



Delaware Water Gap National Recreation Area

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 Delaware Water Gap National Recreation Area (hereafter, the Recreation Area) 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 Recreation Area, 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 Recreation Area today, climate suitability in summer under the high-emissions pathway is projected to improve for 38 (e.g., Figure 2), remain stable for 16, and worsen for 20 species. Suitable climate ceases to occur for 44 species in summer, potentially resulting in extirpation of those species from the Recreation Area. Climate is projected to become suitable in summer for 11 species not found at the Recreation Area today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 51, remain stable for 21, and worsen for 9 species. Suitable climate ceases to occur for 13 species in winter, potentially resulting in extirpation from the Recreation Area. Climate is projected to become suitable in winter for 25 species not

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 Recreation Area based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Recreation Area 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.

found at the Recreation Area today, potentially resulting in local colonization.

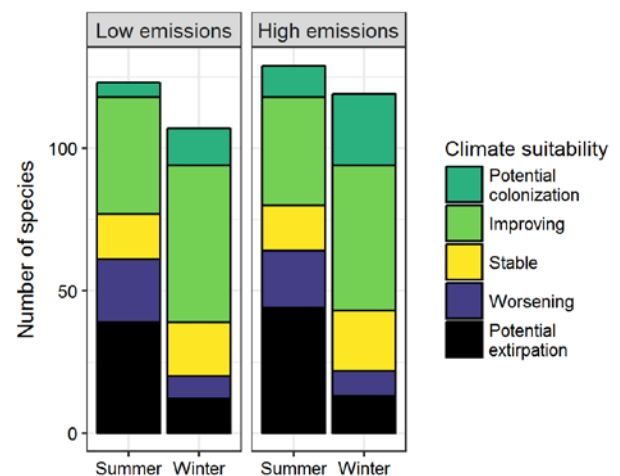


Figure 1. Projected changes in climate suitability for birds at the Recreation Area, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Recreation Area between the present and 2050 is 0.29 in summer (49th percentile across all national parks) and 0.28 in winter (43rd percentile) under the high-emissions pathway. Potential species turnover declines to 0.22 in summer and 0.22 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 Recreation Area is or may become home to 10 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.

Management Implications

Parks differ in potential colonization and extirpation rates, and therefore different climate change adaptation strategies may apply. **Under the high-emissions pathway, Delaware Water Gap National Recreation Area 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 improve habitat connectivity for birds

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

2015). While the Recreation Area may serve as an important refuge for 5 of these climate-sensitive species, 5 might be extirpated from the Recreation Area in at least one season by 2050.



Figure 2. Climate at the Recreation Area 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).

across boundaries, managing the disturbance regime, and possibly more intensive management actions. Furthermore, park managers have an opportunity to focus on supporting the 5 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 Recreation Area based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Recreation Area 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
Mute Swan	x	Potential extirpation
Wood Duck	x	Improving
Gadwall	-	Improving
American Wigeon	-	Improving*
American Black Duck	x	Worsening*
Mallard	Potential extirpation [^]	Worsening
Northern Shoveler	-	Potential colonization
Green-winged Teal	-	Potential colonization
Ring-necked Duck	-	Improving
Greater Scaup	-	Improving [^]
Lesser Scaup	-	Improving
White-winged Scoter	-	Potential extirpation
Long-tailed Duck	-	Stable

Common Name	Summer Trend	Winter Trend
Bufflehead	-	Improving
Common Goldeneye	-	Stable
Hooded Merganser	x	Improving [^]
Common Merganser	x	Worsening*
Red-breasted Merganser	-	Improving [^]
Northern Bobwhite	Improving*	Potential colonization
Ring-necked Pheasant	Potential extirpation	Potential extirpation
Wild Turkey	x	Worsening*
Common Loon	Potential extirpation	Potential colonization [^]
Pied-billed Grebe	x	Potential colonization
Double-crested Cormorant	x	Potential colonization
American White Pelican	-	Potential colonization
Great Blue Heron	Improving	Improving
Great Egret	Improving	-

Common Name	Summer Trend	Winter Trend
Green Heron	Improving	-
Black Vulture	Improving	Improving
Turkey Vulture	x	Improving*
Golden Eagle	-	Stable
Mississippi Kite	Potential colonization	-
Northern Harrier	-	Improving
Sharp-shinned Hawk	x	Improving
Cooper's Hawk	x	Stable
Northern Goshawk	-	Potential extirpation
Bald Eagle	x	Improving
Red-shouldered Hawk	Improving	Improving
Red-tailed Hawk	Improving	Stable
Rough-legged Hawk	-	Stable
American Coot	-	Potential colonization
Killdeer	Improving	Potential colonization
Upland Sandpiper	Potential colonization	-
American Woodcock	x	Improving
Bonaparte's Gull	-	Potential colonization
Ring-billed Gull	Potential extirpation^	Stable
Herring Gull	Potential extirpation	Potential extirpation^
Rock Pigeon	Worsening	Worsening
Eurasian Collared-Dove	-	Potential colonization
Mourning Dove	Improving	Improving
Yellow-billed Cuckoo	Improving*	-
Black-billed Cuckoo	Worsening	-
Barn Owl	-	Potential colonization
Eastern Screech-Owl	x	Stable
Great Horned Owl	x	Stable

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

Common Name	Summer Trend	Winter Trend
White-eyed Vireo	Improving*	-
Bell's Vireo	Potential colonization	-
Yellow-throated Vireo	Stable	-
Warbling Vireo	Stable	-
Red-eyed Vireo	Worsening	-
Blue Jay	Stable	Worsening
American Crow	Worsening	Stable
Fish Crow	Improving	Stable
Common Raven	Potential extirpation	Potential extirpation
Northern Rough-winged Swallow	Improving	-
Purple Martin	Improving*	-
Tree Swallow	Potential extirpation	-
Barn Swallow	Improving	-
Cliff Swallow	Improving	-
Carolina Chickadee	Potential colonization	Potential colonization
Black-capped Chickadee	Potential extirpation	Potential extirpation
Tufted Titmouse	Improving	Improving
Red-breasted Nuthatch	Potential extirpation	Potential extirpation
White-breasted Nuthatch	Worsening	Stable
Brown Creeper	Potential extirpation^	Stable
House Wren	Potential extirpation	-
Pacific/Winter Wren	-	Improving
Sedge Wren	-	Potential colonization
Carolina Wren	Improving	Improving
Blue-gray Gnatcatcher	Improving	-
Golden-crowned Kinglet	Potential extirpation	Improving
Ruby-crowned Kinglet	-	Improving*
Eastern Bluebird	Improving	Improving

Common Name	Summer Trend	Winter Trend
Veery	Potential extirpation	-
Swainson's Thrush	Potential extirpation	-
Hermit Thrush	Potential extirpation	Improving
Wood Thrush	Worsening	-
American Robin	Worsening	Improving
Gray Catbird	Worsening*	Stable
Brown Thrasher	Improving	Potential colonization
Northern Mockingbird	Improving	Improving
European Starling	Worsening	Stable
Cedar Waxwing	Potential extirpation	Improving
Smith's Longspur	-	Potential colonization
Snow Bunting	-	Potential extirpation
Ovenbird	Potential extirpation	-
Worm-eating Warbler	Stable	-
Northern Waterthrush	Potential extirpation	-
Blue-winged Warbler	Worsening	-
Golden-winged Warbler	Potential extirpation	-
Black-and-white Warbler	Potential extirpation	-
Prothonotary Warbler	Potential colonization	-
Kentucky Warbler	Improving*	-
Common Yellowthroat	Worsening	-
Hooded Warbler	Worsening	-
American Redstart	Potential extirpation	-
Northern Parula	Improving*	-
Magnolia Warbler	Potential extirpation	-

Common Name	Summer Trend	Winter Trend
Blackburnian Warbler	Potential extirpation	-
Yellow Warbler	Potential extirpation	-
Chestnut-sided Warbler	Potential extirpation	-
Blackpoll Warbler	Stable	-
Black-throated Blue Warbler	Potential extirpation	-
Pine Warbler	Potential extirpation^	-
Yellow-rumped Warbler	Potential extirpation	Improving
Yellow-throated Warbler	Improving*	-
Prairie Warbler	Stable	-
Black-throated Green Warbler	Potential extirpation	-
Canada Warbler	Potential extirpation	-
Yellow-breasted Chat	Improving*	-
Eastern Towhee	Stable	x
American Tree Sparrow	-	Worsening*
Chipping Sparrow	Worsening	-
Field Sparrow	Improving	Improving*
Vesper Sparrow	Potential extirpation	-
Savannah Sparrow	Potential extirpation	Potential colonization
Grasshopper Sparrow	Improving	-
LeConte's Sparrow	-	Potential colonization
Fox Sparrow	-	Improving
Song Sparrow	Potential extirpation	Improving
Lincoln's Sparrow	-	Potential colonization
Swamp Sparrow	Potential extirpation	Improving
White-throated Sparrow	Potential extirpation	Improving

Common Name	Summer Trend	Winter Trend
Harris's Sparrow	-	Potential colonization
White-crowned Sparrow	-	Improving
Dark-eyed Junco	x	Stable
Summer Tanager	Potential colonization	-
Scarlet Tanager	Worsening*	-
Northern Cardinal	Improving	Improving
Rose-breasted Grosbeak	Potential extirpation	-
Blue Grosbeak	Potential colonization	-
Indigo Bunting	Improving	-
Dickcissel	Potential colonization	-
Bobolink	Potential extirpation	-
Red-winged Blackbird	Improving	Improving
Eastern Meadowlark	Improving	Potential colonization
Rusty Blackbird	-	Improving
Brewer's Blackbird	-	Potential colonization
Common Grackle	Worsening	Improving*
Brown-headed Cowbird	Stable	Improving
Orchard Oriole	Improving*	-
Baltimore Oriole	Worsening	-
Pine Grosbeak	-	Potential extirpation
House Finch	Potential extirpation	Worsening
Purple Finch	Potential extirpation	Stable
Common Redpoll	-	Potential extirpation
Pine Siskin	Potential extirpation	Stable
American Goldfinch	Worsening	Improving
Evening Grosbeak	-	Potential extirpation

Common Name	Summer Trend	Winter Trend
House Sparrow	x	Worsening

Common Name	Summer Trend	Winter Trend
Eurasian Tree Sparrow	-	Potential colonization