



Wright Brothers National Memorial

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 Wright Brothers National Memorial (hereafter, the Memorial) 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 Memorial, 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 Memorial today, climate suitability in summer under the high-emissions pathway is projected to improve for 16 (e.g., Figure 2), remain stable for 16, and worsen for 16 species. Suitable climate ceases to occur for 16 species in summer, potentially resulting in extirpation of those species from the Memorial. Climate is projected to become suitable in summer for 24 species not found at the Memorial today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 33, remain stable for 31, and worsen for 28 species. Suitable climate ceases to occur for 9 species in winter, potentially resulting in extirpation from the Memorial. Climate is projected to become suitable in winter for 56 species not found at the Memorial 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 Memorial based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Memorial 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.

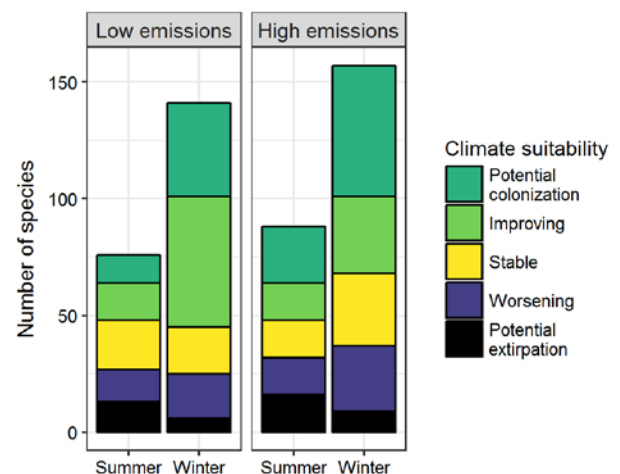


Figure 1. Projected changes in climate suitability for birds at the Memorial, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Memorial between the present and 2050 is 0.24 in summer (39th percentile across all national parks) and 0.19 in winter (24th percentile) under the high-emissions pathway. Potential species turnover declines to 0.14 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 Memorial is or may become home to 27 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).

Management Implications

Parks differ in potential colonization and extirpation rates, and therefore different climate change adaptation strategies may apply. **Under the high-emissions pathway, Wright Brothers National Memorial falls within the intermediate change group.** Parks anticipating intermediate change can best support landscape-scale bird conservation by emphasizing habitat restoration, maintaining natural disturbance regimes, and

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

While the Memorial may serve as an important refuge for 23 of these climate-sensitive species, 4 might be extirpated from the Memorial in at least one season by 2050.



Figure 2. Climate at the Memorial 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).

reducing other stressors. Furthermore, park managers have an opportunity to focus on supporting the 23 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 Memorial based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Memorial 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	Potential colonization	-
Fulvous Whistling-Duck	Potential colonization	-
Brant	-	Worsening*
Cackling/Canada Goose	x	Potential extirpation
Muscovy Duck	-	Potential colonization
Wood Duck	-	Stable
Gadwall	Stable^	Improving
American Wigeon	-	Improving
American Black Duck	-	Potential extirpation
Mallard	Potential extirpation^	Potential extirpation
Mottled Duck	Potential colonization	Potential colonization
Northern Shoveler	-	Improving
Green-winged Teal	-	Improving

Common Name	Summer Trend	Winter Trend
Ring-necked Duck	-	Stable
Lesser Scaup	-	Improving
Surf Scoter	-	Worsening*
White-winged Scoter	-	Worsening*
Black Scoter	-	Worsening*
Bufflehead	-	Worsening
Hooded Merganser	-	Potential extirpation^
Red-breasted Merganser	-	Worsening^
Red-throated Loon	-	Worsening*
Common Loon	Potential extirpation	Worsening^
Least Grebe	-	Potential colonization
Pied-billed Grebe	-	Stable
Horned Grebe	-	Worsening
Red-necked Grebe	-	Worsening^
Eared Grebe	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Wood Stork	Potential colonization	-
Northern Gannet	-	Worsening*^
Neotropic Cormorant	-	Potential colonization
Double-crested Cormorant	-	Improving
Anhinga	Potential colonization^	Potential colonization
American White Pelican	-	Potential colonization
Brown Pelican	Stable	Stable^
American Bittern	-	Stable^
Least Bittern	-	Potential colonization
Great Blue Heron	Improving	Improving
Great Egret	Improving*	Improving
Snowy Egret	x	Improving*
Little Blue Heron	Improving*	-
Tricolored Heron	Improving^	-
Cattle Egret	Improving*	Potential colonization
Green Heron	Stable	-
Black-crowned Night-Heron	-	Improving*
Yellow-crowned Night-Heron	-	Potential colonization
White Ibis	Improving*	Improving*
White-faced Ibis	-	Potential colonization^
Roseate Spoonbill	-	Potential colonization
Black Vulture	Improving	Potential colonization
Turkey Vulture	x	Improving
Osprey	x	Improving*
White-tailed Kite	Potential colonization	Potential colonization
Swallow-tailed Kite	Potential colonization	-
Northern Harrier	-	Worsening

Common Name	Summer Trend	Winter Trend
Sharp-shinned Hawk	-	Worsening
Cooper's Hawk	x	Stable
Bald Eagle	-	Potential extirpation
White-tailed Hawk	-	Potential colonization
Ferruginous Hawk	-	Potential colonization
Limpkin	-	Potential colonization
Black-necked Stilt	x	Potential colonization
American Avocet	-	Improving^
American Oystercatcher	-	Worsening*^
Black-bellied Plover	-	Stable
Snowy Plover	-	Potential colonization
Wilson's Plover	-	Potential colonization
Killdeer	Improving	Stable
Spotted Sandpiper	-	Potential colonization
Willet	Worsening^	Stable^
Lesser Yellowlegs	Stable^	-
Long-billed Curlew	-	Potential colonization
Stilt Sandpiper	-	Potential colonization
Sanderling	-	Worsening
Dunlin	-	Stable^
Bonaparte's Gull	-	Stable
Laughing Gull	Worsening*^	Stable
Ring-billed Gull	Potential extirpation^	Worsening
Herring Gull	Worsening*	Worsening^
Great Black-backed Gull	x	Worsening*
Gull-billed Tern	-	Potential colonization
Caspian Tern	x	Potential colonization

Common Name	Summer Trend	Winter Trend
Black Tern	Stable	-
Forster's Tern	x	Improving
Sandwich Tern	x	Potential colonization [^]
Rock Pigeon	Stable	Improving
Eurasian Collared-Dove	x	Potential colonization
White-winged Dove	-	Potential colonization
Mourning Dove	Improving	Improving
Inca Dove	Potential colonization	Potential colonization
Common Ground-Dove	Potential colonization	-
Yellow-billed Cuckoo	Improving	-
Greater Roadrunner	Potential colonization	-
Groove-billed Ani	-	Potential colonization
Great Horned Owl	-	Stable
Barred Owl	-	Potential colonization
Lesser Nighthawk	Potential colonization	-
Common Nighthawk	Potential colonization	-
Common Pauraque	-	Potential colonization
Chuck-will's-widow	Worsening	-
Chimney Swift	Worsening	-
Allen's Hummingbird	-	Potential colonization
Buff-bellied Hummingbird	-	Potential colonization
Belted Kingfisher	Potential extirpation	Improving
Red-headed Woodpecker	Stable	-
Red-bellied Woodpecker	Stable	Improving
Yellow-bellied Sapsucker	-	Improving

Common Name	Summer Trend	Winter Trend
Ladder-backed Woodpecker	Potential colonization	-
Downy Woodpecker	Worsening	Stable
Hairy Woodpecker	Potential extirpation	-
Northern Flicker	Stable	Worsening
Pileated Woodpecker	Worsening	Stable
Crested Caracara	Potential colonization	Potential colonization
American Kestrel	-	Improving
Merlin	-	Stable [^]
Eastern Phoebe	-	Improving
Vermilion Flycatcher	-	Potential colonization
Great Crested Flycatcher	Potential extirpation	-
Brown-crested Flycatcher	Potential colonization	-
Couch's Kingbird	-	Potential colonization
Western Kingbird	Potential colonization	-
Eastern Kingbird	Improving	-
Scissor-tailed Flycatcher	Potential colonization	-
Loggerhead Shrike	-	Potential colonization
Blue Jay	Worsening	Improving
American Crow	Worsening	Worsening
Fish Crow	Worsening*	Stable
Northern Rough-winged Swallow	Stable	Potential colonization
Purple Martin	Stable	-
Tree Swallow	Stable	-
Barn Swallow	Stable	-
Cliff Swallow	Potential colonization	-
Cave Swallow	Potential colonization	-
Carolina Chickadee	Worsening	Improving

Common Name	Summer Trend	Winter Trend
Tufted Titmouse	Worsening	-
Red-breasted Nuthatch	-	Potential extirpation
Brown-headed Nuthatch	Worsening*^	Worsening*
Brown Creeper	-	Stable
House Wren	-	Improving
Carolina Wren	Worsening	Stable
Bewick's Wren	-	Potential colonization
Blue-gray Gnatcatcher	-	Potential colonization
Ruby-crowned Kinglet	-	Improving
Eastern Bluebird	Improving	Stable
Hermit Thrush	-	Stable
American Robin	Potential extirpation	Stable
Gray Catbird	Potential extirpation	Stable
Brown Thrasher	Potential extirpation	Worsening
Northern Mockingbird	Improving	Improving
European Starling	Worsening	Worsening
Sprague's Pipit	-	Potential colonization
Cedar Waxwing	-	Stable
Smith's Longspur	-	Potential colonization
Orange-crowned Warbler	-	Improving
Common Yellowthroat	Potential extirpation	-
Northern Parula	-	Potential colonization
Palm Warbler	-	Worsening*^
Pine Warbler	Potential extirpation^	Stable
Yellow-rumped Warbler	-	Stable
Wilson's Warbler	-	Potential colonization
Eastern Towhee	Potential extirpation	x

Common Name	Summer Trend	Winter Trend
Cassin's Sparrow	-	Potential colonization
Bachman's Sparrow	Potential colonization	Potential colonization
Chipping Sparrow	-	Stable
Field Sparrow	Potential extirpation	-
Lark Sparrow	Potential colonization	-
Lark Bunting	-	Potential colonization
Savannah Sparrow	-	Worsening
Henslow's Sparrow	-	Potential colonization
Seaside Sparrow	Stable^	-
Fox Sparrow	-	Potential extirpation
Song Sparrow	Potential extirpation	Worsening
Lincoln's Sparrow	-	Potential colonization
Swamp Sparrow	-	Stable
White-throated Sparrow	-	Improving
Harris's Sparrow	-	Potential colonization
White-crowned Sparrow	-	Potential colonization
Dark-eyed Junco	-	Potential extirpation
Western Tanager	-	Potential colonization
Northern Cardinal	Improving	Improving
Indigo Bunting	Stable	Potential colonization
Red-winged Blackbird	Improving	Improving
Eastern Meadowlark	Improving*	Worsening
Common Grackle	Worsening	Improving
Boat-tailed Grackle	Stable^	Worsening*^
Great-tailed Grackle	Potential colonization	Potential colonization

Common Name	Summer Trend	Winter Trend
Bronzed Cowbird	Potential colonization	Potential colonization
Brown-headed Cowbird	Potential extirpation	Stable
Hooded Oriole	Potential colonization	-

Common Name	Summer Trend	Winter Trend
House Finch	Potential extirpation	Potential extirpation
Pine Siskin	-	Stable
American Goldfinch	-	Improving
House Sparrow	x	Stable