



## Manzanar National Historic Site

### 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 Manzanar National Historic Site (hereafter, the Site) 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 Site, 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 Site today, climate suitability in summer under the high-emissions pathway is projected to improve for 5, remain stable for 10, and worsen for 11 species. Suitable climate ceases to occur for 9 species in summer, potentially resulting in extirpation of those species from the Site. Climate is projected to become suitable in summer for 14 species not found at the Site today, potentially resulting in local colonization. Among the species likely to be found at the Site today, climate suitability in winter under the high-emissions pathway is projected to improve for 12 (e.g., Figure 2), remain stable for 5, and worsen for 8 species. Suitable climate ceases to occur for 2 species in winter, potentially resulting in extirpation from the Site. Climate is projected to become suitable in winter for 24 species not found at the Site 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 Site based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Site 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.

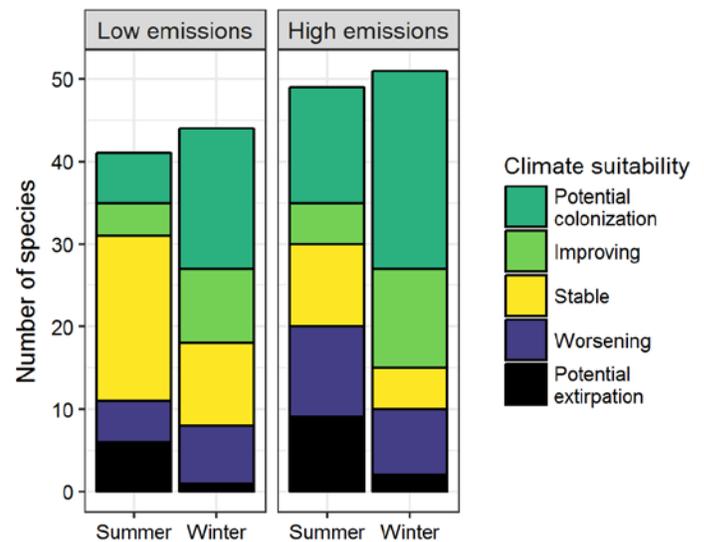


Figure 1. Projected changes in climate suitability for birds at the Site, by emissions pathway and season.

## Results (continued)

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### Potential Turnover Index

**Potential bird species turnover for the Site between the present and 2050 is 0.19 in summer (28<sup>th</sup> percentile across all national parks) and 0.11 in winter (9<sup>th</sup> percentile) under the high-emissions pathway. Potential species turnover declines to 0.10 in summer and 0.07 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 Site is or may become home to 4 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

### Management Implications

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Parks differ in potential colonization and extirpation rates, and therefore different climate change adaptation strategies may apply. **Under the high-emissions pathway, Manzanar National Historic Site 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

Site may serve as an important refuge for 3 of these climate-sensitive species, one, the Western Wood-Pewee (*Contopus sordidulus*), might be extirpated from the Site in summer by 2050.



**Figure 2.** Climate at the Site in winter 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).

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 3 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.

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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 Site based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Site 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
Greater Scaup	-	Potential colonization <sup>^</sup>
Lesser Scaup	-	Potential colonization
Wood Stork	Potential colonization	-
Anhinga	Potential colonization <sup>^</sup>	-
Snowy Egret	-	Potential colonization
Cattle Egret	Potential colonization	-
Green Heron	-	Potential colonization
Yellow-crowned Night-Heron	Potential colonization	-
Harris's Hawk	Potential colonization	Potential colonization
Red-tailed Hawk	Stable	Stable
American Avocet	-	Potential colonization <sup>^</sup>
Long-billed Curlew	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Wilson's Snipe	-	Potential colonization
Ring-billed Gull	-	Potential colonization
Yellow-footed Gull	-	Potential colonization
Gull-billed Tern	-	Potential colonization
Eurasian Collared-Dove	-	Potential colonization
White-winged Dove	Potential colonization	-
Mourning Dove	Worsening	Improving
Inca Dove	Potential colonization	-
Common Ground-Dove	Potential colonization	-
Great Horned Owl	x	Stable
Lesser Nighthawk	Improving*	-
Common Nighthawk	Potential extirpation	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Common Pauraque	-	Potential colonization
Nuttall's Woodpecker	Worsening	Worsening*
Hairy Woodpecker	Potential extirpation	Potential extirpation
Northern Flicker	-	Worsening
American Kestrel	x	Improving
Peregrine Falcon	-	Potential colonization
Northern Beardless-Tyrannulet	Potential colonization	-
Western Wood-Pewee	Potential extirpation^	-
Gray Flycatcher	-	Potential colonization
Say's Phoebe	Stable	Improving
Vermilion Flycatcher	Potential colonization	-
Ash-throated Flycatcher	Improving*	-
Brown-crested Flycatcher	Potential colonization	-
Western Kingbird	Worsening*	-
Loggerhead Shrike	Improving*	Improving
American Crow	Stable	Potential extirpation
Common Raven	Worsening*	Worsening
Horned Lark	Stable	Stable
Northern Rough-winged Swallow	Stable	Potential colonization
Tree Swallow	-	Potential colonization
Violet-green Swallow	Worsening	-
Barn Swallow	Potential extirpation	-
Cliff Swallow	Worsening	-
Bushtit	Worsening	Worsening*
Ruby-crowned Kinglet	-	Improving
Mountain Bluebird	Potential extirpation	Worsening*

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
American Robin	Potential extirpation	Worsening
Curve-billed Thrasher	-	Potential colonization
Northern Mockingbird	Improving*	Improving*
European Starling	Potential extirpation	Worsening
Phainopepla	Improving	-
Common Yellowthroat	-	Potential colonization
Yellow-rumped Warbler	Stable	Improving
Black-throated Gray Warbler	-	Potential colonization
Canyon Towhee	-	Potential colonization
Rufous-winged Sparrow	-	Potential colonization
Cassin's Sparrow	-	Potential colonization
Bachman's Sparrow	Potential colonization	-
Chipping Sparrow	Potential extirpation	Improving*
Brewer's Sparrow	Worsening	Improving*
Henslow's Sparrow	-	Potential colonization
White-crowned Sparrow	-	Stable
Dark-eyed Junco	x	Worsening
Western Tanager	Potential extirpation	-
Pyrrhuloxia	Potential colonization	-
Blue Grosbeak	Potential colonization	-
Red-winged Blackbird	Stable	Improving
Western Meadowlark	Worsening*	Improving
Brewer's Blackbird	Worsening*	-
Brown-headed Cowbird	Stable	-
Bullock's Oriole	Worsening*	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
House Finch	Stable	Improving
Lesser Goldfinch	Stable	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
House Sparrow	x	Stable