



Chesapeake and Ohio Canal

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 Chesapeake and Ohio Canal (hereafter, the Park) 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 Park, 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 Park today, climate suitability in summer under the high-emissions pathway is projected to improve for 46, remain stable for 25, and worsen for 15 species. Suitable climate ceases to occur for 46 species in summer, potentially resulting in extirpation of those species from the Park (e.g., Figure 2). Climate is projected to become suitable in summer for 11 species not found at the Park today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 76, remain stable for 20, and worsen for 17 species. Suitable climate ceases to occur for 17 species in winter, potentially resulting in extirpation from the Park. Climate is projected to become suitable in winter for 28 species not found at the Park 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 Park based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Park 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.

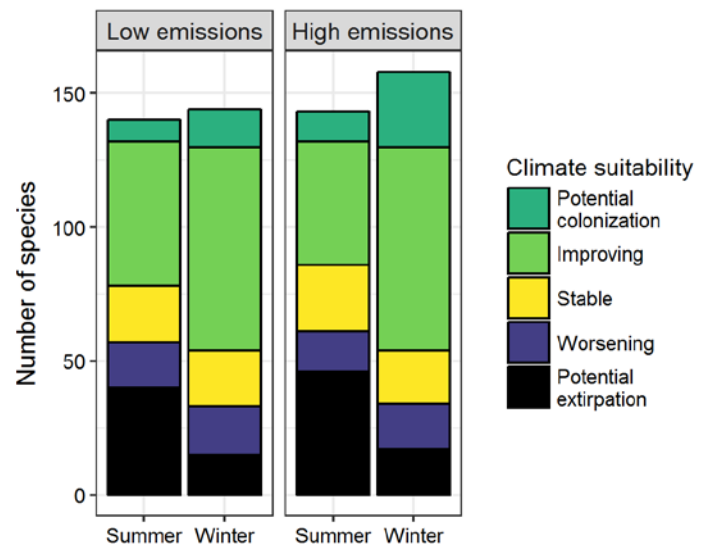


Figure 1. Projected changes in climate suitability for birds at the Park, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Park between the present and 2050 is 0.24 in summer (39th percentile across all national parks) and 0.23 in winter (33rd percentile) under the high-emissions pathway. Potential species turnover declines to 0.18 in summer and 0.16 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 Park is or may become home to 18 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

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

Park may serve as an important refuge for 13 of these climate-sensitive species, 5 might be extirpated from the Park in at least one season by 2050.



Figure 2. Although currently found at the Park, 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 13 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 Park based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Park 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	Worsening
Mute Swan	x	Potential extirpation
Tundra Swan	Stable	x
Wood Duck	x	Improving
Gadwall	-	Improving
American Wigeon	-	Improving
American Black Duck	x	Potential extirpation
Mallard	Potential extirpation [^]	Stable
Blue-winged Teal	-	Potential colonization
Northern Shoveler	-	Improving*
Green-winged Teal	-	Improving
Canvasback	-	Improving
Ring-necked Duck	x	Improving
Greater Scaup	-	Improving [^]
Lesser Scaup	x	Improving

Common Name	Summer Trend	Winter Trend
Surf Scoter	-	Potential extirpation
White-winged Scoter	-	Potential extirpation
Long-tailed Duck	-	Potential extirpation
Bufflehead	x	Improving
Common Goldeneye	x	Improving
Hooded Merganser	x	Improving [^]
Common Merganser	x	Stable
Red-breasted Merganser	Stable	Improving [^]
Ruddy Duck	Stable	Improving
Northern Bobwhite	Improving*	Improving
Ring-necked Pheasant	Potential extirpation	Potential extirpation
Wild Turkey	x	Potential extirpation
Red-throated Loon	-	Potential extirpation
Common Loon	Potential extirpation	Improving [^]

Common Name	Summer Trend	Winter Trend
Pied-billed Grebe	x	Improving
Horned Grebe	x	Improving*
Red-necked Grebe	Potential extirpation	Potential extirpation^
Eared Grebe	-	Potential colonization
Double-crested Cormorant	x	Improving
American White Pelican	-	Potential colonization
American Bittern	Potential extirpation	Improving^
Great Blue Heron	Improving	Improving
Great Egret	Improving*	Improving
Little Blue Heron	Improving	-
Tricolored Heron	Improving^	-
Cattle Egret	Improving*	-
Green Heron	Improving	-
Black-crowned Night-Heron	x	Improving
Yellow-crowned Night-Heron	Improving	-
White Ibis	Improving	-
Black Vulture	Improving	Stable
Turkey Vulture	x	Improving
Osprey	x	Improving
Golden Eagle	-	Potential extirpation
Mississippi Kite	Improving	-
Northern Harrier	Stable^	Improving
Sharp-shinned Hawk	x	Stable
Cooper's Hawk	x	Worsening*
Northern Goshawk	-	Potential extirpation
Bald Eagle	x	Improving
Red-shouldered Hawk	Improving*	Improving
Red-tailed Hawk	Improving	Stable
Rough-legged Hawk	-	Stable
Virginia Rail	-	Improving

Common Name	Summer Trend	Winter Trend
American Coot	x	Improving
Semipalmated Plover	Stable	-
Killdeer	Improving	Improving
Spotted Sandpiper	x	Improving
Greater Yellowlegs	Stable	Potential colonization
Lesser Yellowlegs	Stable^	-
Least Sandpiper	x	Potential colonization
Wilson's Snipe	-	Worsening*
American Woodcock	x	Improving
Bonaparte's Gull	-	Improving*
Laughing Gull	Potential extirpation^	-
Ring-billed Gull	Potential extirpation^	Improving
Herring Gull	Potential extirpation	Stable^
Great Black-backed Gull	-	Stable
Gull-billed Tern	-	Potential colonization
Black Tern	Potential extirpation	-
Forster's Tern	x	Potential colonization
Rock Pigeon	Worsening	Worsening
Eurasian Collared-Dove	-	Potential colonization
Mourning Dove	Improving	Worsening
Inca Dove	-	Potential colonization
Yellow-billed Cuckoo	Improving*	-
Black-billed Cuckoo	Potential extirpation	-
Greater Roadrunner	Potential colonization	Potential colonization
Barn Owl	-	Improving
Eastern Screech-Owl	x	Worsening*
Great Horned Owl	x	Worsening*

Common Name	Summer Trend	Winter Trend
Burrowing Owl	Potential colonization [^]	-
Barred Owl	x	Improving
Common Nighthawk	Improving	-
Chuck-will's-widow	Potential colonization	-
Chimney Swift	Worsening	-
Ruby-throated Hummingbird	Improving	-
Belted Kingfisher	Stable	Improving
Red-headed Woodpecker	Stable	Improving
Red-bellied Woodpecker	Improving	Improving
Yellow-bellied Sapsucker	-	Improving
Downy Woodpecker	Improving	Worsening
Hairy Woodpecker	Potential extirpation	Worsening
Red-cockaded Woodpecker	-	Potential colonization
Northern Flicker	Potential extirpation	Stable
Pileated Woodpecker	Improving	Improving
American Kestrel	x	Improving
Merlin	-	Improving [^]
Peregrine Falcon	x	Stable
Eastern Wood-Pewee	Stable	-
Acadian Flycatcher	Stable	-
Alder Flycatcher	Potential extirpation	-
Willow Flycatcher	Potential extirpation	-
Least Flycatcher	Potential extirpation	-
Eastern Phoebe	Improving	Improving*
Great Crested Flycatcher	Improving	-
Western Kingbird	Potential colonization	-
Eastern Kingbird	Stable	-
Scissor-tailed Flycatcher	Improving*	-

Common Name	Summer Trend	Winter Trend
Loggerhead Shrike	Potential colonization	Improving*
Northern Shrike	-	Potential extirpation
White-eyed Vireo	Improving*	-
Yellow-throated Vireo	Stable	-
Warbling Vireo	Potential extirpation	-
Red-eyed Vireo	Potential extirpation	-
Blue Jay	Improving	Stable
American Crow	Worsening	Worsening
Fish Crow	Stable	Stable
Common Raven	Potential extirpation	Potential extirpation
Horned Lark	Potential extirpation	Stable
Northern Rough-winged Swallow	Improving	-
Purple Martin	Improving*	-
Tree Swallow	Potential extirpation	-
Barn Swallow	Stable	-
Cliff Swallow	Improving	-
Carolina Chickadee	Improving*	Improving
Black-capped Chickadee	Potential extirpation	Potential extirpation
Tufted Titmouse	Improving	Improving
Red-breasted Nuthatch	-	Stable
White-breasted Nuthatch	Worsening	Worsening
Brown-headed Nuthatch	Potential colonization [^]	Potential colonization
Brown Creeper	Potential extirpation [^]	Worsening
House Wren	Potential extirpation	Improving
Pacific/Winter Wren	-	Improving
Sedge Wren	-	Potential colonization
Carolina Wren	Improving	Improving

Common Name	Summer Trend	Winter Trend
Bewick's Wren	Potential colonization	Potential colonization
Blue-gray Gnatcatcher	Improving	Potential colonization
Golden-crowned Kinglet	Potential extirpation	Stable
Ruby-crowned Kinglet	-	Improving
Eastern Bluebird	Improving	Improving
Veery	Potential extirpation	-
Swainson's Thrush	Potential extirpation	-
Hermit Thrush	Potential extirpation	Improving
Wood Thrush	Worsening*	-
American Robin	Worsening	Improving
Gray Catbird	Potential extirpation	Stable
Brown Thrasher	Stable	Improving*
Northern Mockingbird	Improving	Improving
European Starling	Worsening	Worsening
American Pipit	-	Improving*
Sprague's Pipit	-	Potential colonization
Cedar Waxwing	Potential extirpation	Improving
Chestnut-collared Longspur	-	Potential colonization
Smith's Longspur	-	Potential colonization
Ovenbird	Potential extirpation	-
Worm-eating Warbler	Worsening	-
Northern Waterthrush	Potential extirpation	-
Blue-winged Warbler	Worsening	-
Golden-winged Warbler	Stable	-
Black-and-white Warbler	Stable	Improving
Prothonotary Warbler	Improving	-
Swainson's Warbler	Improving	-

Common Name	Summer Trend	Winter Trend
Orange-crowned Warbler	-	Potential colonization
Kentucky Warbler	Improving	-
Common Yellowthroat	Worsening	Improving
Hooded Warbler	Stable	-
American Redstart	Potential extirpation	-
Northern Parula	Improving*	-
Magnolia Warbler	Potential extirpation	-
Yellow Warbler	Potential extirpation	-
Blackpoll Warbler	Potential extirpation	-
Pine Warbler	Stable^	Improving
Yellow-rumped Warbler	-	Improving
Yellow-throated Warbler	Improving	-
Prairie Warbler	Stable	-
Yellow-breasted Chat	Stable	-
Eastern Towhee	Worsening*	x
Rufous-winged Sparrow	Potential colonization	-
Bachman's Sparrow	-	Potential colonization
American Tree Sparrow	-	Worsening*
Chipping Sparrow	Potential extirpation	Improving*
Field Sparrow	Stable	Improving
Vesper Sparrow	Potential extirpation	Potential colonization
Lark Sparrow	Potential colonization	-
Savannah Sparrow	Potential extirpation	Improving*
Grasshopper Sparrow	Stable	-
Henslow's Sparrow	x	Potential colonization
LeConte's Sparrow	-	Potential colonization
Fox Sparrow	-	Improving

Common Name	Summer Trend	Winter Trend
Song Sparrow	Potential extirpation	Stable
Lincoln's Sparrow	-	Potential colonization
Swamp Sparrow	Potential extirpation	Improving
White-throated Sparrow	-	Improving
Harris's Sparrow	-	Potential colonization
White-crowned Sparrow	-	Stable
Dark-eyed Junco	x	Worsening
Summer Tanager	Improving*	-
Scarlet Tanager	Potential extirpation	-
Northern Cardinal	Improving	Improving
Rose-breasted Grosbeak	Potential extirpation	-
Blue Grosbeak	Improving*	-
Indigo Bunting	Improving	-
Painted Bunting	Potential colonization	-
Dickcissel	Improving*	-
Bobolink	Potential extirpation	-
Red-winged Blackbird	Worsening	Improving

Common Name	Summer Trend	Winter Trend
Eastern Meadowlark	Improving	Improving*
Western Meadowlark	-	Potential colonization
Rusty Blackbird	-	Improving
Brewer's Blackbird	-	Potential colonization
Common Grackle	Worsening	Improving
Great-tailed Grackle	Potential colonization	Potential colonization
Brown-headed Cowbird	Worsening	Improving
Orchard Oriole	Stable	-
Baltimore Oriole	Worsening*	-
House Finch	Potential extirpation	Potential extirpation
Purple Finch	Potential extirpation	Stable
White-winged Crossbill	-	Stable
Common Redpoll	-	Potential extirpation
Pine Siskin	-	Improving
American Goldfinch	Potential extirpation	Worsening
Evening Grosbeak	-	Potential extirpation
House Sparrow	x	Worsening