpation
House Sparrow	x	Potential extirpation