



Shiloh National Battlefield

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 Shiloh National Battlefield (hereafter, the Battlefield) 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 Battlefield, 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 Battlefield today, climate suitability in summer under the high-emissions pathway is projected to improve for 5, remain stable for 27, and worsen for 17 species. Suitable climate ceases to occur for 15 species in summer, potentially resulting in extirpation of those species from the Battlefield (e.g., Figure 2). Climate is projected to become suitable in summer for 22 species not found at the Battlefield today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 11, remain stable for 37, and worsen for 12 species. Suitable climate ceases to occur for 7 species in winter, potentially resulting in extirpation from the Battlefield. Climate is projected to become suitable in winter for 47 species not found at the Battlefield 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 Battlefield based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Battlefield 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.

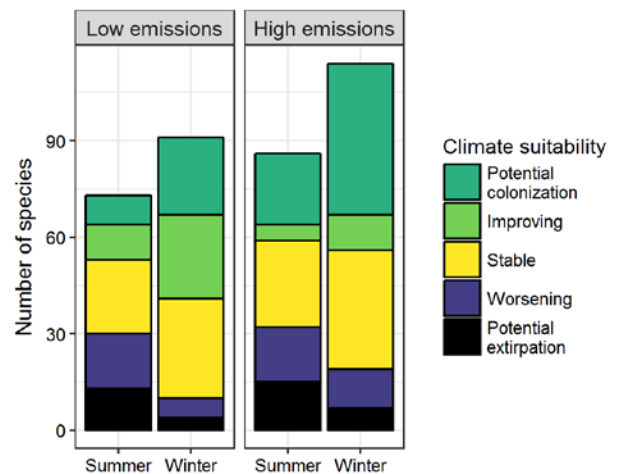


Figure 1. Projected changes in climate suitability for birds at the Battlefield, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Battlefield between the present and 2050 is 0.21 in summer (32nd percentile across all national parks) and 0.22 in winter (32nd percentile) under the high-emissions pathway. Potential species turnover declines to 0.13 in summer and 0.12 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 Battlefield is or may become home to 3 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). Suitable

Management Implications

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

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 is not projected to disappear for these 3 species at the Battlefield; instead the Battlefield may serve as an important refuge for these climate-sensitive species.



Figure 2. Although currently found at the Battlefield, suitable climate for the American Goldfinch (*Spinus tristis*) may cease to occur here in summer by 2050, potentially resulting in local seasonal extirpation. Photo by John Benson/Flickr (CC BY 2.0).

other stressors. 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 Battlefield based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Battlefield 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	-
Wood Duck	-	Stable
Mottled Duck	-	Potential colonization
Blue-winged Teal	-	Potential colonization
Cinnamon Teal	-	Potential colonization
Ring-necked Duck	-	Improving
Northern Bobwhite	Worsening	-
Wild Turkey	x	Potential extirpation
Least Grebe	-	Potential colonization
Pied-billed Grebe	x	Improving
Eared Grebe	-	Potential colonization
Wood Stork	Potential colonization	-

Common Name	Summer Trend	Winter Trend
Neotropic Cormorant	-	Potential colonization
Anhinga	Potential colonization [^]	Potential colonization
Great Blue Heron	Worsening	Stable
Great Egret	-	Potential colonization
Snowy Egret	-	Potential colonization
Little Blue Heron	-	Potential colonization
Cattle Egret	-	Potential colonization
Green Heron	Stable	-
White Ibis	Potential colonization	Potential colonization
Black Vulture	Improving	-
Turkey Vulture	x	Stable
Osprey	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Mississippi Kite	Stable	-
Northern Harrier	-	Stable
Cooper's Hawk	x	Stable
Harris's Hawk	Potential colonization	Potential colonization
White-tailed Hawk	-	Potential colonization
Red-shouldered Hawk	-	Stable
Red-tailed Hawk	Stable	Stable
Ferruginous Hawk	-	Potential colonization
Virginia Rail	-	Potential colonization
Killdeer	Potential extirpation	Stable
Spotted Sandpiper	-	Potential colonization
Greater Yellowlegs	-	Potential colonization
Lesser Yellowlegs	-	Potential colonization
Stilt Sandpiper	-	Potential colonization
Long-billed Dowitcher	-	Potential colonization
Wilson's Snipe	-	Stable
Ring-billed Gull	-	Stable
Rock Pigeon	Potential extirpation	Stable
White-winged Dove	-	Potential colonization
Mourning Dove	Stable	Stable
Inca Dove	Potential colonization	Potential colonization
Common Ground-Dove	Potential colonization	-
Yellow-billed Cuckoo	Improving	-
Greater Roadrunner	Potential colonization	-
Great Horned Owl	-	Potential extirpation

Common Name	Summer Trend	Winter Trend
Barred Owl	-	Stable
Lesser Nighthawk	Potential colonization	-
Common Nighthawk	Potential colonization	-
Common Pauraque	-	Potential colonization
Chuck-will's-widow	Stable	-
Chimney Swift	Stable	-
Black-chinned Hummingbird	Potential colonization	-
Belted Kingfisher	-	Stable
Lewis's Woodpecker	-	Potential colonization
Red-headed Woodpecker	Stable	Worsening*
Golden-fronted Woodpecker	Potential colonization	-
Red-bellied Woodpecker	Stable	Stable
Yellow-bellied Sapsucker	-	Stable
Downy Woodpecker	Worsening	Worsening
Northern Flicker	Stable	Worsening
Pileated Woodpecker	Stable	Stable
Crested Caracara	-	Potential colonization
American Kestrel	-	Worsening
Merlin	-	Improving^
Eastern Wood-Pewee	Worsening	-
Acadian Flycatcher	Stable	-
Eastern Phoebe	Worsening*	Stable
Vermilion Flycatcher	Potential colonization	Potential colonization
Great Crested Flycatcher	Worsening	-
Brown-crested Flycatcher	Potential colonization	-
Western Kingbird	Potential colonization	-
Eastern Kingbird	Worsening	-
Loggerhead Shrike	-	Improving

Common Name	Summer Trend	Winter Trend
White-eyed Vireo	Improving*	Potential colonization
Yellow-throated Vireo	Stable	-
Red-eyed Vireo	Stable	-
Blue Jay	Stable	Worsening
American Crow	Stable	Worsening
Horned Lark	-	Potential extirpation
Northern Rough-winged Swallow	-	Potential colonization
Purple Martin	Worsening	-
Barn Swallow	Worsening	-
Cliff Swallow	Stable	-
Cave Swallow	Potential colonization	-
Carolina Chickadee	Stable	Improving
Tufted Titmouse	Stable	Stable
Black-crested Titmouse	Potential colonization	-
White-breasted Nuthatch	Potential extirpation	Potential extirpation
Brown Creeper	-	Worsening
Pacific/Winter Wren	-	Worsening*
Marsh Wren	-	Potential colonization
Carolina Wren	Stable	Stable
Bewick's Wren	-	Potential colonization
Blue-gray Gnatcatcher	Worsening	Potential colonization
Golden-crowned Kinglet	-	Stable
Ruby-crowned Kinglet	-	Improving
Eastern Bluebird	Worsening	Stable
Hermit Thrush	-	Stable
Wood Thrush	Stable	-
American Robin	Potential extirpation	Worsening
Gray Catbird	Potential extirpation	Potential colonization

Common Name	Summer Trend	Winter Trend
Brown Thrasher	Worsening*	Stable
Long-billed Thrasher	-	Potential colonization
Northern Mockingbird	Stable	Stable
European Starling	Potential extirpation	Stable
American Pipit	-	Stable
Sprague's Pipit	-	Potential colonization
Cedar Waxwing	-	Stable
Common Yellowthroat	Potential extirpation	-
Hooded Warbler	Improving*	-
Northern Parula	Worsening	-
Pine Warbler	Improving*^	-
Yellow-rumped Warbler	-	Stable
Yellow-throated Warbler	Stable	-
Black-throated Gray Warbler	-	Potential colonization
Yellow-breasted Chat	Stable	-
Eastern Towhee	Potential extirpation	x
Canyon Towhee	Potential colonization	-
Cassin's Sparrow	-	Potential colonization
Bachman's Sparrow	Potential colonization	-
Chipping Sparrow	Potential extirpation	Improving
Field Sparrow	Worsening*	Stable
Vesper Sparrow	-	Improving*
Lark Sparrow	Potential colonization	Potential colonization
Lark Bunting	-	Potential colonization
Savannah Sparrow	-	Improving
Grasshopper Sparrow	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Henslow's Sparrow	-	Potential colonization
Fox Sparrow	-	Worsening*
Song Sparrow	-	Worsening
Swamp Sparrow	-	Stable
White-throated Sparrow	-	Stable
Dark-eyed Junco	-	Stable
Summer Tanager	Stable	-
Northern Cardinal	Stable	Improving
Pyrrhuloxia	-	Potential colonization
Blue Grosbeak	Worsening	-
Indigo Bunting	Stable	-
Dickcissel	Worsening	-
Red-winged Blackbird	Potential extirpation	Stable
Eastern Meadowlark	Worsening	Worsening
Western Meadowlark	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Rusty Blackbird	-	Stable
Common Grackle	Potential extirpation	Improving
Great-tailed Grackle	Potential colonization	Potential colonization
Bronzed Cowbird	Potential colonization	Potential colonization
Brown-headed Cowbird	Potential extirpation	Stable
Orchard Oriole	Stable	-
Altamira Oriole	-	Potential colonization
Baltimore Oriole	Potential extirpation	-
House Finch	Potential extirpation	Potential extirpation
Purple Finch	-	Potential extirpation
American Goldfinch	Potential extirpation	Stable
House Sparrow	x	Potential extirpation