Birds and Climate Change

National Park Service
U.S. Department of the Interior

Petrified Forest 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 Petrified Forest 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 17 (e.g., Figure 2), remain stable for 6, and worsen for 5 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 19 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 11, remain stable for 10, and worsen for 4 species. Suitable climate ceases to occur for 1 species in winter, potentially resulting in extirpation from the Park. Climate is projected to become suitable in winter for 43 species not found at the Park today, potentially resulting in local colonization.

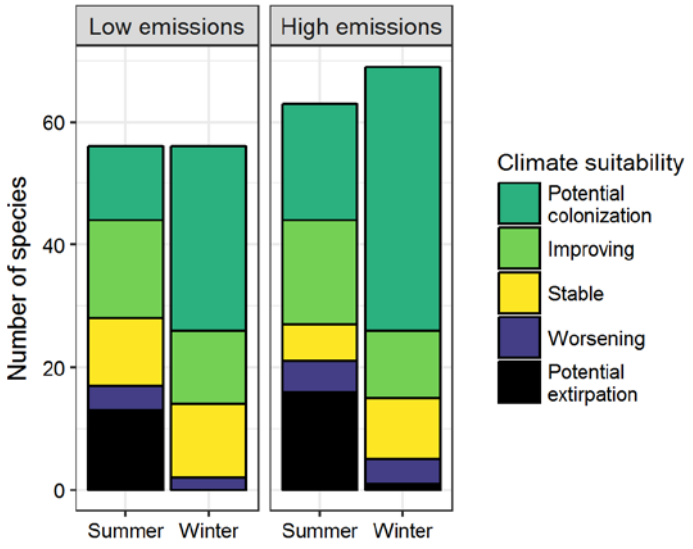

Figure 1. Projected changes in climate suitability for birds at the Park, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Park between the present and 2050 is 0.27 in summer (45th percentile across all national parks) and 0.20 in winter (27th percentile) under the high-emissions pathway. Potential species turnover declines to 0.18 in summer and 0.15 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 8 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 6 of these climate-sensitive species, 2 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).

Management Implications

Parks differ in potential colonization and extirpation rates, and therefore different climate change adaptation strategies may apply. **Under the high-emissions pathway, Petrified Forest National Park falls within the high turnover group.** Parks anticipating high turnover 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 6 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 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
Gadwall	Potential colonization^	-
Redhead	Potential colonization^	-
Hooded Merganser	-	Potential colonization^
Scaled Quail	Improving*	Stable
Ring-necked Pheasant	-	Potential colonization
Neotropic Cormorant	-	Potential colonization
Great Egret	Potential colonization	Potential colonization
Snowy Egret	-	Potential colonization
Cattle Egret	Potential colonization	-
Yellow-crowned Night-Heron	Potential colonization	-
Golden Eagle	-	Stable
Mississippi Kite	Potential colonization	-
Northern Harrier	-	Improving
Swainson's Hawk	Improving*^	-
Red-tailed Hawk	Stable	Stable
Common Gallinule	-	Potential colonization
Killdeer	Improving	Stable
Spotted Sandpiper	-	Potential colonization
Dunlin	-	Potential colonization^
Least Sandpiper	-	Potential colonization
Long-billed Dowitcher	-	Potential colonization
Rock Pigeon	Stable	-
Eurasian Collared-Dove	x	Potential colonization
White-winged Dove	Potential colonization	-
Mourning Dove	Improving	Improving
Greater Roadrunner	Improving*	Improving*

Common Name	Summer Trend	Winter Trend
Burrowing Owl	Improving^	Potential colonization
Common Nighthawk	Worsening*	-
White-throated Swift	-	Potential colonization
Anna's Hummingbird	Potential colonization	Potential colonization
Acorn Woodpecker	-	Potential colonization
Gila Woodpecker	Potential colonization	Potential colonization
Northern Flicker	Potential extirpation	Worsening
Gilded Flicker	-	Potential colonization
American Kestrel	x	Improving
Peregrine Falcon	-	Potential colonization
Western Wood-Pewee	Potential extirpation^	-
Hammond's Flycatcher	-	Potential colonization
Gray Flycatcher	Potential extirpation	Potential colonization
Dusky Flycatcher	-	Potential colonization
Eastern Phoebe	-	Potential colonization
Say's Phoebe	Improving	-
Vermilion Flycatcher	-	Potential colonization
Ash-throated Flycatcher	Improving	-
Western Kingbird	Improving	-
Loggerhead Shrike	Improving	Improving
Hutton's Vireo	-	Potential colonization
Mexican Jay	-	Potential colonization
Common Raven	Potential extirpation	Potential extirpation
Horned Lark	Worsening*	Worsening*

Common Name	Summer Trend	Winter Trend
Northern Rough-winged Swallow	Potential colonization	-
Tree Swallow	-	Potential colonization
Barn Swallow	Stable	-
Cliff Swallow	Improving	-
Bridled Titmouse	-	Potential colonization
Verdin	Potential colonization	Potential colonization
Bushtit	Potential extirpation	Stable
Rock Wren	Stable	Improving
House Wren	-	Potential colonization
Bewick's Wren	Worsening*	-
Black-tailed Gnatcatcher	Potential colonization	Potential colonization
American Robin	Stable	Stable
Bendire's Thrasher	x	Potential colonization
Sage Thrasher	Potential extirpation	-
Northern Mockingbird	Improving	Improving
European Starling	Potential extirpation	Stable
Phainopepla	-	Potential colonization
Orange-crowned Warbler	-	Potential colonization
Lucy's Warbler	Potential colonization	-
MacGillivray's Warbler	Potential extirpation	-
Yellow Warbler	Potential extirpation	-
Canyon Towhee	-	Stable
Abert's Towhee	-	Potential colonization
Rufous-winged Sparrow	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Cassin's Sparrow	-	Potential colonization
Chipping Sparrow	-	Potential colonization
Brewer's Sparrow	Potential extirpation	-
Black-chinned Sparrow	-	Potential colonization
Vesper Sparrow	-	Potential colonization
Lark Sparrow	Worsening*	-
Black-throated Sparrow	Improving*	-
Sagebrush/Bell's Sparrow (Sage Sparrow)	Potential extirpation^	Stable
Henslow's Sparrow	-	Potential colonization
Song Sparrow	Potential extirpation	-
Swamp Sparrow	-	Potential colonization
White-crowned Sparrow	-	Improving
Dark-eyed Junco	x	Worsening*
Western Tanager	Potential extirpation	-
Pyrrhuloxia	Potential colonization	-

Common Name	Summer Trend	Winter Trend
Lazuli Bunting	Potential extirpation	-
Painted Bunting	Potential colonization	-
Red-winged Blackbird	-	Improving
Tricolored Blackbird	Potential colonization	-
Eastern Meadowlark	Potential colonization	Potential colonization
Western Meadowlark	Worsening*	Stable
Yellow-headed Blackbird	Stable	-
Brewer's Blackbird	Potential extirpation	-
Great-tailed Grackle	Improving	Improving
Bronzed Cowbird	Potential colonization	Potential colonization
Brown-headed Cowbird	Improving*	-
Hooded Oriole	Potential colonization	-
Bullock's Oriole	Improving*	-
House Finch	Improving	Improving
Cassin's Finch	Potential extirpation	-
House Sparrow	x	Worsening*