



Lake Meredith 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 Lake Meredith 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 26, remain stable for 44 (e.g., Figure 2), and worsen for 5 species. Suitable climate ceases to occur for 7 species in summer, potentially resulting in extirpation of those species from the Recreation Area. Climate is projected to become suitable in summer for 31 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 40, remain stable for 52, and worsen for 12 species. Suitable climate ceases to occur for 18 species in winter, potentially resulting in extirpation from the Recreation Area. Climate is projected to become suitable in winter for 50 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.

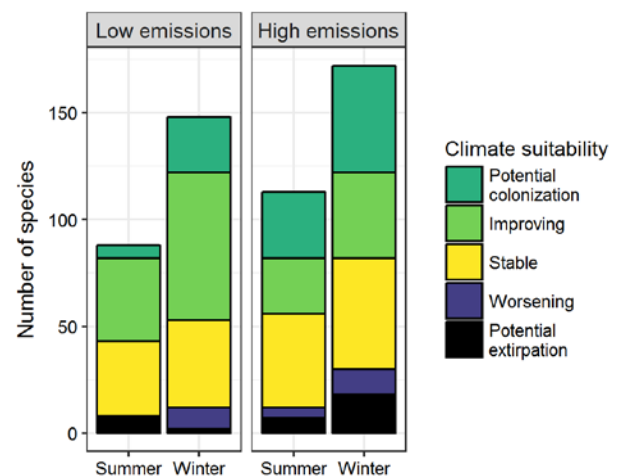


Figure 1. Projected changes in climate suitability for birds at the Recreation Area, by emissions pathway and season.

Results (continued)

Potential Turnover Index

Potential bird species turnover for the Recreation Area between the present and 2050 is 0.27 in summer (45th percentile across all national parks) and 0.25 in winter (36th percentile) under the high-emissions pathway. Potential species turnover declines to 0.13 in summer and 0.14 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 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.

Management Implications

Parks differ in potential colonization and extirpation rates, and therefore different climate change adaptation strategies may apply. **Under the high-emissions pathway, Lake Meredith National Recreation Area falls within the high potential colonization group.** Parks anticipating high potential colonization 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 16 of these climate-sensitive species, 2 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 16 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
Black-bellied Whistling-Duck	Potential colonization	-
Cackling/Canada Goose	x	Potential extirpation
Wood Duck	x	Stable
Gadwall	-	Stable
American Wigeon	-	Improving
Mallard	Potential extirpation [^]	Stable
Blue-winged Teal	Stable	Improving
Cinnamon Teal	-	Potential colonization
Northern Shoveler	Stable [^]	Improving
Northern Pintail	Potential colonization	x
Green-winged Teal	x	Improving
Canvasback	-	Improving
Ring-necked Duck	-	Improving
Greater Scaup	-	Stable [^]

Common Name	Summer Trend	Winter Trend
Lesser Scaup	-	Improving
Bufflehead	-	Improving
Common Goldeneye	-	Stable
Hooded Merganser	-	Improving [^]
Common Merganser	-	Stable
Red-breasted Merganser	-	Improving [^]
Ruddy Duck	Stable	Improving*
Scaled Quail	Stable	Stable
Northern Bobwhite	Stable	Stable
Ring-necked Pheasant	Worsening*	Potential extirpation
Wild Turkey	x	Worsening*
Red-throated Loon	-	Improving
Common Loon	-	Stable [^]
Least Grebe	-	Potential colonization
Pied-billed Grebe	x	Improving
Horned Grebe	-	Stable

Common Name	Summer Trend	Winter Trend
Eared Grebe	-	Improving*
Western Grebe	-	Stable
Clark's Grebe	-	Potential colonization
Wood Stork	Potential colonization	-
Neotropic Cormorant	-	Potential colonization
Double-crested Cormorant	x	Stable
Anhinga	Potential colonization^	-
American White Pelican	x	Stable
Great Blue Heron	Stable	Improving
Great Egret	Stable	Potential colonization
Snowy Egret	x	Potential colonization
Little Blue Heron	Potential colonization	-
Cattle Egret	Improving	-
Green Heron	Stable	-
Black-crowned Night-Heron	x	Potential colonization
Black Vulture	Potential colonization	-
Golden Eagle	-	Worsening*
Mississippi Kite	Improving*	x
Northern Harrier	Potential extirpation^	Stable
Sharp-shinned Hawk	-	Worsening
Cooper's Hawk	x	Stable
Bald Eagle	-	Potential extirpation
Harris's Hawk	Potential colonization	Potential colonization
Swainson's Hawk	Improving^	-
Red-tailed Hawk	Stable	Worsening
Ferruginous Hawk	-	Worsening*
Rough-legged Hawk	-	Potential extirpation

Common Name	Summer Trend	Winter Trend
Virginia Rail	-	Improving
Sora	-	Potential colonization
Common Gallinule	-	Potential colonization
American Coot	x	Improving
American Avocet	x	Potential colonization^
Killdeer	Stable	Improving
Spotted Sandpiper	-	Potential colonization
Greater Yellowlegs	Stable	Improving*
Lesser Yellowlegs	Stable^	Stable
Long-billed Curlew	-	Potential colonization
Dunlin	-	Improving^
Least Sandpiper	-	Improving*
Western Sandpiper	-	Potential colonization
Long-billed Dowitcher	x	Potential colonization
Wilson's Snipe	-	Improving
Wilson's Phalarope	Improving^	-
Bonaparte's Gull	-	Improving*
Franklin's Gull	Stable	-
Ring-billed Gull	Improving^	Stable
Yellow-footed Gull	-	Potential colonization
Herring Gull	-	Stable^
Forster's Tern	x	Potential colonization
Rock Pigeon	Stable	Potential extirpation
Eurasian Collared-Dove	x	Improving
White-winged Dove	Improving	Improving*
Mourning Dove	Stable	Improving
Inca Dove	Potential colonization	-

Common Name	Summer Trend	Winter Trend
Common Ground-Dove	Potential colonization	-
Yellow-billed Cuckoo	Improving	-
Greater Roadrunner	Improving*	Improving
Barn Owl	x	Stable
Eastern Screech-Owl	-	Stable
Great Horned Owl	x	Worsening
Burrowing Owl	Stable^	-
Common Nighthawk	Stable	-
Common Pauraque	-	Potential colonization
Chimney Swift	Improving	-
Ringed Kingfisher	-	Potential colonization
Belted Kingfisher	Stable	Stable
Red-headed Woodpecker	Stable	Stable
Gila Woodpecker	Potential colonization	-
Golden-fronted Woodpecker	Improving*	Stable
Red-bellied Woodpecker	Stable	Stable
Yellow-bellied Sapsucker	-	Stable
Ladder-backed Woodpecker	Improving*	Stable
Downy Woodpecker	Stable	Potential extirpation
Hairy Woodpecker	-	Potential extirpation
Red-cockaded Woodpecker	-	Potential colonization
Northern Flicker	Improving	Worsening
Gilded Flicker	Potential colonization	-
Crested Caracara	-	Potential colonization
American Kestrel	x	Stable
Merlin	-	Stable^
Peregrine Falcon	-	Potential colonization
Prairie Falcon	-	Stable

Common Name	Summer Trend	Winter Trend
Northern Beardless-Tyrannulet	Potential colonization	-
Western Wood-Pewee	Stable^	-
Dusky Flycatcher	Potential colonization	-
Black Phoebe	-	Potential colonization
Eastern Phoebe	Improving	Potential colonization
Say's Phoebe	-	Improving*
Vermilion Flycatcher	-	Potential colonization
Ash-throated Flycatcher	Improving*	-
Great Crested Flycatcher	Stable	-
Brown-crested Flycatcher	Potential colonization	-
Great Kiskadee	Potential colonization	-
Western Kingbird	Stable	-
Eastern Kingbird	Potential extirpation	-
Scissor-tailed Flycatcher	Improving*	-
Loggerhead Shrike	Stable	Improving
Northern Shrike	-	Stable
White-eyed Vireo	-	Potential colonization
Blue Jay	Stable	Stable
California/Woodhouse's Scrub-Jay (Western Scrub-Jay)	-	Potential extirpation
American Crow	Stable	Potential extirpation
Chihuahuan Raven	Improving*	Stable
Horned Lark	Potential extirpation	Worsening*
Northern Rough-winged Swallow	Improving	Potential colonization
Purple Martin	Potential colonization	-
Violet-green Swallow	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Barn Swallow	Worsening*	-
Cliff Swallow	Improving	-
Cave Swallow	Potential colonization	-
Carolina Chickadee	Stable	Improving*
Black-crested Titmouse	Potential colonization	Potential colonization
White-breasted Nuthatch	-	Potential extirpation
Pygmy Nuthatch	Potential colonization	-
Brown Creeper	-	Potential extirpation
Rock Wren	Stable	Stable
House Wren	Potential extirpation	Potential colonization
Marsh Wren	-	Stable
Carolina Wren	-	Potential colonization
Bewick's Wren	Improving	Stable
Cactus Wren	-	Potential colonization
Blue-gray Gnatcatcher	Stable	Potential colonization
Black-tailed Gnatcatcher	Potential colonization	Potential colonization
Ruby-crowned Kinglet	-	Improving
Eastern Bluebird	Stable	Worsening
Western Bluebird	-	Potential colonization
Mountain Bluebird	-	Stable
Townsend's Solitaire	-	Worsening*
Hermit Thrush	-	Stable
American Robin	Potential extirpation	Potential extirpation
Curve-billed Thrasher	Improving*	Stable
Brown Thrasher	-	Stable
Long-billed Thrasher	-	Potential colonization

Common Name	Summer Trend	Winter Trend
Bendire's Thrasher	-	Potential colonization
LeConte's Thrasher	-	Potential colonization
Crissal Thrasher	Potential colonization	-
Northern Mockingbird	Stable	Improving
European Starling	Stable	Stable
American Pipit	-	Improving*
Cedar Waxwing	-	Potential extirpation
Phainopepla	Potential colonization	-
Swainson's Warbler	Potential colonization	-
Orange-crowned Warbler	-	Potential colonization
Lucy's Warbler	Potential colonization	-
Common Yellowthroat	Potential extirpation	Potential colonization
Black-throated Gray Warbler	-	Potential colonization
Yellow-breasted Chat	Stable	-
Green-tailed Towhee	-	Potential colonization
Rufous-crowned Sparrow	x	Worsening*
Canyon Towhee	Potential colonization	Stable
Abert's Towhee	Potential colonization	-
Rufous-winged Sparrow	-	Potential colonization
Cassin's Sparrow	Worsening	-
Bachman's Sparrow	Potential colonization	Potential colonization
American Tree Sparrow	-	Potential extirpation
Chipping Sparrow	-	Improving
Field Sparrow	-	Stable
Vesper Sparrow	-	Improving*

Common Name	Summer Trend	Winter Trend
Lark Sparrow	Stable	Potential colonization
Black-throated Sparrow	-	Potential colonization
Lark Bunting	Worsening*	-
Savannah Sparrow	-	Improving
Grasshopper Sparrow	-	Potential colonization
Henslow's Sparrow	-	Potential colonization
Song Sparrow	-	Stable
Lincoln's Sparrow	-	Improving
Swamp Sparrow	-	Stable
White-throated Sparrow	-	Stable
Harris's Sparrow	-	Stable
White-crowned Sparrow	-	Improving
Dark-eyed Junco	-	Potential extirpation
Northern Cardinal	Improving*	Stable
Pyrrhuloxia	Potential colonization	-
Blue Grosbeak	Improving	-
Lazuli Bunting	Stable	-
Indigo Bunting	Stable	-
Painted Bunting	Improving*	-

Common Name	Summer Trend	Winter Trend
Dickcissel	Stable	-
Red-winged Blackbird	Stable	Stable
Eastern Meadowlark	Stable	Stable
Western Meadowlark	Worsening*	Worsening
Yellow-headed Blackbird	Improving	-
Brewer's Blackbird	-	Stable
Common Grackle	Stable	Improving
Great-tailed Grackle	Stable	Improving*
Bronzed Cowbird	Potential colonization	Potential colonization
Brown-headed Cowbird	Stable	Stable
Orchard Oriole	Stable	-
Hooded Oriole	Potential colonization	-
Bullock's Oriole	Improving*	-
Altamira Oriole	-	Potential colonization
Scott's Oriole	Potential colonization	-
House Finch	Improving	Stable
Pine Siskin	-	Potential extirpation
American Goldfinch	-	Potential extirpation
House Sparrow	x	Potential extirpation