



Monocacy 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 Monocacy 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 28, remain stable for 16, and worsen for 10 species. Suitable climate ceases to occur for 22 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 17 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 36, remain stable for 14, and worsen for 11 species. Suitable climate ceases to occur for 3 species in winter, potentially resulting in extirpation from the Battlefield. Climate is projected to become suitable in winter for 38 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.

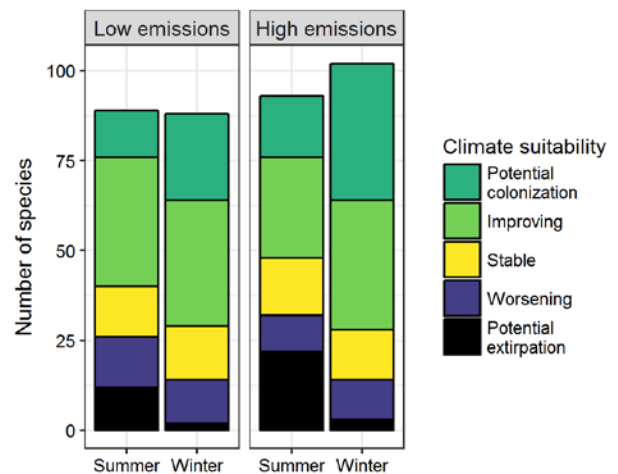


Figure 1. Projected changes in climate suitability for birds at the Battlefield, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Battlefield between the present and 2050 is 0.22 in summer (35th percentile across all national parks) and 0.22 in winter (30th 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 Battlefield 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

Battlefield may serve as an important refuge for 6 of these climate-sensitive species, 2 might be extirpated from the Battlefield in at least one season by 2050.



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).

Management Implications

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

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.

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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
Cackling/Canada Goose	x	Stable
Wood Duck	x	Improving
American Black Duck	-	Potential extirpation
Mallard	Potential extirpation [^]	Stable
Blue-winged Teal	-	Potential colonization
Greater Scaup	-	Improving [^]
Lesser Scaup	-	Improving
Bufflehead	-	Potential colonization
Hooded Merganser	-	Improving [^]
Common Merganser	-	Potential extirpation
Red-breasted Merganser	-	Potential colonization [^]
Eared Grebe	-	Potential colonization

Common Name	Summer Trend	Winter Trend
American White Pelican	-	Potential colonization
Great Blue Heron	Improving	Improving
Great Egret	Potential colonization	Potential colonization
Little Blue Heron	Potential colonization	-
Cattle Egret	Potential colonization	-
Green Heron	Improving	-
Yellow-crowned Night-Heron	Potential colonization	-
Black Vulture	Improving	Improving
Turkey Vulture	x	Improving
Mississippi Kite	Potential colonization	-
Sharp-shinned Hawk	-	Stable
Cooper's Hawk	x	Worsening*
Bald Eagle	-	Improving
Red-shouldered Hawk	Improving	Improving

Common Name	Summer Trend	Winter Trend
Red-tailed Hawk	Stable	Improving
Killdeer	Improving	Improving
Greater Yellowlegs	-	Potential colonization
Least Sandpiper	-	Potential colonization
Bonaparte's Gull	-	Potential colonization
Ring-billed Gull	-	Stable
Herring Gull	-	Stable^
Great Black-backed Gull	-	Stable
Forster's Tern	-	Potential colonization
Rock Pigeon	Worsening	Worsening*
Eurasian Collared-Dove	-	Potential colonization
Mourning Dove	Improving	Worsening
Inca Dove	-	Potential colonization
Yellow-billed Cuckoo	Improving*	-
Greater Roadrunner	Potential colonization	Potential colonization
Barn Owl	-	Potential colonization
Western Screech-Owl	-	Potential colonization
Great Horned Owl	x	Worsening*
Barred Owl	x	Improving
Common Nighthawk	Potential colonization	-
Chuck-will's-widow	Potential colonization	-
Chimney Swift	Worsening	-
Ruby-throated Hummingbird	Improving	-
Belted Kingfisher	Stable	Improving
Red-bellied Woodpecker	Improving	Improving
Yellow-bellied Sapsucker	-	Improving
Downy Woodpecker	Improving	Worsening

Common Name	Summer Trend	Winter Trend
Hairy Woodpecker	Potential extirpation	Worsening*
Northern Flicker	Potential extirpation	Stable
Pileated Woodpecker	Improving	Improving
Eastern Wood-Pewee	Stable	-
Acadian Flycatcher	Stable	-
Willow Flycatcher	Potential extirpation	-
Eastern Phoebe	Improving	Potential colonization
Great Crested Flycatcher	Improving	-
Western Kingbird	Potential colonization	-
Eastern Kingbird	Stable	-
Scissor-tailed Flycatcher	Potential colonization	-
Loggerhead Shrike	Potential colonization	Potential colonization
White-eyed Vireo	Improving*	-
Yellow-throated Vireo	Stable	-
Warbling Vireo	Potential extirpation	-
Red-eyed Vireo	Potential extirpation	-
Blue Jay	Improving	Stable
American Crow	Stable	Worsening
Fish Crow	Stable	Stable
Horned Lark	-	Stable
Northern Rough-winged Swallow	Improving	-
Purple Martin	Improving*	-
Tree Swallow	Potential extirpation	-
Barn Swallow	Stable	-
Cliff Swallow	Potential colonization	-
Carolina Chickadee	Improving	Improving
Tufted Titmouse	Improving	Improving

Common Name	Summer Trend	Winter Trend
White-breasted Nuthatch	Stable	Worsening*
Brown-headed Nuthatch	Potential colonization^	Potential colonization
Brown Creeper	Potential extirpation^	Stable
House Wren	Potential extirpation	Potential colonization
Pacific/Winter Wren	-	Improving
Sedge Wren	-	Potential colonization
Marsh Wren	-	Potential colonization
Carolina Wren	Stable	Improving
Bewick's Wren	-	Potential colonization
Blue-gray Gnatcatcher	Improving	-
Golden-crowned Kinglet	-	Stable
Ruby-crowned Kinglet	-	Improving
Eastern Bluebird	Improving	Improving
Wood Thrush	Potential extirpation	-
American Robin	Worsening	Improving
Gray Catbird	Potential extirpation	-
Brown Thrasher	Worsening	-
Northern Mockingbird	Improving	Improving
European Starling	Worsening	Worsening
American Pipit	-	Potential colonization
Sprague's Pipit	-	Potential colonization
Cedar Waxwing	Potential extirpation	Improving
Smith's Longspur	-	Potential colonization
Ovenbird	Potential extirpation	-
Worm-eating Warbler	Stable	-
Black-and-white Warbler	Improving	-

Common Name	Summer Trend	Winter Trend
Orange-crowned Warbler	-	Potential colonization
Kentucky Warbler	Improving	-
Common Yellowthroat	Worsening	Potential colonization
American Redstart	Potential extirpation	-
Northern Parula	Improving*	-
Yellow Warbler	Potential extirpation	-
Palm Warbler	-	Potential colonization^
Pine Warbler	-	Potential colonization
Yellow-rumped Warbler	-	Improving
Eastern Towhee	Potential extirpation	-
Rufous-winged Sparrow	Potential colonization	-
Bachman's Sparrow	Potential colonization	Potential colonization
Chipping Sparrow	Potential extirpation	Improving*
Field Sparrow	Stable	Improving
Vesper Sparrow	Potential extirpation	Potential colonization
Lark Sparrow	Potential colonization	-
Grasshopper Sparrow	Stable	-
Henslow's Sparrow	-	Potential colonization
LeConte's Sparrow	-	Potential colonization
Song Sparrow	Potential extirpation	Stable
Lincoln's Sparrow	-	Potential colonization
Swamp Sparrow	-	Improving
White-throated Sparrow	-	Improving
Harris's Sparrow	-	Potential colonization

Common Name	Summer Trend	Winter Trend
White-crowned Sparrow	-	Improving
Dark-eyed Junco	-	Stable
Scarlet Tanager	Potential extirpation	-
Northern Cardinal	Improving	Improving
Blue Grosbeak	Stable	-
Indigo Bunting	Improving	-
Painted Bunting	Potential colonization	-
Red-winged Blackbird	Worsening	Improving
Eastern Meadowlark	Improving	Improving
Western Meadowlark	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Brewer's Blackbird	-	Potential colonization
Common Grackle	Worsening	Improving
Great-tailed Grackle	-	Potential colonization
Brown-headed Cowbird	Worsening	Improving
Orchard Oriole	Stable	-
Baltimore Oriole	Worsening	-
House Finch	Potential extirpation	Potential extirpation
American Goldfinch	Potential extirpation	Worsening
House Sparrow	x	Worsening*