



## John Muir 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 John Muir 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 4 (e.g., Figure 2), remain stable for 6, and worsen for 35 species. Suitable climate ceases to occur for 12 species in summer, potentially resulting in extirpation of those species from the Site. Climate is projected to become suitable in summer for 31 species not found at the Site today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 16, remain stable for 30, and worsen for 19 species. Suitable climate ceases to occur for 4 species in winter, potentially resulting in extirpation from the Site. Climate is projected to become suitable in winter for 21 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.

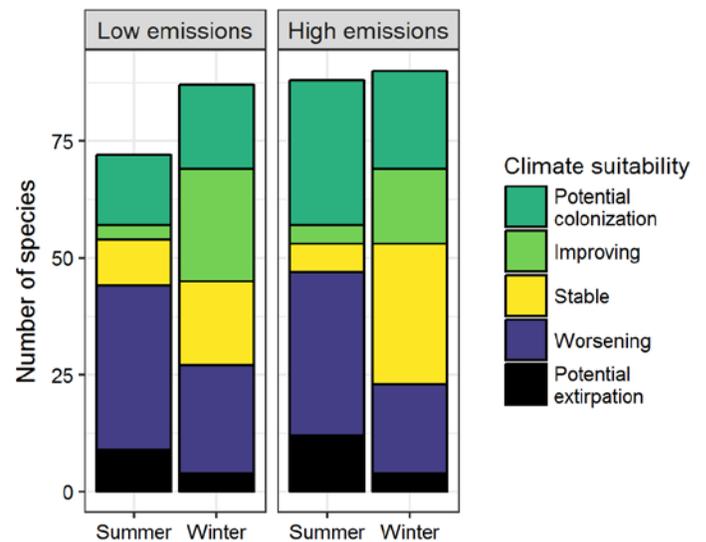


Figure 1. Projected changes in climate suitability for birds at the Site, by emissions pathway and season.

## Results (continued)

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### Potential Turnover Index

**Potential bird species turnover for the Site between the present and 2050 is 0.23 in summer (38<sup>th</sup> percentile across all national parks) and 0.08 in winter (4<sup>th</sup> percentile) under the high-emissions pathway. Potential species turnover declines to 0.15 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 15 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, John Muir National Historic Site 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

### Caveats

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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 14 of these climate-sensitive species, one, the Brown Creeper (*Certhia americana*), might be extirpated from the Site in summer by 2050.



**Figure 2.** Climate at the Site in summer is projected to remain suitable for the Mourning Dove (*Zenaida macroura*) through 2050. Photo by KS Black/Flickr (Public Domain).

across boundaries, managing the disturbance regime, and possibly more intensive management actions. Furthermore, park managers have an opportunity to focus on supporting the 14 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

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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
Fulvous Whistling-Duck	Potential colonization	-
Gadwall	-	Improving
Mallard	Worsening <sup>^</sup>	Stable
Mottled Duck	Potential colonization	-
Bufflehead	-	Improving
Red-breasted Merganser	-	Potential colonization <sup>^</sup>
California Quail	Worsening	Worsening
Wild Turkey	x	Potential extirpation
Wood Stork	-	Potential colonization
Anhinga	Potential colonization <sup>^</sup>	-
Least Bittern	-	Potential colonization
Tricolored Heron	Potential colonization <sup>^</sup>	-

Common Name	Summer Trend	Winter Trend
Reddish Egret	-	Potential colonization
Cattle Egret	Potential colonization	-
Yellow-crowned Night-Heron	Potential colonization	-
White Ibis	Potential colonization	-
Black Vulture	Potential colonization	-
Turkey Vulture	x	Improving
White-tailed Kite	-	Worsening
Golden Eagle	-	Worsening*
Mississippi Kite	Potential colonization	-
Northern Harrier	Improving* <sup>^</sup>	Stable
Sharp-shinned Hawk	-	Improving
Cooper's Hawk	x	Worsening
Harris's Hawk	Potential colonization	-
Red-shouldered Hawk	Stable	Stable

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Red-tailed Hawk	Worsening	Stable
Ferruginous Hawk	-	Stable
American Oystercatcher	-	Potential colonization <sup>^</sup>
Piping Plover	-	Potential colonization <sup>^</sup>
Killdeer	-	Improving
Red Knot	-	Potential colonization <sup>^</sup>
Gull-billed Tern	-	Potential colonization
Black Skimmer	-	Potential colonization <sup>^</sup>
Rock Pigeon	Worsening	Stable
Band-tailed Pigeon	-	Stable
Mourning Dove	Improving	Stable
Inca Dove	Potential colonization	-
Common Ground-Dove	Potential colonization	Potential colonization
Groove-billed Ani	-	Potential colonization
Western Screech-Owl	x	Stable
Great Horned Owl	x	Stable
Burrowing Owl	Potential colonization <sup>^</sup>	-
Lesser Nighthawk	-	Potential colonization
White-throated Swift	x	Stable
Black-chinned Hummingbird	Potential colonization	-
Anna's Hummingbird	Worsening	Stable
Acorn Woodpecker	Worsening	Worsening
Golden-fronted Woodpecker	Potential colonization	-
Red-breasted Sapsucker	-	Worsening*
Ladder-backed Woodpecker	Potential colonization	-
Nuttall's Woodpecker	Worsening*	Stable

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Downy Woodpecker	Potential extirpation	Stable
Northern Flicker	Worsening	Stable
American Kestrel	x	Improving
Western Wood-Pewee	Worsening <sup>^</sup>	-
Hammond's Flycatcher	-	Potential colonization
Gray Flycatcher	-	Potential colonization
Dusky Flycatcher	-	Potential colonization
Pacific-slope Flycatcher	Stable	-
Black Phoebe	Worsening	Stable
Vermilion Flycatcher	Potential colonization	Potential colonization
Ash-throated Flycatcher	Worsening	-
Brown-crested Flycatcher	Potential colonization	-
Western Kingbird	Stable	-
White-eyed Vireo	Potential colonization	-
Bell's Vireo	Potential colonization	-
Hutton's Vireo	Worsening <sup>^</sup>	Worsening*
Steller's Jay	Worsening	Worsening*
California/Woodhouse's Scrub-Jay (Western Scrub-Jay)	Worsening	Stable
American Crow	Worsening	Stable
Fish Crow	Potential colonization	-
Common Raven	Potential extirpation	Worsening
Northern Rough-winged Swallow	Improving*	Potential colonization
Tree Swallow	Potential extirpation	-
Violet-green Swallow	Worsening*	-
Barn Swallow	Worsening	-
Cliff Swallow	Stable	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Chestnut-backed Chickadee	Worsening*	Potential extirpation
Oak Titmouse	Worsening*	Worsening*
Black-crested Titmouse	Potential colonization	-
Verdin	Potential colonization	-
Bushtit	Worsening*	Stable
White-breasted Nuthatch	Potential extirpation	Worsening
Brown-headed Nuthatch	Potential colonization <sup>^</sup>	-
Brown Creeper	Potential extirpation <sup>^</sup>	Potential extirpation
House Wren	Potential extirpation	Improving*
Bewick's Wren	Worsening*	Worsening
Cactus Wren	Potential colonization	Potential colonization
Blue-gray Gnatcatcher	Improving*	-
Golden-crowned Kinglet	-	Stable
Ruby-crowned Kinglet	-	Improving
Western Bluebird	Worsening*	Worsening
Hermit Thrush	-	Improving
American Robin	Potential extirpation	Stable
Varied Thrush	-	Worsening*
Northern Mockingbird	Stable	Improving
European Starling	Worsening	Stable
Cedar Waxwing	-	Improving
Black-and-white Warbler	-	Potential colonization
Swainson's Warbler	Potential colonization	-
Orange-crowned Warbler	Worsening	Improving*
Yellow-rumped Warbler	-	Improving
Hermit Warbler	Stable	-
Yellow-breasted Chat	Potential colonization	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Green-tailed Towhee	-	Potential colonization
Spotted Towhee	Worsening	x
Canyon Towhee	Potential colonization	-
California Towhee	Worsening*	Stable
Bachman's Sparrow	Potential colonization	-
Chipping Sparrow	Potential extirpation	Improving*
Lark Sparrow	Worsening	Stable
Savannah Sparrow	-	Stable
Henslow's Sparrow	-	Potential colonization
Song Sparrow	Potential extirpation	Worsening
Lincoln's Sparrow	-	Improving
White-crowned Sparrow	-	Worsening
Golden-crowned Sparrow	-	Worsening
Dark-eyed Junco	x	Worsening
Black-headed Grosbeak	Worsening	-
Blue Grosbeak	Potential colonization	-
Lazuli Bunting	Worsening	-
Red-winged Blackbird	Worsening	Improving
Western Meadowlark	Worsening	Stable
Brewer's Blackbird	-	Stable
Boat-tailed Grackle	Potential colonization <sup>^</sup>	-
Hooded Oriole	Worsening	-
House Finch	Worsening	Stable
Purple Finch	Potential extirpation	Potential extirpation
Pine Siskin	Potential extirpation	Stable
Lesser Goldfinch	Worsening	Stable
Lawrence's Goldfinch	Worsening	-
American Goldfinch	Potential extirpation	Worsening

