



## George Washington Memorial Parkway

### 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 George Washington Memorial Parkway (hereafter, the Parkway) 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 Parkway, 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 Parkway today, climate suitability in summer under the high-emissions pathway is projected to improve for 28, remain stable for 42, and worsen for 16 species. Suitable climate ceases to occur for 33 species in summer, potentially resulting in extirpation of those species from the Parkway (e.g., Figure 2). Climate is projected to become suitable in summer for 16 species not found at the Parkway today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 70, remain stable for 27, and worsen for 13 species. Suitable climate ceases to occur for 20 species in winter, potentially resulting in extirpation from the Parkway. Climate is projected to become suitable in winter for 39 species not found at the Parkway 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 Parkway based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Parkway 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.

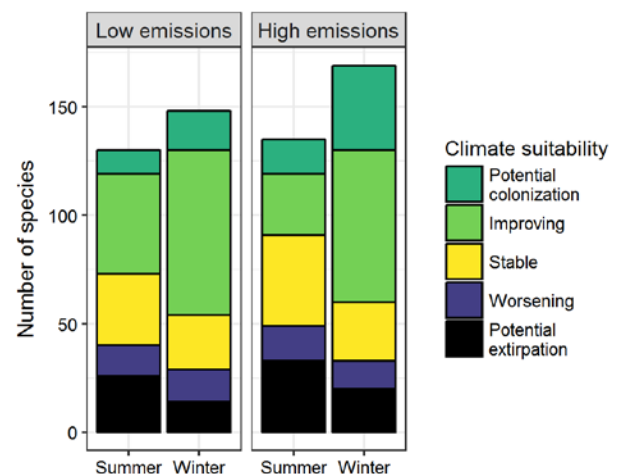


Figure 1. Projected changes in climate suitability for birds at the Parkway, by emissions pathway and season.

## Results (continued)

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### Potential Turnover Index

**Potential bird species turnover for the Parkway between the present and 2050 is 0.27 in summer (45<sup>th</sup> percentile across all national parks) and 0.26 in winter (38<sup>th</sup> percentile) under the high-emissions pathway. Potential species turnover declines to 0.19 in summer and 0.17 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 Parkway is or may become home to 23 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, George Washington Memorial Parkway falls within the high turnover group.** Parks anticipating high turnover 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

### 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

Parkway may serve as an important refuge for 15 of these climate-sensitive species, 8 might be extirpated from the Parkway in at least one season by 2050.



**Figure 2. Although currently found at the Parkway, 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).

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 15 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 Parkway based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Parkway 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	-
Brant	-	Potential extirpation
Cackling/Canada Goose	x	Worsening
Mute Swan	x	Potential extirpation
Tundra Swan	Stable	x
Wood Duck	x	Improving
Gadwall	Improving <sup>^</sup>	Improving
Eurasian Wigeon	-	Potential extirpation
American Wigeon	Improving <sup>^</sup>	Improving
American Black Duck	x	Potential extirpation
Mallard	Potential extirpation <sup>^</sup>	Stable
Blue-winged Teal	Stable	Potential colonization
Northern Shoveler	-	Improving

Common Name	Summer Trend	Winter Trend
Green-winged Teal	-	Improving
Canvasback	x	Improving
Ring-necked Duck	x	Improving
Greater Scaup	Stable	Stable <sup>^</sup>
Lesser Scaup	x	Improving
Surf Scoter	-	Potential extirpation
White-winged Scoter	-	Potential extirpation
Long-tailed Duck	-	Potential extirpation
Bufflehead	x	Improving
Common Goldeneye	-	Stable
Hooded Merganser	x	Improving <sup>^</sup>
Common Merganser	x	Stable
Red-breasted Merganser	Stable	Stable <sup>^</sup>
Ruddy Duck	Stable	Improving
Northern Bobwhite	Stable	-

Common Name	Summer Trend	Winter Trend
Wild Turkey	x	Potential extirpation
Red-throated Loon	-	Potential extirpation
Common Loon	Potential extirpation	Stable^
Pied-billed Grebe	x	Improving
Horned Grebe	x	Stable
Red-necked Grebe	-	Potential extirpation^
Eared Grebe	-	Potential colonization
Neotropic Cormorant	-	Potential colonization
Double-crested Cormorant	x	Improving
Anhinga	-	Potential colonization
American White Pelican	-	Potential colonization
Brown Pelican	-	Potential colonization^
American Bittern	Potential extirpation	-
Great Blue Heron	Stable	Improving
Great Egret	Improving*	Improving*
Little Blue Heron	Improving	-
Tricolored Heron	Improving^	-
Cattle Egret	Improving*	-
Green Heron	Improving	-
Black-crowned Night-Heron	x	Stable
Yellow-crowned Night-Heron	Improving	-
White Ibis	-	Potential colonization
Black Vulture	Improving	Improving*
Turkey Vulture	x	Improving
Osprey	x	Improving
Mississippi Kite	Improving	-
Northern Harrier	-	Stable

Common Name	Summer Trend	Winter Trend
Sharp-shinned Hawk	x	Stable
Cooper's Hawk	x	Stable
Northern Goshawk	-	Potential extirpation
Bald Eagle	x	Stable
White-tailed Hawk	-	Potential colonization
Red-shouldered Hawk	Improving	Improving
Red-tailed Hawk	Stable	Improving
Virginia Rail	-	Potential colonization
Sora	-	Potential colonization
American Coot	x	Improving
Semipalmated Plover	Stable	-
Killdeer	Improving	Improving
Spotted Sandpiper	x	Potential colonization
Greater Yellowlegs	Stable	Improving*
Willet	Potential extirpation^	-
Lesser Yellowlegs	Stable^	Potential colonization
Sanderling	x	Potential extirpation
Dunlin	x	Stable^
Least Sandpiper	x	Potential colonization
Western Sandpiper	-	Improving
Long-billed Dowitcher	-	Potential colonization
Wilson's Snipe	-	Stable
American Woodcock	x	Improving
Bonaparte's Gull	Stable	Improving
Laughing Gull	Potential extirpation^	Stable
Ring-billed Gull	Potential extirpation^	Stable
California Gull	-	Improving^

Common Name	Summer Trend	Winter Trend
Herring Gull	Potential extirpation	Potential extirpation^
Iceland Gull (Thayer's)	-	Potential extirpation
Great Black-backed Gull	x	Potential extirpation
Gull-billed Tern	-	Potential colonization
Black Tern	Improving	-
Forster's Tern	x	Potential colonization
Rock Pigeon	Worsening	Worsening
Eurasian Collared-Dove	-	Potential colonization
White-winged Dove	-	Potential colonization
Mourning Dove	Improving	Worsening
Inca Dove	Potential colonization	Potential colonization
Yellow-billed Cuckoo	Improving*	-
Black-billed Cuckoo	Potential extirpation	-
Greater Roadrunner	Potential colonization	-
Groove-billed Ani	-	Potential colonization
Barn Owl	-	Improving
Eastern Screech-Owl	x	Stable
Great Horned Owl	x	Worsening*
Snowy Owl	-	Potential extirpation
Burrowing Owl	Potential colonization^	-
Barred Owl	x	Improving
Common Nighthawk	Improving*	-
Common Pauraque	-	Potential colonization
Chuck-will's-widow	Stable	-
Chimney Swift	Worsening	-
Ruby-throated Hummingbird	Improving	-

Common Name	Summer Trend	Winter Trend
Belted Kingfisher	Stable	Improving
Red-headed Woodpecker	Worsening	Stable
Golden-fronted Woodpecker	Potential colonization	-
Red-bellied Woodpecker	Improving	Improving
Yellow-bellied Sapsucker	-	Improving
Downy Woodpecker	Stable	Worsening
Hairy Woodpecker	Potential extirpation	Worsening*
Red-cockaded Woodpecker	-	Potential colonization
American Three-toed Woodpecker	-	Potential colonization^
Northern Flicker	Stable	Worsening
Pileated Woodpecker	Improving*	Improving
American Kestrel	x	Stable
Merlin	-	Improving^
Peregrine Falcon	x	Stable
Olive-sided Flycatcher	Improving	-
Eastern Wood-Pewee	Worsening	-
Acadian Flycatcher	Worsening	-
Willow Flycatcher	Potential extirpation	-
Eastern Phoebe	Improving*	Improving*
Great Crested Flycatcher	Worsening	-
Western Kingbird	Potential colonization	-
Eastern Kingbird	Worsening	-
Scissor-tailed Flycatcher	Potential colonization	-
Loggerhead Shrike	Potential colonization	Potential colonization
White-eyed Vireo	Stable	Potential colonization
Yellow-throated Vireo	Stable	-
Warbling Vireo	Potential extirpation	-
Red-eyed Vireo	Potential extirpation	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Blue Jay	Stable	Improving
American Crow	Worsening	Stable
Fish Crow	Stable	Stable
Common Raven	Potential extirpation	Potential extirpation
Horned Lark	-	Stable
Northern Rough-winged Swallow	Improving*	-
Purple Martin	Stable	-
Tree Swallow	Potential extirpation	-
Barn Swallow	Stable	-
Cliff Swallow	Improving*	-
Cave Swallow	Potential colonization	-
Carolina Chickadee	Stable	Improving
Tufted Titmouse	Stable	Improving
Red-breasted Nuthatch	-	Stable
White-breasted Nuthatch	Stable	Worsening
Brown-headed Nuthatch	Potential colonization^	-
Brown Creeper	-	Worsening
House Wren	Potential extirpation	Improving
Pacific/Winter Wren	-	Improving
Marsh Wren	x	Improving
Carolina Wren	Stable	Improving
Bewick's Wren	-	Potential colonization
Blue-gray Gnatcatcher	Stable	Improving
Golden-crowned Kinglet	-	Improving
Ruby-crowned Kinglet	-	Improving
Eastern Bluebird	Improving	Improving
Veery	Potential extirpation	-
Gray-cheeked Thrush	Stable	-
Swainson's Thrush	Potential extirpation	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Hermit Thrush	-	Improving
Wood Thrush	Potential extirpation	-
American Robin	Potential extirpation	Stable
Gray Catbird	Potential extirpation	Stable
Brown Thrasher	Worsening*	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	Stable	-
Worm-eating Warbler	Stable	-
Black-and-white Warbler	Improving	Improving
Prothonotary Warbler	Stable	-
Swainson's Warbler	Potential colonization	-
Orange-crowned Warbler	-	Improving*
Kentucky Warbler	Improving*	-
Common Yellowthroat	Potential extirpation	Improving
Hooded Warbler	Stable	-
American Redstart	Stable	-
Northern Parula	Stable	-
Yellow Warbler	Potential extirpation	x
Blackpoll Warbler	Potential extirpation	-
Palm Warbler	-	Potential extirpation^
Pine Warbler	Potential extirpation^	Improving*

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Yellow-rumped Warbler	-	Improving
Yellow-throated Warbler	Stable	-
Prairie Warbler	Stable	-
Yellow-breasted Chat	Stable	-
Eastern Towhee	Potential extirpation	x
Rufous-winged Sparrow	Potential colonization	-
Bachman's Sparrow	Potential colonization	Potential colonization
American Tree Sparrow	-	Potential extirpation
Chipping Sparrow	Potential extirpation	Improving*
Field Sparrow	Worsening*	Improving
Vesper Sparrow	-	Potential colonization
Lark Sparrow	Potential colonization	Potential colonization
Savannah Sparrow	-	Improving
Grasshopper Sparrow	Worsening*	-
Henslow's Sparrow	-	Potential colonization
Fox Sparrow	-	Improving
Song Sparrow	Potential extirpation	Stable
Lincoln's Sparrow	-	Potential colonization
Swamp Sparrow	Potential extirpation	Improving
White-throated Sparrow	Stable	Improving
Harris's Sparrow	-	Potential colonization
White-crowned Sparrow	-	Improving

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Dark-eyed Junco	-	Worsening
Summer Tanager	Stable	-
Scarlet Tanager	Potential extirpation	-
Northern Cardinal	Improving	Improving
Rose-breasted Grosbeak	Potential extirpation	-
Blue Grosbeak	Stable	-
Indigo Bunting	Stable	-
Painted Bunting	Potential colonization	-
Red-winged Blackbird	Stable	Improving
Western Meadowlark	-	Potential colonization
Rusty Blackbird	-	Improving
Brewer's Blackbird	-	Potential colonization
Common Grackle	Worsening	Improving
Great-tailed Grackle	Potential colonization	Potential colonization
Bronzed Cowbird	-	Potential colonization
Brown-headed Cowbird	Worsening	Improving
Orchard Oriole	Worsening	-
Baltimore Oriole	Worsening	-
House Finch	Potential extirpation	Potential extirpation
Purple Finch	-	Improving
Pine Siskin	-	Improving
American Goldfinch	Potential extirpation	Worsening
House Sparrow	x	Worsening