



## Sleeping Bear Dunes National Lakeshore

### 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 Sleeping Bear Dunes National Lakeshore (hereafter, the Lakeshore) 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 Lakeshore, 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 Lakeshore today, climate suitability in summer under the high-emissions pathway is projected to improve for 29, remain stable for 25 (e.g., Figure 2), and worsen for 20 species. Suitable climate ceases to occur for 52 species in summer, potentially resulting in extirpation of those species from the Lakeshore. Climate is projected to become suitable in summer for 13 species not found at the Lakeshore today, potentially resulting in local colonization. Climate suitability in winter under the high-emissions pathway is projected to improve for 29, remain stable for 16, and worsen for 11 species. Suitable climate ceases to occur for 10 species in winter, potentially resulting in extirpation from the Lakeshore. Climate is projected to become suitable in winter for 47 species not found at the Lakeshore 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 Lakeshore based on both NPS Inventory & Monitoring Program data and eBird observation data (2016), plus those species for which climate at the Lakeshore 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.

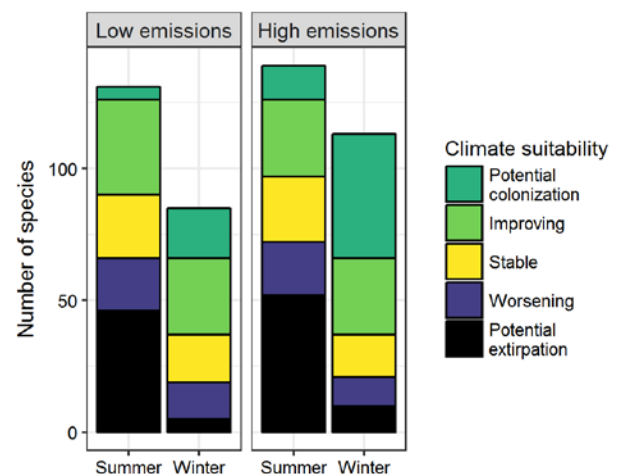


Figure 1. Projected changes in climate suitability for birds at the Lakeshore, by emissions pathway and season.

## Results (continued)

### Potential Turnover Index

**Potential bird species turnover for the Lakeshore between the present and 2050 is 0.34 in summer (60<sup>th</sup> percentile across all national parks) and 0.43 in winter (71<sup>st</sup> percentile) under the high-emissions pathway. Potential species turnover declines to 0.27 in summer and 0.27 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 Lakeshore 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).

### Management Implications

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

### 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

While the Lakeshore may serve as an important refuge for 12 of these climate-sensitive species, 6 might be extirpated from the Lakeshore in at least one season by 2050.



**Figure 2. Climate at the Lakeshore 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 12 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 Lakeshore based on both NPS Inventory & Monitoring Program data and eBird observation data, plus those species for which climate at the Lakeshore 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
Brant	-	Potential colonization
Cackling/Canada Goose	x	Improving
Mute Swan	x	Improving
Wood Duck	x	Potential colonization
Gadwall	Potential extirpation <sup>^</sup>	Improving
American Wigeon	-	Improving
American Black Duck	x	Worsening
Mallard	Worsening <sup>^</sup>	Improving
Blue-winged Teal	Potential extirpation	-
Northern Shoveler	-	Potential colonization
Green-winged Teal	-	Potential colonization
Canvasback	-	Potential colonization

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

Common Name	Summer Trend	Winter Trend
Wild Turkey	x	Worsening*
Red-throated Loon	-	Improving
Common Loon	Potential extirpation	-
Pied-billed Grebe	x	Potential colonization
Horned Grebe	-	Improving
Red-necked Grebe	-	Stable^
Double-crested Cormorant	x	Potential colonization
American Bittern	Potential extirpation	Potential colonization^
Great Blue Heron	Improving	Improving
Great Egret	Potential colonization	-
Green Heron	Improving	-
Black-crowned Night-Heron	-	Potential colonization
Turkey Vulture	x	Potential colonization
Northern Harrier	Worsening^	-
Cooper's Hawk	x	Improving
Northern Goshawk	x	Potential extirpation
Bald Eagle	x	Stable
Red-shouldered Hawk	Improving	Improving
Red-tailed Hawk	Improving	Improving
Rough-legged Hawk	-	Worsening*
Clapper Rail	-	Potential colonization
Virginia Rail	x	Potential colonization
American Coot	x	Potential colonization
Black-bellied Plover	x	Potential colonization
Semipalmated Plover	Stable	-
Killdeer	Improving	-
Greater Yellowlegs	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Willet	Stable^	-
Lesser Yellowlegs	Potential extirpation^	-
Upland Sandpiper	Worsening	-
Marbled Godwit	Potential extirpation^	-
Ruddy Turnstone	-	Potential colonization^
Dunlin	x	Potential colonization^
Wilson's Snipe	-	Potential colonization
American Woodcock	x	Potential colonization
Bonaparte's Gull	Potential extirpation	Potential colonization
Ring-billed Gull	Worsening*^	Improving
Herring Gull	Worsening	Stable^
Black Tern	Potential extirpation	-
Rock Pigeon	Stable	Worsening
Mourning Dove	Improving	Improving
Yellow-billed Cuckoo	Improving*	-
Black-billed Cuckoo	Worsening	-
Great Horned Owl	-	Potential colonization
Barred Owl	x	Stable
Common Nighthawk	Stable	-
Chimney Swift	Improving*	-
Ruby-throated Hummingbird	Stable	-
Belted Kingfisher	Potential extirpation	Improving*
Red-headed Woodpecker	Improving*	Improving
Red-bellied Woodpecker	Improving*	Improving
Yellow-bellied Sapsucker	Potential extirpation	Potential colonization
Downy Woodpecker	Stable	Improving
Hairy Woodpecker	Potential extirpation	Stable

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Northern Flicker	Potential extirpation	Improving
Pileated Woodpecker	Potential extirpation	Worsening
Olive-sided Flycatcher	Potential extirpation	-
Eastern Wood-Pewee	Stable	-
Acadian Flycatcher	Potential colonization	-
Alder Flycatcher	Potential extirpation	-
Willow Flycatcher	Stable	-
Least Flycatcher	Potential extirpation	-
Eastern Phoebe	Worsening*	-
Great Crested Flycatcher	Worsening	-
Eastern Kingbird	Worsening	-
Northern Shrike	-	Potential extirpation
White-eyed Vireo	Potential colonization	-
Bell's Vireo	Potential colonization	-
Yellow-throated Vireo	Stable	-
Warbling Vireo	Worsening	-
Red-eyed Vireo	Worsening	-
Blue Jay	Stable	Stable
American Crow	Stable	Worsening
Fish Crow	Potential colonization	Potential colonization
Common Raven	Potential extirpation	Potential extirpation
Horned Lark	Improving	Potential colonization
Northern Rough-winged Swallow	Improving	-
Purple Martin	Improving*	-
Tree Swallow	Potential extirpation	-
Barn Swallow	Improving	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Cliff Swallow	Worsening	-
Carolina Chickadee	Potential colonization	Potential colonization
Black-capped Chickadee	Potential extirpation	Worsening
Tufted Titmouse	Improving*	Improving*
Red-breasted Nuthatch	Potential extirpation	Potential extirpation
White-breasted Nuthatch	Stable	Stable
Brown Creeper	Potential extirpation^	Improving
House Wren	Stable	-
Pacific/Winter Wren	Potential extirpation	Potential colonization
Sedge Wren	Worsening	-
Carolina Wren	Improving*	Potential colonization
Blue-gray Gnatcatcher	Improving	-
Golden-crowned Kinglet	Potential extirpation	Improving
Ruby-crowned Kinglet	-	Potential colonization
Eastern Bluebird	Stable	Potential colonization
Townsend's Solitaire	-	Potential extirpation
Veery	Potential extirpation	-
Swainson's Thrush	Potential extirpation	-
Hermit Thrush	Potential extirpation	Potential colonization
Wood Thrush	Stable	-
American Robin	Worsening	Improving
Gray Catbird	Stable	Potential colonization
Brown Thrasher	Improving	-
Northern Mockingbird	Improving*	Potential colonization
European Starling	Improving	Stable

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Bohemian Waxwing	-	Potential extirpation
Cedar Waxwing	Worsening	Worsening
Snow Bunting	-	Worsening*
Ovenbird	Potential extirpation	-
Worm-eating Warbler	Potential colonization	-
Northern Waterthrush	Potential extirpation	-
Blue-winged Warbler	Stable	-
Golden-winged Warbler	Potential extirpation	-
Black-and-white Warbler	Potential extirpation	-
Nashville Warbler	Potential extirpation	-
Mourning Warbler	Potential extirpation	-
Kentucky Warbler	Potential colonization	-
Common Yellowthroat	Worsening	-
Hooded Warbler	Potential colonization	-
American Redstart	Potential extirpation	-
Northern Parula	Improving	-
Magnolia Warbler	Potential extirpation	-
Blackburnian Warbler	Potential extirpation	-
Yellow Warbler	Potential extirpation	-
Chestnut-sided Warbler	Potential extirpation	-
Black-throated Blue Warbler	Potential extirpation	-
Pine Warbler	Potential extirpation^	-
Yellow-rumped Warbler	Potential extirpation	Potential colonization

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Yellow-throated Warbler	Potential colonization	-
Prairie Warbler	Improving	-
Black-throated Green Warbler	Potential extirpation	-
Canada Warbler	Potential extirpation	-
Wilson's Warbler	Potential extirpation	-
Yellow-breasted Chat	Potential colonization	-
Eastern Towhee	Improving*	-
American Tree Sparrow	-	Stable
Chipping Sparrow	Stable	-
Clay-colored Sparrow	Potential extirpation	-
Field Sparrow	Improving*	Potential colonization
Vesper Sparrow	Stable	-
Savannah Sparrow	Potential extirpation	Potential colonization
Grasshopper Sparrow	Improving	-
Fox Sparrow	-	Potential colonization
Song Sparrow	Stable	Potential colonization
Swamp Sparrow	Potential extirpation	Potential colonization
White-throated Sparrow	Potential extirpation	-
White-crowned Sparrow	-	Potential colonization
Dark-eyed Junco	x	Improving
Scarlet Tanager	Stable	-
Northern Cardinal	Improving	Improving
Rose-breasted Grosbeak	Worsening	-
Indigo Bunting	Stable	-
Dickcissel	Improving*	-
Bobolink	Worsening*	-
Red-winged Blackbird	Stable	Improving*

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
Eastern Meadowlark	Stable	Potential colonization
Rusty Blackbird	-	Potential colonization
Brewer's Blackbird	Potential extirpation	-
Common Grackle	Improving	Potential colonization
Brown-headed Cowbird	Improving	Potential colonization
Orchard Oriole	Potential colonization	-
Baltimore Oriole	Worsening	-

<b>Common Name</b>	<b>Summer Trend</b>	<b>Winter Trend</b>
House Finch	Stable	Improving
Purple Finch	Potential extirpation	Potential extirpation
Red Crossbill	Potential extirpation <sup>^</sup>	-
Common Redpoll	-	Potential extirpation
Pine Siskin	Potential extirpation	Potential extirpation
American Goldfinch	Worsening	Stable
House Sparrow	x	Stable
Eurasian Tree Sparrow	-	Potential colonization